5th Annual CMMI Technology Conference and User Group

Denver, CO

14-17 November 2005

Agenda

Monday, 14 November 2005

Tutorial Tracks

Track 1:

- Calculating CMMI-Based Return on Investment (ROI): Why, When, What, How?, Mr. Rolf W. Reitzig, Cognece, Inc.
- A Practical Guide to Implementing Levels 4 and 5, Mr. Rick Hefner, Northrop Grumman Corporation

Track 2:

- Agile/Lean Workshop, Mr. Jeffrey Dutton, Jacobs Sverdrup
- Mr. Tim Kasse, Kasse Initiatives, LLC:
  1. Leveraging ITIL Services (Suppport and Delivery) Capability and Maturity with the CMMI
  2. Service Management “A Process Led Approach”
  3. ITIL IT Infrastructure Library Overview
  4. Overview of Service Support & Service Delivery Functions
  5. Configuration Management & Change Management
  6. “Service Support” Change Management
  7. “Service Support” Configuration Management
  8. Configuration Management & Change Management ITIL - CMMI
  9. ITIL Process Maturity Self-Assessment & Action Plan

Track 3:

- The Look and Feel of a Successful CMMI Implementaiton, Mr. Tim Kasse, Kasse Initiatives, LLC
- How to Define CMMI Based Process That are Short and Usable and Using a Process Measurement Framework to Successfully Achieve Measurable Results, Mr. Timothy G. Olson, Quality Improvement Consultatnts, Inc.

Track 4:

- Using Simulation to Support Better Management Decisions, Dr. David M. Raffo, Portland State University
- Institutionalizing Resource Planning and Management Part I and Part II, Mr. Donald A. Borcherding, NexSummit, LLC

Track 5:

- The CMMI V1.2 ... A Tutorial, Mr. David M. Phillips, SEI

Track 6:

- Integrated Porject Management (IPM) - The CMMI and Collaborative Product Develop and Requirement Engineering: A Practicial Approach to Modeling and Managing Requirements, Mr. William J. Deibler, II Software Systems Quality Consulting - SSQC

Tuesday, 15 November 2005

General Sessions

LTG Joseph Yakovac, USA, Miliatry Deputy Office of the Secretary of the Army, Acquisition, Logistics & Technology

Executive Panel: "How Has CMMI Improved Our Program & Project Performance -- Or Has It?":

Mr. Mark Schaeffer, Director, Systems Engineering, OUSD(AT&L) Defense System and OSD Sponsor, CMMI
- Mr. Dev Banerjee, Division Director, Systems & Flight Engineering, Boeing Integrated Defense Systems
- Mr. John Evers, Raytheon Processes Program Manager, Raytheon Common Engineering Process Program
- Brig Gen Gary Salisbury, USAF (Ret), Executive Director Business Development, Defense Mission Systems, Northrop Grumman Mission Systems

Lunch: CMMI State of the Model, Mr. Bob Rassa, Raytheon; Mr. Clyde Chittister, SEI

Technical Sessions

Track 1: CMMI Process Improvement

- CMMI/ISO - "Can't we all just get along?", Mr. Dale R. Spaulding, The Boeing Company
- Real World Application of IEEE Software Engineering Standards to CMM/CMMI Software Process Improvement Initiatives, Ms. Susan K. Land, Norhtrop Gurmman IT/TASC
- The CMMI Product Suite and International Standards -- An Update, Mr. David H. Kitson, SEI

Track 2: Practical Guidance

- Verification in CMMI using Peer Reviews - Presentation and Paper, Ms. Jeanne H. Balsam, Georgia Tech Research Institute
- Process QA in the Information Age: Keep it Light!, Hillel Glazer, Entinex, Inc
- Defect Datat and Configuation Management, Ms. Julie E. Schmarje, Raytheon Company

Track 3: Appraisals

- Wasted Days and Wasted Nights - Leveraging Your Appraisal Team as a Resource, Dr. Timothy J. Davis, Raytheon Missile Systems
- Building a Credible SCAMPI Appraisal Representative Sample, Mr. Robert L. Moore, III., Business Transformation Institute, Inc.
- Top 10 Signs You're Ready (or Not) for an Appraisal, Mr. Gary Natwick, Harris Corporation

Track 4: ROI & Benefits of CMMI

- Measuring Performance: Evidence About the Results of CMMI, Ms. Diane Gibson, SEI
- Prioritizing Process Improvement Strategies in CMMI to Optimize Business Objectives, Dr. Aldo Dagnino, ABB, Inc. US Corporate Research
- Implementing a Plan for Controlling ROI for CMMI Process Improvement, Mr. J. M. Perry, BAE Systems
- Lessons Learned in the Engineering of Process Performance Models on the Journey to Higher Maturity Levels, Mr. Dr. Mary Anne Herndon, SAIC

Track 5: Acquisition / High Maturity

- Getting Lost on the Way to Level 5, Ms. Kathy King, The Center for Systems Management
- Understanding Why?, Mr. David N. Card, Q-Labs

Track 6: Transitioning to CMMI

- Migrating Best Practices Within an Organization: Experiences in Adapting CMMI Policies and Procedures Used in One Part of a Business to Another, Mr. Scott Sherrill, Georgia Tech Research Institute
- An Enterprise Wide CMMI Implementation at Accenture, Ms. Sarah S. Bengzon, Accenture
- Stakeholder Identification and Involvement in the CMMI, Mr. James R. Armstrong, Systems and Software Consortium
- Ensuring the Right Process is Deployed Right: Synchronizing Process Checkpoints with Business Rhythm, Ms. Joan Weszka, Lockheed Martin Corporation

Track 7: CMMI for Small Projects anhd Organizations

- Making PPQA Work on Small Projects Presentation and Paper, Ms. Jean M. Swank, Georgia Tech Research Institute
- Does Size Matter in CMMI Implementation or Was Yoda Wrong?, Mr. Paul H. Meyers, SAIC

Wednesday, 16 November 2005

Technical Sessions

Track 1: CMMI Process Improvement

- A Change Agent in a Level 1 Organization; How to Survive in a Hostile Environment, Mr. Andrew Cordes, ABB - United States Corporate Research Center
- "Sound Systems Engineering Using CMMI, Mr. Michael T. Kutch, Jr., SPAWAR - Charleston
- Using CMMI to "Dig Out" from an Ad Hoc Development?, Mr. Donald A. Borcherding, NexSummit, LLC
- Strategic Planning: Selling a CMMI-Based Improvement Effort to Senior Management, Dr. Aldo Dagnino, ABB, Inc., US Corporate Research
- Enterprise Process Intergration within the Space and Airborne Systems Business Area of Raytheon, Mrs. Deana A. Seigler, Raytheon Company
- Interpreting the CMMI: It Depends!, Mr. Rick Hefner, Northrop Grumman Corporation
- CMMI as Safeguard Against Software Entropy: A Manager's Perspective, Dr. Thomas F. Christian, Jr., 402 SMXG
- "Its how big? How will you deploy it without killing my team and my program?", Mr. William Borkowski, Jr., Raytheon Missile Systems

Track 2: Practical Guidance

- Are You Making the Most of Your Project Schedules?, Ms. Susan Byrnes, PMP, Natural SPI, Inc.

- Keeping the Team Motivated for Success and “Barrier Busting” – Obtaining Active Leadership Support, Mr. Michael D. Scott, Raytheon Missile Systems
- Using a Level 3 Process to Achieve CMMI Level 3, Mr. Stephen Ross, Raytheon Company
- Accelerating Process Improvement through Collaboratio: The NAVAIR Systems Process Improvement Community of Practice, Ms. Katie Smith, Naval Air Systems Command
- What the CMMI Doesn't Say About Training (But Should!), Sree Yellayi, Siemens Corporate Research
- CMMI CP 2.8 Interpretation and Implementation: Is This Practice Just About Numbers?, Mr. Lester Stamnas, Norausky Process Solutions, Inc.
- Creating Helpful process Directives, Mr. Kenneth I. Weinberg, Raytheon Company

Track 3: Appraisals

- Lessions Learned in Helping Large and Small Organizations Prepare for their First Appraisal, Mr. Robert J. Pomietto, Center for Systems Management
- Behind Closed Doors, Mr. Tom G. Lienhard, Raytheon Missile Systems
- CMMI Appraisal Results: The Shocking Truth Revealed and Lead Appraisers Gone Wild, Ms. Margaret A. Glover, SEI
- Improving Document Reviews for Appraisals, Mr. Kent McClurg, Raytheon Company
- Finding CMMI Compliant Artifacts and a Needle in a Haystack, Adrio J. DeCicco, Raytheon Company
- Lessons Learned and Best Practices for Evidence Collection in Preparation for a SCAMPI Appraisal, Mr. Ben Berauer, Raytheon Company
- Maximizing Value for SCAMPI(SM) Preparation, Ms. Joan Weszka, Lockheed Martin Corporation

Track 4: ROI & Benefits of CMMI

- Evaluating the Impact New Tools and Technologies Using Simulation, Dr. David M. Raffo, Portland State University
- The ROI Dashbord (c): Understanding the Benefits of CMMI, Mr. Thomas L. McGibbon, ITT Industries, AES
- Quality Assurance Involvement Compared to Program Results, Ms. Jill Brooks, Raytheon Company
- Rapidly Achieving Measurable ROI Using Early Defect Detection, Mr. Timothy G. Olson, Quality Improvement Consultants, Inc
- CMMI Process Improvement: Its not a technical problem, its a people problem, Mr. Rolf W. Reitzig, Cognence, Inc.
- A Project's Perspective of a CMMI Level 5, Mr. Warren Scheinin, Northrop Grumman Corporation
- Achieving the Promised Benefits of CMMI, Dr. Rick Hefner, Norhtrop Grumman Corporation
- Measuring Economic Benefits of Process Improvement in CMMI Level 1 Organization, Dr. Aldo Dagnino, ABB, Inc., US Corporate Research

Track 5: High Maturity

- Logarithms Can Be Your Friends: Controlling Peer Review Cost?, Dr. Richard L. W. Welch, Northrop Grumman Corporation
- Journeys on the Road to Level 5, Mr. Joseph V. Vanderville, Northrop Grumman Corporation
- Lessons Learned on the SCAMPI Road to CMMI-Software Level 5, Mr. Joseph N. Frisina, BAE Systems
- Merging Measurement in Mature Companies - A Success Story of Measurement Process Integration, Ms. Sharon Rohde, Lockheed Martin IS&S
- The Road to Process Improvement Successes: CMMI Level 5/ISO 9001-2000 Business Model, Mrs. Debra S. Roy, BAE Systems, National Security Solutions
- Reducing Variation at Each CMMI Maturity Level?, Mr. Timothy Kasse, Kasse Initiatives, LLC
- Ways to Ensure the Culture Supports Level 5, Mr. Warren Scheinin, Northrop Grumman Corporation
- Analyzing Defects Can Tell a Story About a Company?, Ms. Diane A. Mitzukami-Williams, Northrop Grumman Corporation Mission Systems

Track 6: Transition to CMMI

- Combining Six IPTS and Transitioning to CMMI, Ms. Judy Overhouser-Duett, NAVAIR
- How to Transition Models and Disciplines - Looking for Transition in all the Wrong Places, Ms. Lori G. Smailes, TYBRIN Corporation
- Using SW-SMM SQA Independent Verificaiton as a First Step for the Transition to CMMI, Mr. Alfredo N. Tsukumo, CenPRA-Centro de Pesquisas Renato Archer
- Service Extensions to the CMMI, Mr. Craig R. Hollenbach, Northrop Grumman Corporation
- Applying CMMI to Services, Mr. Juan C. Ceva, Raytheon ITSS
- Management Challenges & Lessons Learned Implementing CMMI in a Services Environment, Mr. Thomas E. Zience, BAE Systems Information Technology
- CMMI v1.1 for a Service Oriented Organization, Mr. Steven K. Hall, Raytheon Corporation

Track 7: Measurement

- Software Size Growth and Uncertainity - Both Affect Estimate Quality and Project Risk Presentation and Paper, Mr. Michael A. Ross, Galorath, Inc.
- Building an Automated System to Support Measurement in CMMI, Dr. Richard Hayden, Pragma Systems Corporation
- Team of Three - How to Get Program, Functional and Process Management Working Together, Mr. Mark A. Marsh, Raytheon Company
- Parametric Project Monitoring and Control: Performance-Based Progress Assessment and Prediction Presentation and Paper, Mr. Michael A. Ross, Galorath, Inc.
- Measuring and Estimating Process Performance, Dr. Richard D. Stutzke, SAIC

Thursday, 17 November 2005

Technical Sessions

Track 1: CMMI Process Improvement

- “Barrier Busting” – Obtaining Active Leadership Support, Mr. Michael D. Scott, Raytheon
- Don’t Write the Wrong Processes!, Ms. Suzanne B. Zampella, The Center for Systems Management

- Contrasting CMMI Contrasting CMMI and the PMBOK, Mr. Wayne Sherer, Anteon Corporation
- Being Customer Oriented, Mr. Tim Kasse, Kasse Initiatives, LLC
- Learning from Lessons Observed - Mitigating Resistance to Process Improvement, Mr. Bob Norris, National Geospatial-Intelligence Agency

Track 2: Practical Guidance

- Supplier Management Strategy Considerations with CMMI, Mr. Rick Hefner, Northrop Grumman Corporation
- Simplifying Process Tailoring To Enhance Project Execution, Mr. Howard T. Kaplan, Raytheon Company
- CMMI and agile: a High Tech R&D Success Story, Mr. Gene Miluk, SEI
- How to Incorporate “Lessons Learned” for Sustained Process Improvements, Mr. Anil K. Midha, BAE Systems
- Data Management: The Hidden Enabler or (The Key Data and Work Product Integrator), Mr. Lester Stamnas, Norausky Process Solutions

Track 3: Appraisals

- Techniques for Shortening the Time and Cost of CMMI Appraisals, Mr. Sam Fogle, Systems and Software Consortium, Inc.
- Using Classified Programs in CMMI Appraisals, Mr. Kenneth I. Weinberg, Raytheon Company
- The Best Intentions of SCAMPI V1.1: What We Meant and What Some People Heard, Mr. Will Hayes, SEI
- A Quantitative Comparison of SCAMPI A, B, and C, Mr. Dan Luttrell, Northrop Grumman Mission Systems
- Performing Consistent Appraisals in a Global Organization, Ms. Jeanine Courtney-Clark, Integrated System Diagnostics, Inc

Track 4: ROI & Benefits of CMM I / SCAMPI B/C

- The Effects of CMMI on Program Performance, Mr. Joseph P. Elm, SEI
- Squeezing Variation for Profit, Mr. Donald R. Corpron, Northrop Grumman Corporation
- Process In Execution Review (PIER) and the SCAMPI B Method, Ms. Lorraine J. Adams, SEI
- Planning a SCAMPI C Appraisal from a Strategic Perspective, Mr. John P. Kennedy, The Mitre Corporation
- Critical Path SCAMPISM Getting Real Business Results from Appraisals, Mr. Michael J. West, Natural SPI, Inc.
- Using SCAMPI C for Collective Improvement Across a Multi-Business Program, Mr. Oktawian Nowak, Motorola, Inc.

Track 5: High Maturity

- A Statistical Approach to Product Quality Assurance, mr. Randall J. Varga, BAE Systems
- The Key to a High Maturity Rating is - ORGANIZATION, Mrs. Karen M. Pelletier, Northrop Grumman Corporation
- Paladin Drives Forward To CMMI® Maturity Level 5, Mr. Victor Elias, M.S., Armament Software Engineering Center, US Army
- Business Improvements Achieving CMMI®Level 5 at SAIC: Who Keeps Moving My Process?, Ms. Sharon Cobb Flanagan, SAIC
- Extending CMMI Level 4/5 Organization Metrics Beyond Software Development, Ms. Linda R. Brooks, Northrop Grumman Corporation

Track 6: CMMI Extensions

- Capability Maturity Model Integration (CMMI®) Tailoring for an IT/MS Services Environment, Ms. Stacy Savage, BAE Systems Information Technology
- Adapting CMMI for Acquisition Organizations: A Preliminary Report, Dr. Hubert Hofmann, General Motors
- How to Become Your Customer’s Software Provider of Choice, Mr. David Herron, DCG, Inc.
- Space and Missile Systems CenteSpace and Missile Systems Center, Mr. Keith Wright, SPARTA, Inc.
- Software Outsourcing with CMMI, Dr. John W. Mishler, SEI

Track 7: Systems Engineering

- Sound Systems Engineering using CMMI®, Ms. Sandee D. Guidry, TECHSOFT
- Systems Engineering Influence Throughout the CMMI, Mr. Tim Kasse, Kasse Initiatives, LLC
- Future of System and Software Engineering Project Management and the CMMI, Dr. Kenneth E. Nidiffer, Systems and Software Consortium

NATIONAL DEFENSE INDUSTRIAL ASSOCIATION

STRENGTH THROUGH INDUSTRY & TECHNOLOGY

5th Annual

CMMI® TECHNOLOGY CONFERENCE AND USER GROUP

Conference Agenda

Sponsored by:

The National Defense Industrial Association

Systems Engineering Division

in conjunction with the

Software Engineering Institute,

Carnegie Mellon University

Carnegie Mellon
Software Engineering Institute

Event # 6110
November 14 - 17, 2005
Hyatt Regency Tech Center
Denver, CO

CMMI is registered in the US Patent & Trademark Office by Carnegie Mellon University

Sunday, November 13, 2005

12:00 PM - 4:00 PM — Atrium
Registration for Conference and Tutorial

Monday, November 14, 2005

7:00 AM - 5:00 PM — Atrium
Tutorial Registration ($200 Tutorial Fee)

7:00 AM - 8:00 AM — Atrium
Continental Breakfast (Tutorial Attendees Only)

8:00 AM - 5:00 PM — See Following Pages
CMMI Tutorial Tracks (Tutorial Attendees Only)

12:00 PM - 1:00 PM — Grand Mesa ABC
Lunch (Tutorial Attendees Only)

5:00 PM - 6:30 PM — Display Area
Reception **(All CMMI Conference Attendees)**

Tuesday, November 15, 2005

7:30 AM - 8:30 AM — Atrium
Registration and Continental Breakfast

8:30 AM - 8:45 AM — Grand Mesa DEF
Opening Remarks

8:45 AM - 9:30 AM — Grand Mesa DEF
Session A
LTG Joseph Yakovac, USA, Military Deputy, Office of the Secretary of the Army, Acquisition, Logistics & Technology

9:30 AM - 10:00 AM — Atrium
Break

10:00 AM - 12:00 PM — Grand Mesa DEF
Session B
Executive Panel - “How Has CMMI Improved Our Program & Project Performance - Or Has it?”
Moderator:
Mr. Mark Schaeffer, Director, Systems Engineering, OUSD(AT&L) Defense Systems and OSD Sponsor, CMMI

Panelists:
Mr. Dev Banerjee, Division Director, Systems & Flight Engineering, Boeing Integrated Defense Systems
Mr. John Evers, Raytheon Processes Program Manager, Raytheon Common Engineering Process Program
Brig Gen Gary Salisbury, USAF (Ret), Executive Director, Business Development, Defense Mission Systems, Northrop Grumman Mission Systems

12:00 PM - 1:30 PM — Grand Mesa ABC
Lunch
CMMI - State of the Model
Mr. Bob Rassa, Raytheon; ***Mr. Clyde Chittister***, SEI

1:30 PM - 5:00 PM
Technical Sessions — See Following Pages

3:00 PM - 3:30 PM — Display Area
Break

5:00 PM - 6:30 PM — Display Area
Reception

Wednesday, November 16, 2005

7:00 AM - 8:00 AM — Atrium
Registration and Continental Breakfast

8:00 AM - 5:00 PM — See Following Pages
Technical Sessions

9:30 AM - 10:30 AM — Display Area
Break

12:00 PM - 1:30 PM — Grand Mesa ABC
Lunch
Conference Best Paper Awards

3:00 PM - 3:30 PM — Display Area
Break

Thursday, November 17, 2005

7:00 AM - 8:00 AM — Atrium
Registration and Continental Breakfast

8:00 AM - 2:30 PM — See Following Pages
Technical Sessions

9:30 AM - 10:30 AM — Display Area
Break

12:00 PM - 1:00 PM — Grand Mesa ABC
Lunch

2:30 PM
Conference Adjourns

CMMI Tutorial Tracks - Monday, November 14, 2005

	Session A	Session B	Session C	Session D
	8:00 AM	10:15 AM	1:00 PM	3 :15 PM
Track 1 Grand Mesa D/E	1A1 *Calculating CMMI-based Return On Investment (ROI): Why, When, What, How?* *Mr. Rolf W. Reitzig, Cognence, Inc.*	1B1 *Calculating CMMI-based Return On Investment (ROI): Why, When, What, How? (con't.)* *Mr. Rolf W. Reitzig, Cognence, Inc.*	1C1 *A Practical Guide to Implementing Levels 4 and 5* *Dr. Rick Hefner, Northrop Grumman Corporation*	1D1 *A Practical Guide to Implementing Levels 4 and 5 (con't.)* *Dr. Rick Hefner, Northrop Grumman Corporation*
Track 2 Grand Mesa F	1A2 *Agile/Lean Workshop* *Mr. Jeffrey Dutton, Jacobs Sverdrup*	1B2 *Agile/Lean Workshop (con't.)* *Mr. Jeffrey Dutton, Jacobs Sverdrup*	1C2 *Leveraging ITIL Services (Support and Delivery) Capability and Maturity with the CMMI* *Mr. Tim Kasse, Kasse Initiatives, LLC*	1D2 *Leveraging ITIL Services (Support and Delivery) Capability and Maturity with the CMMI (con't.)* *Mr. Tim Kasse, Kasse Initiatives, LLC*
Track 3 Highlands	1A3 *The Look and Feel of a Successful CMMI Implementation* *Mr. Tim Kasse, Kasse Initiatives, LLC*	1B3 *The Look and Feel of a Successful CMMI Implementation (con't.)* *Mr. Tim Kasse, Kasse Initiatives, LLC*	1C3 *How to Define CMMI Based Processes That are Short and Usable* *Mr. Timothy G. Olson, Quality Improvement Consultants, Inc.*	1D3 *How to Define CMMI Based Processes That are Short and Usable (con't.)* *Mr. Timothy G. Olson, Quality Improvement Consultants, Inc.*
Track 4 Chasm Creek	1A4 *The ROI of CMMI: Using Process Simulation to Support Better Management Decisions* *Dr. David M. Raffo, Portland State University*	1B4 *The ROI of CMMI: Using Process Simulation to Support Better Management Decisions (con't.)* *Dr. David M. Raffo, Portland State University*	1C4 *Institutionalizing Resource Planning and Management* *Mr. Donald A. Borcherding, NexSummit LLC*	1D4 *Institutionalizing Resource Planning and Management (con't.)* *Mr. Donald A. Borcherding, NexSummit LLC*
Track 5 Mesa Verde	1A5 *Using a Measurement Framework to Successfully Achieve Measurable Results* *Mr. Timothy G. Olson, Quality Improvement Consultants, Inc.*	1B5 *Using a Measurement Framework to Successfully Achieve Measurable Results (con't.)* *Mr. Timothy G. Olson, Quality Improvement Consultants, Inc.*	1C5 *The CMMI V1.2 – An Update* *Mr. Mike Phillips, SEI*	1D5 *The CMMI V1.2 – An Update (con't.)* *Mr. Mike Phillips, SEI*
Track 6 Wind River	1A6 *Integrated Project Management (IPM) – The CMMI and Collaborative Product Development* *Mr. William J. Deibler, II, Software Systems Quality Consulting - SSQC*	1B6 *Integrated Project Management (IPM) – The CMMI and Collaborative Product Development (con't)* *Mr. William J. Deibler, II, Software Systems Quality Consulting - SSQC*	1C6 *Requirements Engineering: A Practical Approach to Modeling and Managing Requirements* *Mr. William J. Deibler, II, Software Systems Quality Consulting - SSQC*	1D6 *Requirements Engineering: A Practical Approach to Modeling and Managing Requirements (con't)* *Mr. William J. Deibler, II, Software Systems Quality Consulting - SSQC*

BREAK (9:45 AM) (TUTORIAL ATTENDEES ONLY)

LUNCH (12:00 PM) (TUTORIAL ATTENDEES ONLY)

BREAK (2:45 PM) (TUTORIAL ATTENDEES ONLY)

RECEPTION IN DISPLAY AREA (5:00 PM) (ALL ATTENDEES)

CMMI Technical Tracks - Tuesday, November 15, 2005

	Session/Chair	Session C	Session C	Session/Chair	Session D	Session D
		1:30 PM	2:15 PM		3:30 PM	4:15 PM
Track 1 Grand Mesa D/E	***CMMI and Process Improvement*** **Mr. Brian Gallagher, SEI**	2C1 CMMI / ISO - "Can't we all just get along?" ***Mr. Dale R. Spaulding***, The Boeing Company	2C1 Layering CMMI over ISO 9000 and BS 7799: A Case Study in Improvement ***Mr. Edwin B. Smith, III***, Hart InterCivic	***CMMI and Process Improvement con't.***	2D1 Real World Application of IEEE Software Engineering Standards to CMM® /CMMI® Software Process Improvement Initiatives ***Mr. Susan K. Land***, Northrop Grumman IT/TASC	2D1 The CMMI Product Suite and International Standards – an Update ***Mr. David H. Kitson***, SEI
Track 2 Grand Mesa F	***Practical Guidance*** **Mr. Fred Schenker, SEI**	2C2 Verification in CMMI using Peer Reviews ***Ms. Jeanne H. Balsam***, Georgia Tech Research Institute	2C2 Process QA in the Information Age: Keep it Light! ***Mr. Hillel Glazer***, Entinex, Inc.	***Practical Guidance con't.***	2D2 Defect Data and Configuration Management ***Ms. Julie E. Schmarje,*** Raytheon Company	2D2 Cancel
Track 3 Highlands	***Appraisals*** **Mr. Geoff Draper, Harris Corporation**	2C3 SEI Quality Assurance Activities for CMMI Appraisals ***Mr. Will Hayes***, Software Engineering Institute	2C3 Wasted Days and Wasted Nights - Leveraging Your Appraisal Team As A Resource ***Mr. Timothy J. Davis***, Raytheon Missile Systems	***Appraisals con't.***	2D3 Building a Credible SCAMPI Appraisal Representative Sample ***Mr. Robert L. Moore, III***, Business Transformation Institute, Inc.	2D3 Top 10 Signs You're Ready (or Not) for an Appraisal ***Mr. Gary Natwick***, Harris Corporation
Track 4 Chasm Creek	***ROI & Benefits of CMMI*** **Ms. Diane Gibson SEI**	2C4 Measuring Performance: Evidence about the Results of CMMI® ***Ms. Diane Gibson***, SEI	2C4 Prioritizing Process Improvement Strategies in CMMI to Optimize Business Objectives ***Dr. Aldo Dagnino***, ABB, Inc. US Corporate Research	***ROI & Benefits of CMMI con't.***	2D4 Implementing a Plan for Controlling ROI for CMMI® Process Improvement ***Mr. J. M. Perry***, BAE Systems	2D4 Lessons Learned in the Engineering of Process Performance Models on the Journey to Higher Maturity Levels ***Dr. Mary Anne Herndon***, Transdyne Corporation
Track 5 Mesa Verde	***Acquisition*** **Mr. Jerry Fisher, The Aerospace Corporation**	2C5 Cancel	2C5 Using CMMI to raise the capability bar within Australia ***Mr. Keith Korzec***, Defense Contract Management Agency	***High Maturity***	2D5 Getting lost on the Way to Level 5 ***Ms. Kathy King***, The Center for Systems Management	2D5 Understanding Why? ***Mr. David N. Card***, Q-Labs
Track 6 Wind River	***Transitioning to CMMI*** **Mr. Hal Wilson, Northrop Grumman Corporation**	2C6 Migrating Best Practices Within an Organization: Experiences in Adapting CMMI Policies and Procedures Used In One Part of a Business to Snother ***Mr. Scott Sherrill***, Georgia Tech Research Institute	2C6 An Enterprise Wide CMMI Implementation at Accenture ***Ms. Sarah S. Bengzon***, Accenture	***Transitioning to CMMI con't.***	2D6 Stakeholder Identification and Involvement in the CMMI ***Mr. James R. Armstrong***, Systems and Software Consortium	2D6 Ensuring the Right Process is Deployed Right: Synchronizing Process Checkpoints with Business Rhythm ***Ms. Joan Weszka***, Lockheed Martin Corporation
Track 7 Wind Star	***CMMI for Small Projects and Organizations*** **Dr. Rich Turner, OSD**	2C7 Implementing CMMI in Small Businesses: A Mission Success Approach ***Mr. James E. Jones***, Support Systems Associates, Inc.	2C7 CMMI Implementation Strategies, CMMI Level 3, A small company experience, Artifact Ideas and Implementation ***Ms. Allison J. Heinen***, Mnemonics, Inc.	***CMMI for Small Projects and Organizations con't.***	2D7 Making PPQA Work on Small Projects ***Ms. Jean M. Swank***, Georgia Tech Research Institute	2D7 Does Size Matter In CMMI Implementation or Was Yoda Wrong? ***Mr. Paul H. Meyers***, SAIC

BREAK IN DISPLAY AREA (3:00 PM - 3:30 PM)

RECEPTION IN DISPLAY AREA (5:00 PM - 6:30 PM)

CMMI Technical Tracks - Wednesday, November 16, 2005

	Session/Chair	Session A	Session A	Session/Chair	Session B	Session B
		8:00 AM	8:45 AM		10:30 AM	11:15 AM
Track 1 Grand Mesa D/E	***CMMI and Process Improvement*** **Ms. Lorraine Adams, SEI**	3A1 A Change Agent in a Level 1 Organization; How to Survive in a Hostile Environment ***Mr. Andrew Cordes***, ABB - United States Corporate Research Center	3A1 "Sound Systems Engineering Using CMMI®" ***Mr. Michael T. Kutch, Jr.***, SPAWAR - Charleston	***CMMI and Process Improvement con't.***	3B1 Using CMMI to "Dig Out" from an Ad Hoc Development ***Mr. Donald A. Borcherding***, NexSummit, LLC	3B1 Strategic Planning; Selling a CMMI-based Improvement Effort to Senior Management ***Dr. Aldo Dagnino***, ABB USCRC
Track 2 Grand Mesa F	***Practical Guidance*** **Mr. Fred Schenker, CSC**	3A2 Are You Making the Most Of Your Project Schedules? ***Ms. Susan Byrnes***, PMP, Natural SPI, Inc.	3A2 Dual-Shore Program Management Experience In Packaged Solution Development, Testing & Implementation ***Mr. Rajakumard Duraimurugan***, Infinite Computer Solutions	***Practical Guidance con't.***	3B2 Keeping the Team Motivated for Success ***Mr. Michael D. Scott***, Raytheon Missile Systems	3B2 Using a Level 3 Process to Achieve CMMI Level 3 ***Mr. Stephen Ross***, Raytheon Company
Track 3 Highlands	***Appraisals*** **Mr. Geoff Draper, Harris Corporation**	3A3 Lessons Learned in helping large and small organizations prepare for their first appraisal ***Mr. Robert J. Pomietto***, Center For Systems Management	3A3 Behind Closed Doors ***Mr. Tom G. Lienhard***, Raytheon Missile Systems	***Appraisals con't.***	3B3 CMMI Appraisal Results: The Shocking Truth Revealed ***Ms. Margaret A. Glover***, SEI	3B3 Appriasers Gone Bad ***Ms. Margaret A. Glover***, SEI
Track 4 Chasm Creek	***ROI & Benefits of CMMI*** **Dr. Dennis Goldenson, SEI**	3A4 Evaluating the Impact New Tools and Technologies Using Simulation ***Dr. David M. Raffo***, Portland State University	3A4 The ROI Dashboard (c) : Understanding the Benefits of CMMI ***Mr. Thomas L. McGibbon***, ITT Industries, AES	***ROI & Benefits of CMMI con't.***	3B4 Quality Assurance Involvement Compared to Program Results ***Ms. Jill Brooks***, Raytheon Company	3B4 Rapidly Achieving Measurable ROI Using Early Defect Detection ***Mr. Timothy G. Olson***, Quality Improvement Consultants, Inc.
Track 5 Mesa Verde	***High Maturity*** **Mr. Jerry Fisher, The Aerospace Corporation**	3A5 Logarithms Can Be Your Friends: Controlling Peer Review Costs ***Dr. Richard L. W. Welch***, Northrop Grumman Corporation	3A5 Journeys on the Road to Level 5 ***Mr. Joseph V. Vandeville***, Northrop Grumman Corporation	***High Maturity con't.***	3B5 Lessons Learned on the SCAMPI Road to CMMI-Software Level 5 ***Mr. Joseph N. Frisina***, BAE Systems	3B5 Merging Measurement in Mature Companies - A Success Story of Measurement Process Integration ***Ms. Sharon Rohde***, Lockheed Martin IS&S
Track 6 Wind River	***Transitioning to CMMI*** **Mr. Hal Wilson, Northrop Grumman Corporation**	3A6 ACncel	3A6 Combining Six IPTS and Transitioning To CMMI ***Ms. Judy Overhauser-Duett***, NAVAIR	***Transitioning to CMMI con't.***	3B6 How to Transition Models and Disciplines - Looking for Transition in all the Wrong Places ***Ms. Lori G. Smailes***, TYBRIN Corporation	3B6 Using SW-CMM SQA Independent Verification as A First Step for the Transition To CMMI ***Mr. Alfredo N. Tsukumo***, CenPRA - Centro de Pesquisas Renato Archer
Track 7 Wind Star	***Measurement*** **Mr. Jeff Dutton, Jacobs Sverdrup**	3A7 Software Size Growth and Uncertainty - Both Affect Estimate Quality and Project Risk ***Mr. Michael A. Ross***, Galorath, Inc.	3A7 COCOMO II and COQUALMO Estimation Modeling ***Mr. Qingchuan Liu***, Motorola (China) Electronics, Ltd.	***Measurement con't.***	3B7 Building an Automated System to Support Measurement in CMMI ***Dr. Richard Hayden***, Pragma Systems Corporation	3B7 Team of Three - How to get Program, Functional and Process Management Working Together ***Mr. Mark A. Marsh***, Raytheon Company

BREAK IN DISPLAY AREA (9:30 AM - 10:30 AM)

LUNCH IN GRAND MESA ABC (12:00 PM - 1:30 PM)

CMMI Technical Tracks - Wednesday, November 16, 2005

	Session/Chair	Session C	Session C	Session/Chair	Session D	Session D
		1:30 PM	2:15 PM		3:30 PM	4:15 PM
Track 1 Grand Mesa D/E	***CMMI and Process Improvement*** **Mr. Brian Gallagher, SEI**	3C1 Enterprise Process Integration within the Space and Airborne Systems Business Area of Raytheon ***Mrs. Deana A. Seigler***, Raytheon Company	3C1 Interpreting the CMMI: It Depends! **Dr. Rick Hefner**, Seimens Corporate Research	***CMMI and Process Improvement con't.***	3D1 CMMI as Safeguard Against Software Entropy: A Manager's Perspective ***Dr. Thomas F. Christian, Jr.***, 402 SMXG	3D1 "Its how big? How Will You Deploy It Without Killing My Team and My Program?" ***Mr. William J. Borkowski, Jr.***, Raytheon Missile Systems
Track 2 Grand Mesa F	***Practical Guidance*** **Mr. Paul Croll, CSC**	3C2 Accelerating Process Improvement through Collaboration: The NAVAIR Systems Process Improvement Community of Practice ***Ms. Katie Smith***, Naval Air Systems Command	3C2 What the CMMI Doesn't Say About Training (But should!) ***Mr. Sree Yellayi***, Northrop Grumman Corporation	***Practical Guidance con't.***	3D2 CMMI GP 2.8 Interpretation and Implementation: Is This Practice Just about Numbers? ***Mr. Lseter Stamnas***, Norausky Process Solutions, Inc.	3D2 Creating Helpful Process Directives ***Mr. Kenneth I. Weinberg***, Raytheon Company
Track 3 Highlands	***Appraisals*** **Mr. Geoff Draper, Harris Corporation**	3C3 Improving Document Reviews for Appraisals ***Mr. Kent McClurg***, Raytheon Company	3C3 Finding CMMI Compliant Artifacts and a Needle in a Haystack ***Mr. Adrio J. DeCicco***, Raytheon Company	***Appraisals*** **con't.**	3D3 Lessons Learned and Best Practices for Evidence Collection in Preparation for a SCAMPI Appraisal ***Mr. Ben Berauer,*** Raytheon Company	3D3 Maximizing Value for SCAMPI(SM) Preparation ***Ms. Joan Weszka***, Lockheed Martin Corporation
Track 4 Chasm Creek	***ROI & Benefits of CMMI*** **Dr. Dennis Goldenson, SEI**	3C4 CMMI Process Improvement: Its not a technical problem, its a people problem! ***Mr. Rolf W. Reitzig***, Cognence, Inc.	3C4 A Project's Perspective of CMMI Level 5 ***Mr. Warren Scheinin***, Northrop Grumman Corporation	**ROI & Benefits of CMMI *con't.***	3D4 Achieving the Promised Benefits of CMMI ***Dr. Rick Hefner***, Northrop Grumman Corporation	3D4 Measuring Economic Benefits of Process Improvement in CMMI Level 1 Organizations ***Dr. Aldo Dagnino***, ABB, Inc. US Corporate Research
Track 5 Mesa Verde	***High Maturity*** **Mr. Jerry Fisher, The Aerospace Corporation**	3C5 The Road to Process Improvement Successes: CMMI Level 5/ISO 9001:2000 Business Model ***Mrs. Debra S. Roy***, BAE Systems National Security Solutions	3C5 Reducing Variation At Each CMMI Maturity Level ***Mr. Tim Kasse***, Kasse Initiatives, LLC	***High Maturity con't.***	3D5 Ways to Ensure the Culture Supports Level 5 ***Mr. Warren Scheinin***, Northrop Grumman Corporation	3D5 Analyzing Defects Can Tell a Story About a Company ***Ms. Diane A. Mizukami-Williams***, Northrop Grumman Mission Systems
Track 6 Wind River	***CMMI Extensions*** **Mr. Randy Walters, Northrop Grumman Corporation**	3C6 Service Extensions to the CMMI ***Mr. Craig R. Hollenbach***, Northrop Grumman Corporation	3C6 Applying CMMI to Services ***Mr. Juan C. Ceva***, Raytheon ITSS	***CMMI Extensions con't.***	3D6 Management Challenges & Lessons Learned Implementing CMMI in a Services Environment ***Mr. Thomas E. Zience***, BAE Systems Information Technology	3D6 CMMI v1.1 for a Service Oriented Organization ***Mr. Steven K. Hall***, Raytheon Corporation
Track 7 Wind Star	***Measurement*** **Mr. Jeff Dutton, Jacobs Sverdrup**	3C7 Cancel	3C7 Parametric Project Monitoring and Control: Performance-Based Progress Assessment and Prediction ***Mr. Michael A. Ross***, Galorath, Inc.	***Measurement con't.***	3D7 Measuring and Estimating Process Performance ***Dr. Richard D. Stutzke***, SAIC	3D7 Cancel

BREAK IN DISPLAY AREA (3:00 PM - 3:30 PM)

ADJOURN FOR THE DAY

CMMI Technical Tracks - Thursday, November 17, 2005

	Session/Chair	Session A	Session A	Session/Chair	Session B	Session B
		8:00 AM	8:45 AM		10:30 AM	11:15 AM
Track 1 Grand Mesa D/E	***CMMI and Process Improvement*** **Mr. Brian Gallagher, SEI**	4A1 "Barrier Busting" – Obtaining Active Leadership Support ***Mr. Michael D. Scott***, Raytheon	4A1 Cancel	***CMMI and Process Improvement con't.***	4B1 Don't Waste Time Writing the Wrong Processes ***Ms. Suzanne B. Zampella***, The Center for Systems Management	4B1 Contrasting CMMI and the PMBOK ***Mr. Wayne Sherer***, Anteon Corporation
Track 2 Grand Mesa F	***Practical Guidance*** **Mr. Paul Croll, CSC**	4A2 Supplier Management Strategy Considerations with CMMI ***Dr. Rick Hefner***, Northrop Grumman Corporation	4A2 Simplifying Process Tailoring To Project Execution ***Mr. Howard T. Kaplan***, Raytheon Company	***Practical Guidance con't.***	4B2 CMMI and Agile: A High Tech R&D Success Story ***Mr. Gene Miluk***, SEI	4B2 How to Incorporate "Lessons Learned" for Sustained Process Improvements ***Mr. Anil K. Midha***, BAE Systems
Track 3 Highlands	***Appraisals*** **Mr. Geoff Draper, Harris Corporation**	4A3 Techniques for Shortening the Time and Cost of CMMI Appraisals ***Mr. Sam Fogle***, Systems and Software Consortium, Inc.	4A3 Using Classified Programs in CMMI Appraisals ***Mr. Kenneth I. Weinberg***, Raytheon Company	***Appraisals con't.***	4B3 The best intentions of SCAMPI V1.1; what we meant and what they heard ***Mr. Will Hayes***, SEI	4B3 Success the First Time: How to Get the Rating You Want or How to Fool Your Lead Appraiser ***Mr. Paul H. Meyers***, SAIC
Track 4 Chasm Creek	***ROI & Benefits of CMMI*** **Dr. Dennis Goldenson, SEI**	4A4 The Effects of CMMI® on Program Performance ***Mr. Joseph P. Elm***, SEI	4A4 Squeezing Variation for Profit ***Mr. Donald R. Corpron***, Northrop Grumman Corporation	***SCAMPI B/C***	4B4 Process In-Execution Review (PIER) for Contract Monitoring ***Ms. Lorraine J. Adams***, SEI	4B4 Planning a SCAMPI C Appraisal from a Strategic Perspective ***Mr. John P. Kennedy***, The MITRE Corporation
Track 5 Mesa Verde	***High Maturity*** **Mr. Jerry Fisher, The Aerospace Corporation**	4A5 Cancel	4A5 A Statistical Approach To Product Quality Assurance ***Mr. Randall J. Varga***, BAE Systems	***High Maturity con't.***	4B5 A Key to a High Maturity Rating is - ORGANIZATION ***Mrs. Karen M. Pelletier***, Northrop Grumman Corporation	4B5 Extending CMMI Level 4/5 Organization Metrics Beyond Software Development ***Ms. Linda R. Brooks***, Northrop Grumman Corporation
Track 6 Wind River	***CMMI Extensions*** **Mr. Randy Walters, Northrop Grumman Corporation**	4A6 Tailoring CMMI for Use in an IT Services Environment ***Ms. Stacy Savage***, BAE Systems Information Technology	4A6 Interpretation of CMMI for Outsourcing and Associated Measures ***Dr. Hubert Hofmann***, General Motors	***CMMI Extensions con't.***	4B6 How to Become Your Customer's Software Provider Of Choice ***Mr. David Herron***, DCG, Inc.	4B6 CMMI® and Process Improvement at the LA AFB Space and Missile Center (SMC) ***Mr. Keith Wright***, SPARTA, Inc.
Track 7 Wind Star	***Systems Engineering*** **Mr. Mike Phillips, HSBC**	4A7 Practical Experiences and Lessons Learned In Implementing CMMI ***Ms. Sandee D. Guidry***, TECHSOFT	4A7 Cancel	***Systems Engineering con't.***	4B7 Systems Engineering Influence Throughout the CMMI ***Mr. Tim Kasse***, Kasse Initiatives, LLC	4B7 Does Process Capability buy Product Assurance? – Implications for Safe and Secure Systems ***Mr. Paul R. Croll***, CSC

BREAK IN DISPLAY AREA (9:30 AM - 10:30 AM)

LUNCH IN GRAND MESA ABC (12:00 PM - 1:00 PM)

CMMI Technical Tracks - Thursday, November 17, 2005

	Session/Chair	Session C 1:00 PM	Session C 1:45 PM
Track 1 Grand Mesa D/E	***CMMI and Process Improvement*** **Mr. Gene Miluk, SEI**	4C1 Being Customer Oriented ***Mr. Tim Kasse***, Kasse Initiatives, LLC	4C1 Learning from Lessons Observed--Mitigating Resistance to Process Improvement ***Mr. Bob Norris***, National Geospatial-Intelligence Agency
Track 2 Grand Mesa F	***Practical Guidance*** **Lorraine Adams, SEI**	4C2 Cancel	4D2 Data Management: The Hidden Enabler or (The Key Data and Work Product Integrator) ***Mr. Lester Stamnas***, Norausky Process Solutions, Inc.
Track 3 Highlands	***Appraisals*** **Mr. Geoff Draper, Harris Corporation**	4C3 Quantitative Comparison of SCAMP A, B, and C ***Mr. Dan Luttrell***, Northrop Grumman Mission Systems	4C3 Performing standard and consistent global appraisals in large multi-cultural organizations ***Ms. Jeanine Courtney-Clark***, Integrated System Diagnostics, Inc.
Track 4 Chasm Creek	***SCAMPI B/C*** **Mr. Jerry Fisher, The Aerospace Corporation**	4C4 Critical Path SCAMPIs: Getting Real Business Results from Appraisals ***Mr. Michael J. West***, Natural SPI, Inc.	4C4 Using a SCAMPI C for Collective Improvement Across a Multi-Business Program ***Mr. Oktawian Nowak***, Motorola, Inc.
Track 5 Mesa Verde	***High Maturity*** **Mr. Andrew Boyd, Northrop Grumman Corporation**	4C5 Paladin Drives Forward to CMMI Maturity Level 5 ***Mr. Victor Elias, M.S***, Armament Software Engineering Center, US Army	4C5 Business Improvements Achieving CMMI(R) Level 5 at SAIC: Who Moved My Process? ***Ms. Sharon Cobb Flanagan***, SAIC
Track 6 Wind River	***CMMI Extensions*** **Mr. Randy Walters, Northrop Grumman Corporation**	4C6 Software Outsourcing with CMMI ***Dr. John W. Mishler***, SEI	4C6 Cancel
Track 7 Wind Star	***Systems Engineering*** **Mr. Jeff Dutton, Jacobs Sverdrup**	4C7 Future of Software Engineering Project Management and the CMMI ***Dr. Kenneth E. Nidiffer***, Systems and Software Consortium	4C7 Cancel

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Raytheon
Raytheon Networking Centric Systems
Schweitzer Engineering Labs
The Center for Systems Managment
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Institutionalizing Resource Planning and Management Part I

10-15-05

Agenda

- **Background and Problem Statement**
- **Part I: Define a Resource Management Process**
  - **Develop a Project Roadmap**
  - **Develop a Resource Plan**
  - **Monitor the Resource Plan**
- Part II: Managing the Second Project

Background

- Organization Overview
  - 40 Engineers:
    - 25 Technologists, EEs, MEs, Designers
    - 15 Software Engineers
  - Overcommitted lead to late deliveries
  - Late deliveries lead to shortcuts
  - Short Cuts lead to poor quality
  - Poor quality lead to escalations and chaos

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Background

- Qualitatively captured the common reasons why projects were 2 or more months late.
  - Captured:
    - Number of Months Late
    - Result: Schedule Delay versus Product Redesign.
  - Captured the reason(s) why the project was late in percent.

New Tool #1

Cause of Problem/Delay	Description	Percentage
Invention	Project problems and delays were due to the normal challenges of invention: “haven’t done this before”.	15%
Resources	Project problems and delays were due to not getting personnel and/or equipment when needed, resources did not have the right skill set or resources did receive necessary training.	25%
Missing Requirements	Project problems and delays were due to poorly defined requirements or requirements were missing.	15%
Added Requirements	As the project progressed, the project was delayed due to adding features to the original requirements.	15%
Requirements Not Traced	Project problems and delays were due to design and implementation tasks that deviated from the requirements during the course of the development.	0%
Development Process	Project problems and delays were due to poor development practices that resulted in unnecessary delays.	10%
Underestimating	The project complexity and/or time estimates were under estimated from the start of the project.	20%
Parts Procurement	Project problems and delays were due to parts were not ordered when they could have due to lack of documentation, BOMs or Purchasing over-sights.	0%
Vendor Selection	Project problems and delays were due to the vendor selected by either contract talks, development methods, technology and/or product delivery	0%
Interruptions	Project problems and delays were due to frequent interruptions from other projects and customer field escalations.	0%

Determine Improvements Areas

Identify 10 comm… reasons why … project is late

When a project is 2 or more … late, record the reason for …

First 3 Projects: … Problems (27%

Next 3 Projects: Resource Problems (18%)

Add improvements that … correct highest percentage. …ects: Resource … 6%)

Invention: (19%)

Record how many

Record the result:
"S" Schedule delay only
"R" Redesign required

Resource Problems	0	25	55	5	30	20	15	25	15	10	**20**
Vendor Selection	10	0	0	20	0	15	35	25	30	25	16
Invention	10	15	5	30	5	10	25	20	20	10	15
Parts Procurement	0	0	0	0	10	15	15	…	20	25	10.5
Added Requirements	20	15	5	15	…	…	…	…	…	10	10.5
Missing Requirements	20	15	5	10	…	…	…	…	…	5	7.5
Inter…	…	0	10	5	0	5	5	0	0	10	5.5
Un…	…	…	10	10	15	0	5	0	5	5	7
Pro…	…	…	10	5	0	15	0	0	0	0	6
Rec…	…	…	0	0	10	0	0	10	0	0	2
Mo…	…	…	9	4	12	4	4	6	3	3	
Result	S	S	S	S	R	S	S	R	S	S	

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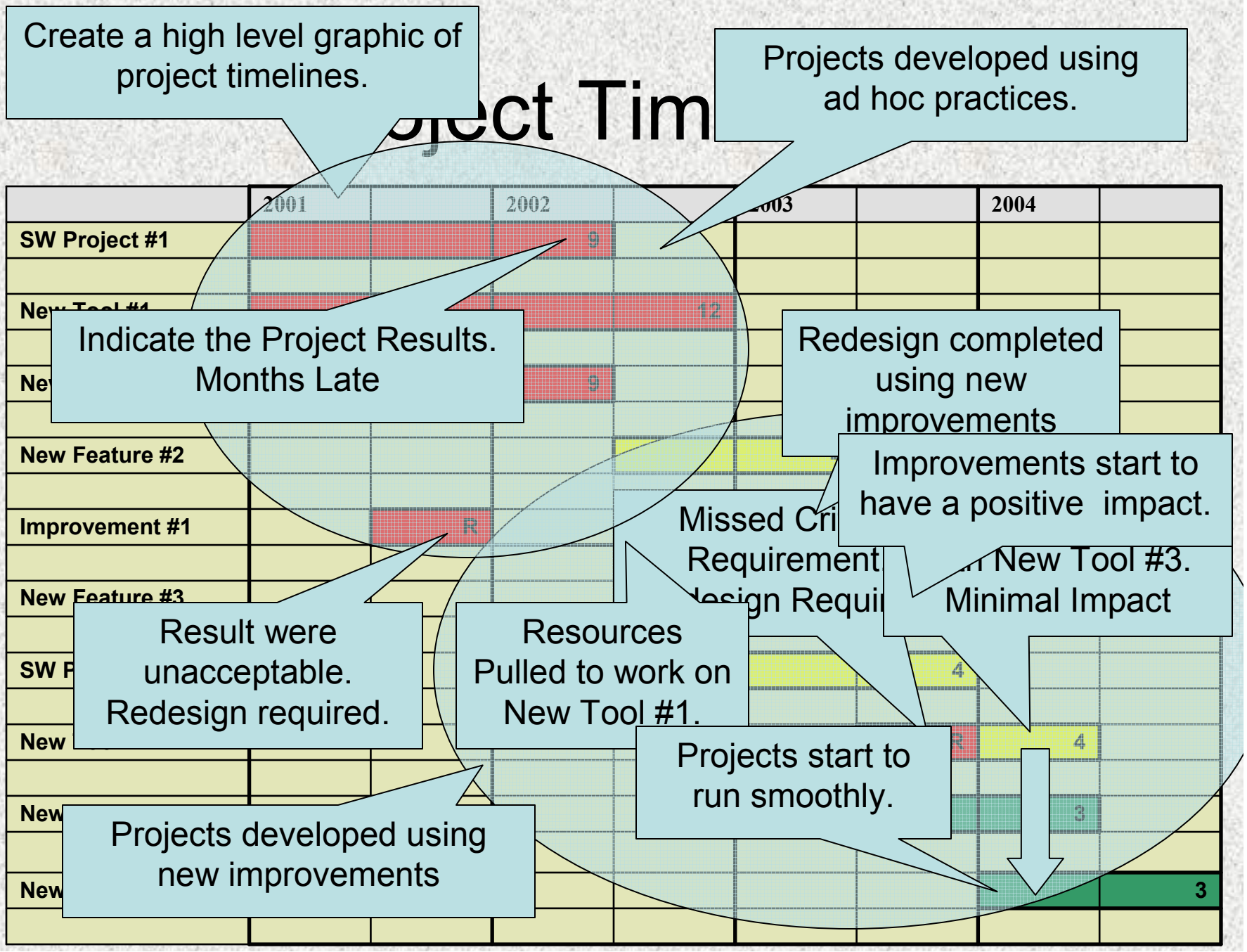
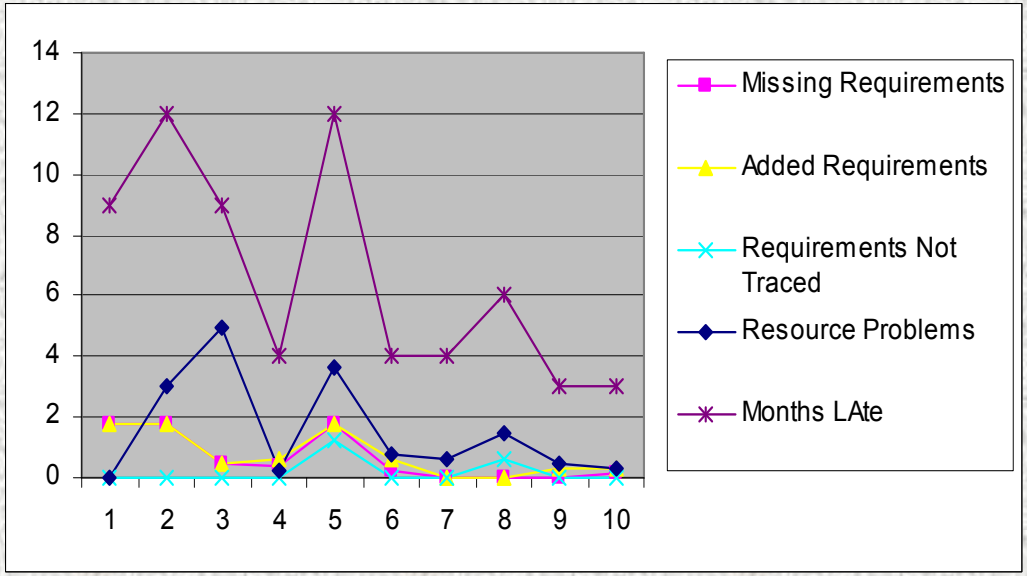


Resource Problems

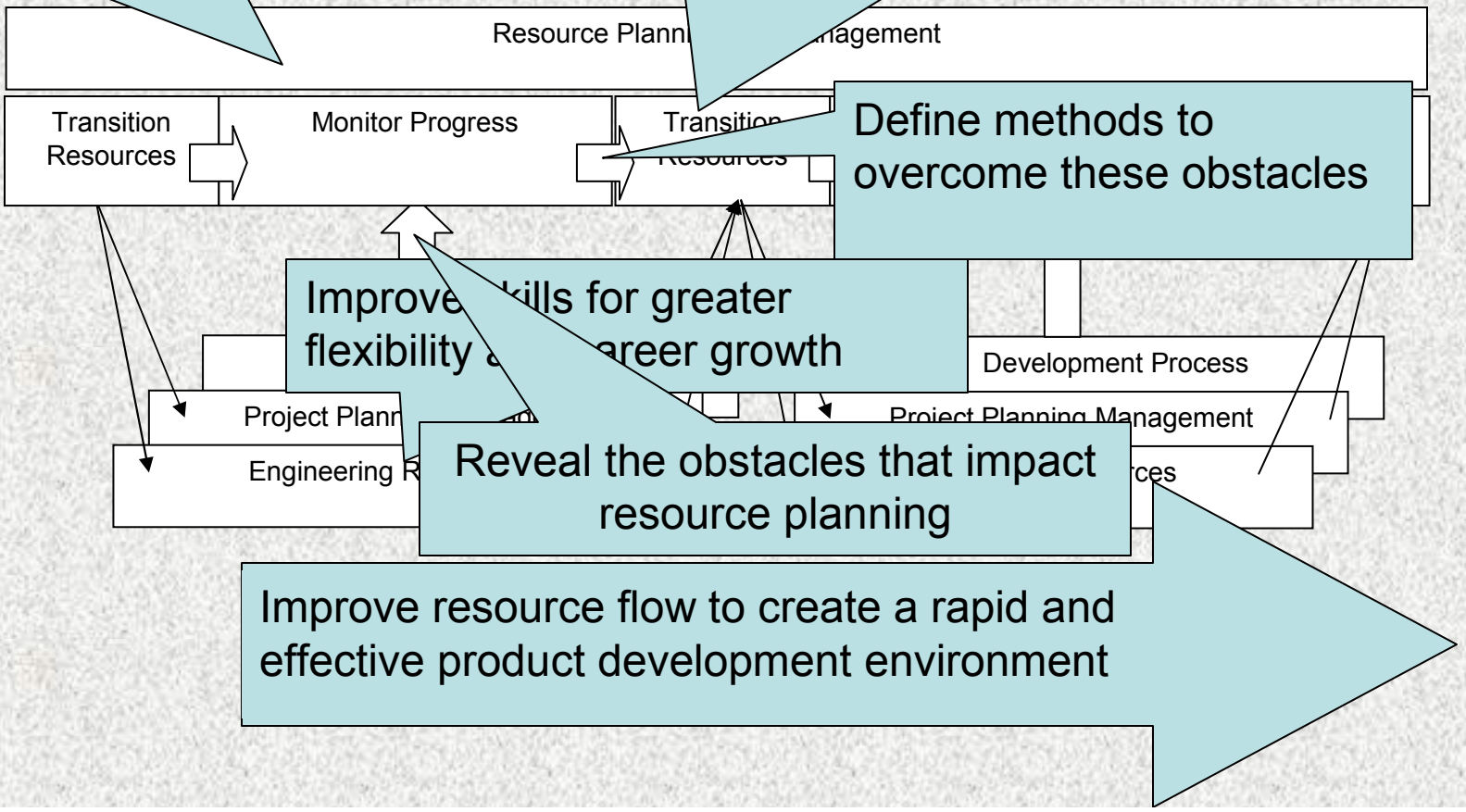
- Too Many Projects/Missing Projects
- Frequently Changing Priorities
- Wrong Skill Set/Lack of Training
- Unclear Responsibilities



A Successful Resource Management Process should…

Provide a view of all projects to and eliminate over commitment

Manage shared resources across multiple projects and product lines



Define methods to overcome these obstacles

Improve skills for greater flexibility and career growth

Reveal the obstacles that impact resource planning

Improve resource flow to create a rapid and effective product development environment

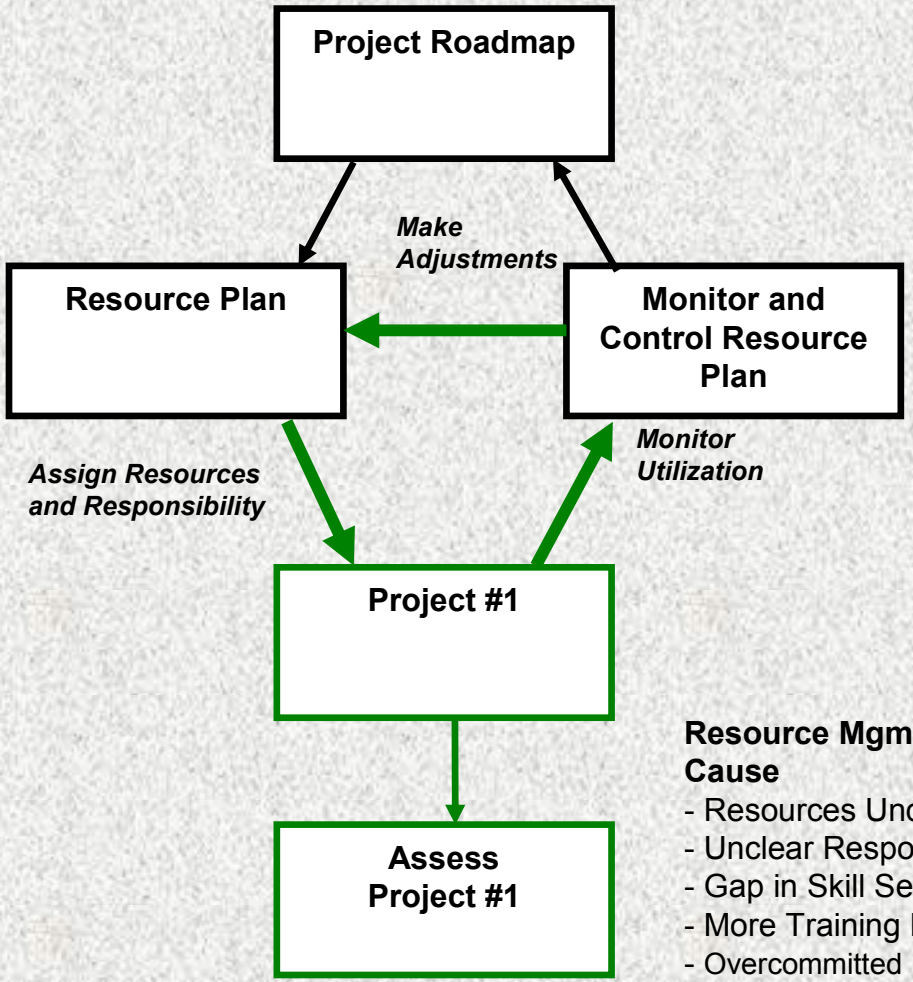
CMMI Generic Practices

- GP2.3 – Provide Resources
  - Provide adequate resources for performing the process, developing work products, and providing the services of the process.
- GP2.4 – Assign Responsibility
  - Assign responsibility and authority for performing the process, developing the work products, and providing the services of the process.
- GP2.5 – Train People
  - Train the people performing or supporting the process as needed

Common Pitfalls

- Plan Resources once a Year for Budgets
- Roll all the Project Gantt Charts up into a Master Plan

Resource Allocation and Management Process (RAMP)



Resource Mgmt - Root Cause

- Resources Underestimated
- Unclear Responsibilities
- Gap in Skill Sets
- More Training Required
- Overcommitted

Fundamentals

- Develop a Project Roadmap
  - Develop a Project List
  - Develop Project Resource Models
    - Project Planning-PA: Estimating Models
  - Develop a Project Priority List
  - Develop a Staffing Plan
  - Analyze and Validate the Roadmap

Fundamentals

- Develop the Resource Plan
  - Develop Job Descriptions
  - Develop a Skills Inventory List
    - Project Planning-PA
  - Develop Performance Models
  - Assign Names to the Roadmap
  - Analyze and Validate the Resource Plan

Develop a Project Roadmap

- Develop a Project List
  - Identify ALL the known projects and commitments and new product ideas.
    - New Product Ideas
    - New Development Projects
    - New Features
    - Sustaining Activities
    - Internal Improvement Projects
  - Identify hard and soft dates for the listed projects.

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Develop a Project Roadmap

- Develop Project Resource Models
  - Review projects conducted for the past year to establish models for typical development projects
    - Number of Months in each Development Phase
    - Number of Engineers in each phase
  - Develop Models for each Project Size
    - Category 1 – Small Correction/Improvement
    - Category 2 – New feature requiring one discipline
    - Category 3 – Medium effort with multiple disciplines
    - Category 4 – Large project, all disciplines

Develop a Project Roadmap

- Using Timesheets to Develop Resource Models
  - Time sheets indicate the total man-hours to complete the project
  - Time sheets do not indicate the project length
  - Time sheets are best used to:
    - Improve proposal estimates
    - Determine if project length is too short

Develop a Project Roadmap

- Develop a 2 Dimensional Project Priority List

		Priority = 1	Priority = 2	Priority = 3	Priority = 4	Priority = 5
Priority	**Ranked Examples**	**Product Line A**	**Product Line B**	**Product Line C**	**Product Line D**	**Product Line E**
1 – Critical	Safety Issue Quarterly Shipments					
2 – High	Customer escalation Critical Shipment Product develop – A					
3 - Medium	Non-critical Shipment Critical Obsolete Part Product develop – B					
4 - Low	Product develop – C Non-critical Obsolete Part					

- Priority List will serve as a decision making tool during development

Using EXCEL to develop a Project Roadmap

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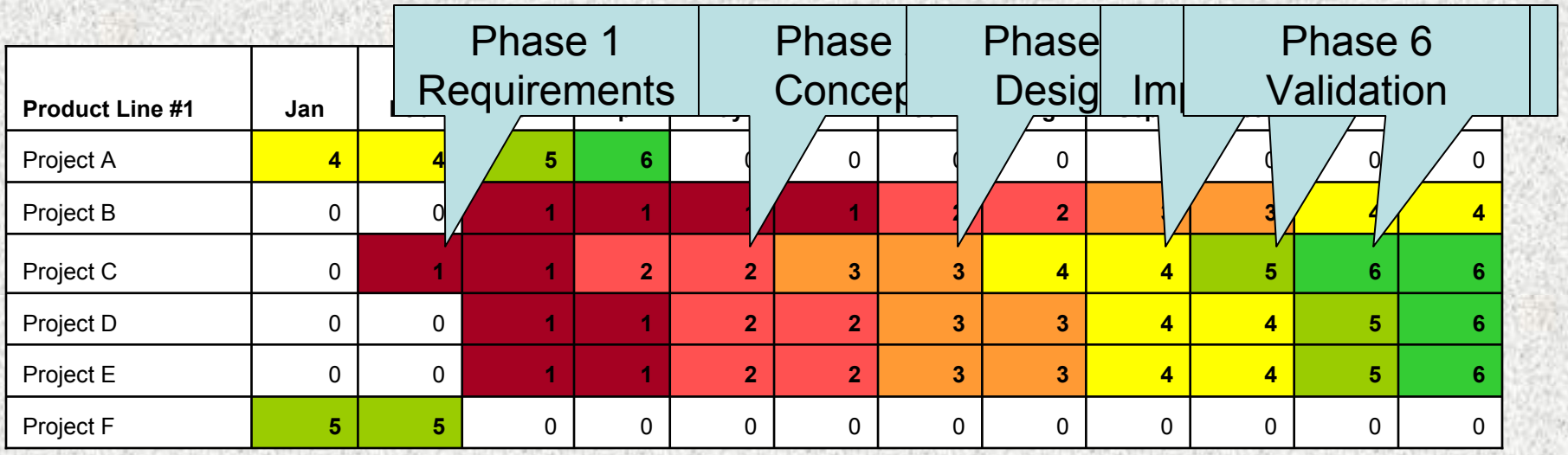
Roadmap Committee

- Background
- 6 Members
- Manual Planning – EXCEL
  - Captured the project length – One cell per month
  - A Phase number was placed in cells (1 through 6)
  - Each Cell with a Phase Number was colored (Red through Green)

Roadmap Committee

Manual Roadmap



Product Line #1	Jan											
Project A	4	4	5	6	0	0	0	0		0	0	0
Project B	0	0	1	1	1	1	2	2	3	3	4	4
Project C	0	1	1	2	2	3	3	4	4	5	6	6
Project D	0	0	1	1	2	2	3	3	4	4	5	6
Project E	0	0	1	1	2	2	3	3	4	4	5	6
Project F	5	5	0	0	0	0	0	0	0	0	0	0

Roadmap Committee

- Problems Encountered
  - Many discussions with actions for next meeting
  - The Roadma[illegible]aintain
  - The Roadmap was difficult to validate
  - The Roadmap was too aggressive and didn't match project estimates

THERE MUST BE A BETTER WAY!

Roadmap Tools

- Develop a viable plan before resources are actually assigned to projects
  - Avoid Over-committing
  - Not Just Graphics but be tied to actual resources
- Easy to Understand
  - Important during kick-off
  - Important for monthly or quarterly reviews
- Easy to Change
  - Ideally: Develop roadmap to drive projects
  - Real life: Every project continues while Roadmap is being developed
  - Goal: Short implementation and approval cycle

EXCEL Roadmap

- Automated EXCEL Spreadsheet
  - Real-time Feedback
  - Real-time Decision Making
  - Very Good Charts and Graphs
- Recommended Tabs
  - Roadmap
  - Resource Targets for each Discipline
    - Systems, SW, EE, ME, etc..
  - Total Staffing
  - Project Summaries

Roadmap Worksheet

- Phase Definition
  - Phase 1: Requirements Phase
  - Phase 2: Concept Phase
  - Phase 3: Design Phase
  - Phase 4: Implementation/Verification
  - Phase 5: Integration/Verification
  - Phase 6: Validation /Product Transfer

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Roadmap Worksheet

Project Priorities are used to determine Project Start Dates

Project List and Roadmap

Product Line #1	Jan		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Project A	4	4	5	6	0	0	0	0	0	0	0	0
Project B	0	0	1	1	1	1	2	2	3	3	4	4
Project C	0	1	1	2	2	3	3	4	4	5	6	6
Project D	0	0	1	1	2	2	3	3	4	4	5	6
Project E	0	0	1	1	2	2	3	3	4	4	5	6
Project F	5	5	0	0	0	0	0	0	0	0	0	0

Roadmap Setup

Setup	
Start	Phase
1	0
3	1
2	1
3	1
3	1
1	5

Phase Length					
1	2	3	4	5	6
0	0	0	2	1	1
2	2	2	2	1	2
2	2	2	2	1	2
2	2	2	2	1	2
2	2	2	2	1	2
2	2	2	2	2	0

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Resource Targets Worksheet

Category 3

Category

Category 1

ce Model for Each Discipline

Product Line #1	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6
Project A	1.00	1.50	2.00	2.00	1.00	1.00
Project B	1.00	1.50	2.00	2.00	1.00	1.00
Project C	1.00	1.00	1.00	1.00	1.00	0.50
Project D	1.00	1.00	1.00	1.00	1.00	0.50
Project E	1.00	1.00	1.00	1.00	1.00	0.50
Project F	0.50	0.50	0.50	0.50	1.00	0.50
Project G	1.00	1.00	1.00	1.00	1.00	0.50

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Resource Targets Worksheet

Assign a Model to a Project by entering a "1"

Assigning a Model to a Project

Product Line #1	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	D…	EE
Project A	2.00	2.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

Electrical Engineering Model (Fixed)

Product Line #1	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6
Project A	1.00	1.50	2.00	2.00	1.00	1.00

Project Roadmap (Fixed)

Product Line #1	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Project A	4	4	5	6	0	0	0	0	0	0	0	0

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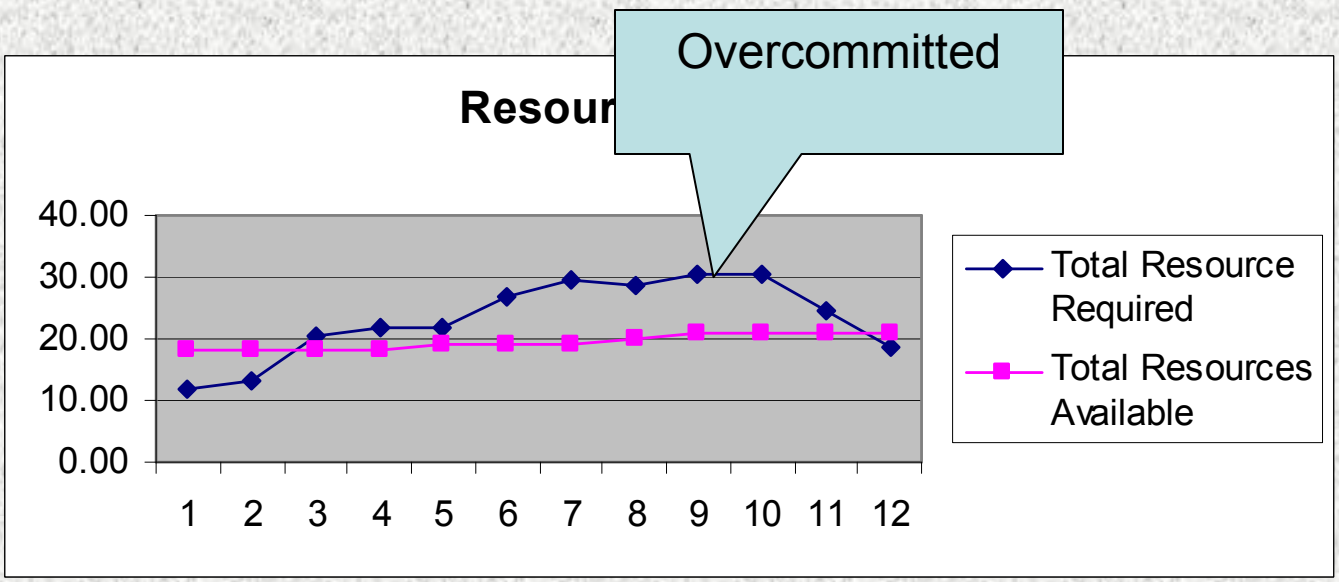
Resource Targets Worksheet

. EE Resource Plan for Product Line #1

Product Line #1	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	EE
Project A	2.00	2.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1
Project B	0.00	0.00	0.50	0.50	0.50	0.50	1.50	1.50	2.00	2.00	2.00	2.00	1
Project C	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.50	0.50	1
Project D	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.50	1
Project E	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.50	1
Project F	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	1
TOTAL	3.0	4.0	4.5	4.5	3.5	3.5	3.5	4.5	5.0	5.0	4.5	3.5	

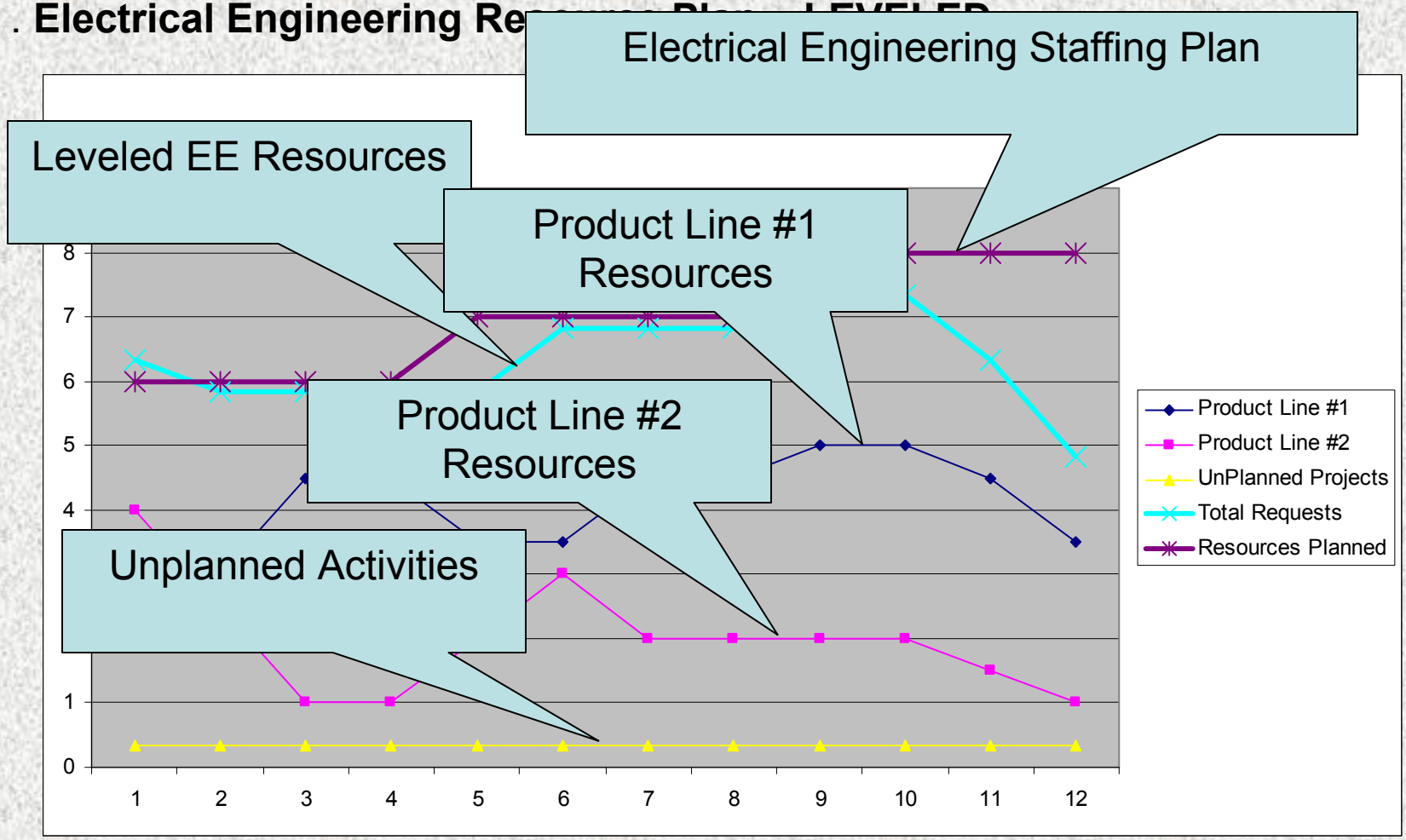
Total Staffing Plan

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Electrical Engineering	6	6	6	6	7	7	7	7	8	8	8	8
Mechanical Engineering	2	2	2	2	2	2	2	2	2	2	2	2
Software Engineering	9	9	9	9	9	9	9	10	10	10	10	10
Project Management	1	1	1	1	1	1	1	1	1	1	1	1
Total Resources Available	**18**	**18**	**18**	**18**	**19**	**19**	**19**	**20**	**21**	**21**	**21**	**21**



Leveling the Roadmap

. **Electrical Engineering Re**



Analyzing the Roadmap

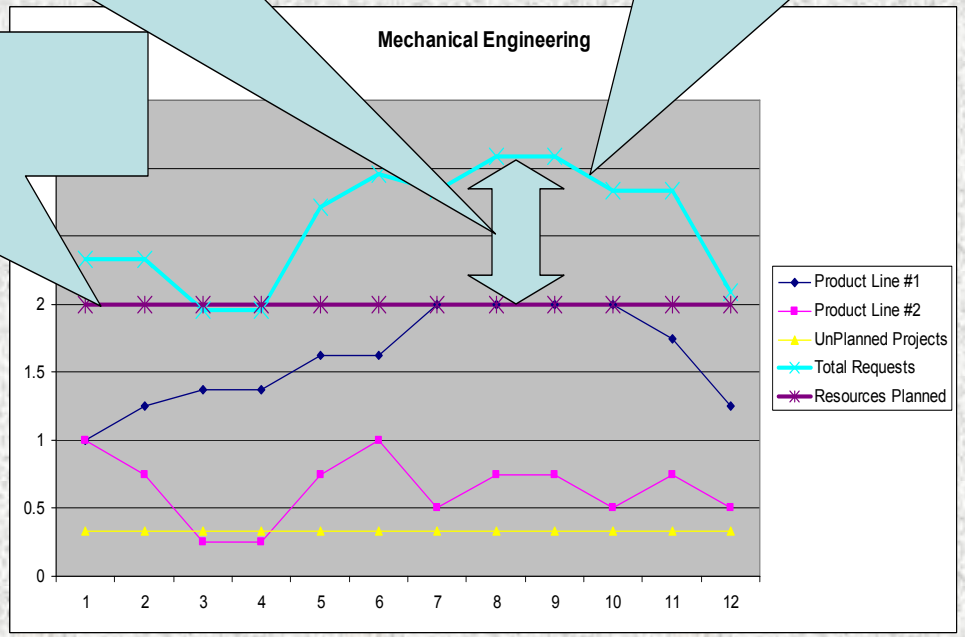
- Resolving Over-commitment

Resources required determined by integrating:
- Roadmap
- Resource Models
- Priority List

NEGOTIATE

Current Headcount

- Ad
- Adjust the Roadmap
  - Remove Projects
  - Remove Features
  - Change Deadlines
- Outsource
- Adjust Models



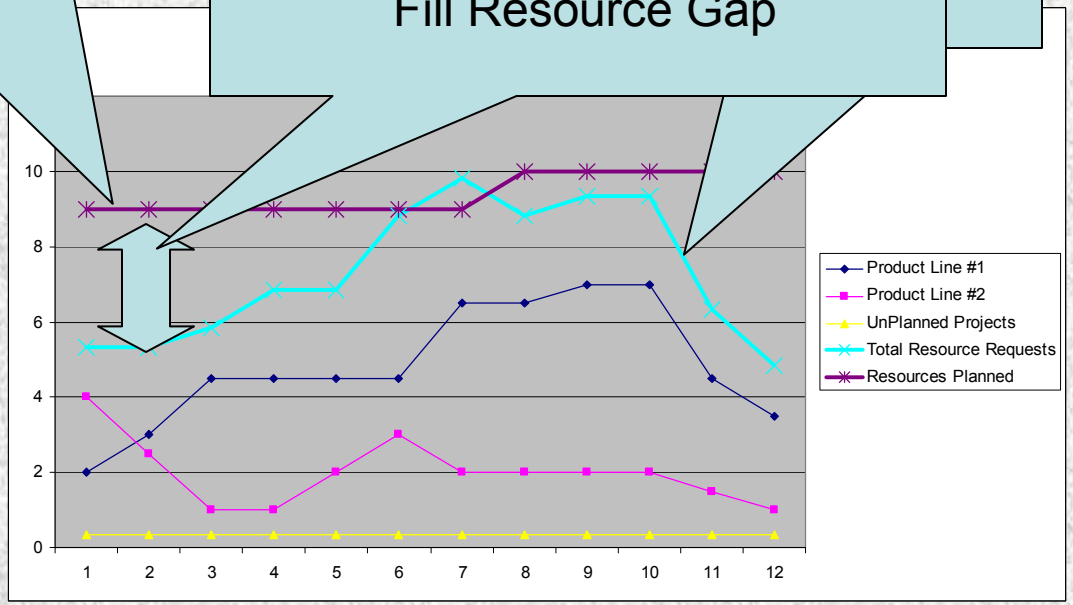
Analyzing the Roadmap

- Resolving Under-Utilization
  - rs
- Add Projects
  - New Features
  - New Products
- Training
- Process Improvements
- Adjust Models

Resources required determined by integrating:
- Roadmap
- Resource Models
- Priority List

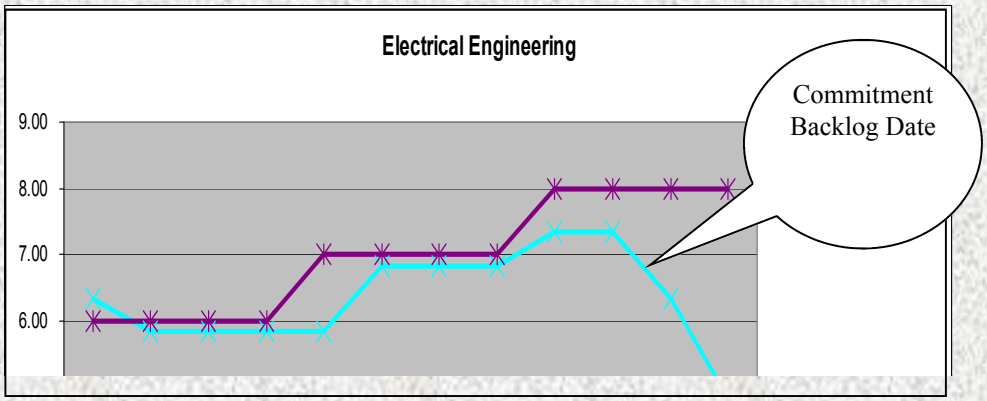
Current Staffing Plan

Fill Resource Gap



Analyzing the Roadmap

- Validate Commitments
  - Determine the Backlog
  - Determine the “Commitment Backlog Date (CBD)”
  - Convey “CBD” on a regular basis



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Project Summaries

- Roll-up of all resources by project

Product Line #1	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Project A	2.00	2.00	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Project B	0.00	0.00	2.00	2.00	2.00	2.00	6.00	6.00	8.00	8.00	8.00	8.00
Project C	0.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	4.00	2.00	2.00
Project D	0.00	0.00	4.00	4.00	4.50	4.50	5.00	5.00	5.00	5.00	4.00	2.00
Project E	0.00	0.00	4.00	4.00	4.50	4.50	5.00	5.00	5.00	5.00	4.00	2.00
Project F	2.00	2.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total Product #1 Resources	4	8	16	16	15	15	20	20	22	22	18	14

Develop a Resource Plan

- Develop Job Descriptions
- Develop a Skills Inventory List
- Develop Performance Models
- Assign Names to the Roadmap
- Analyze and Validate the Resource Plan

Develop a Resource Plan

- Develop Job Descriptions
  - Develop Job Titles
    - Engineer 1, 2, 3, 4
    - Associate, Engineer, Sr. Engineer, Principal
  - Develop Requirements for each Engineering Level
  - Assign a Job Title to each Resource

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Develop a Resource Plan

- Develop a Skills Inventory List
  - Define a skills list for each discipline
  - Identify the skills of each Engineer (X)
  - Rate the Engineer's skill level (1-4)
  - Evaluate each Engineer's skill with respect to their job title
- Set Expectations and Career Growth

Develop a Resource Plan

Skills Inventory List Example

	Systems Engineer III	Electrical Engineer III	Electrical Engineer II	Electrical Engineer II	Mechanical Engineer II	Firmware Engineer II	PCB Designer II
Requirements Development	3	2	2	2	2	3	2
Design Spec Development	3	3	3	2	2	3	2
System Architecture	3	2	2	2	1	2	1
Single Processor Design	4	3	3	3	1	4	2
Multiprocessor Design	3	2	2	2	1	1	1
PLD (ABEL)	2	3	2	2	1	1	1
FPGA/CPLD (Schematics)	2	3	3	3	1	1	1
FPGA/CPLD (Verilog)	1	1	1	1	1	1	1
Digital Design	3	4	3	2	1	3	3

Develop the Resource Plan

- Assign Names to the Project Roadmap to create a Resource Plan
  - Use the Skills Inventory List to Assign Alternate Resources to the Resource Plan
  - Evaluate the resource assignments with the resource requirements of the Roadmap

Using EXCEL to Develop a Resource Plan

EXCEL Resource Plan

- An EXCEL spreadsheet should be developed for each discipline
- Recommended Tabs
  - Resource Requests (Targets)
  - Resource 1 through “n”
  - Staffing Plan
  - Project Assignments

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Resource Requests

- Links to the Resource Targets from the Roadmap

Product Line #1	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	
Project A	2.00	2.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	
Project B	0.00	0.00	0.50	0.50	0.50	0.50	1.50	1.50	2.00	2.00	2.00	2.00	
Project C	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.50	0.50	
Project D	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.50	
Project E	0.00	0.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	0.50	
Project F	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	

Resource Requests | Project Assignments | Resource 1 | Resource 2 | Resource 3 | Resource n

Resource 1 through “n” Worksheet

- A Separate Tab for Each Resource that includes:
  - Resource Assignment Table
    - Table to indicate whether the resource has been assigned to the Roadmap Projects
  - Individual Performance Model
    - Models the individual skills to each project phase
    - Can be Job Title based or unique for each Engineer

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Resource 1 Worksheet

Project A starts at Phase 4

Assign This resource to a Project by entering a "1"

Resource Assi

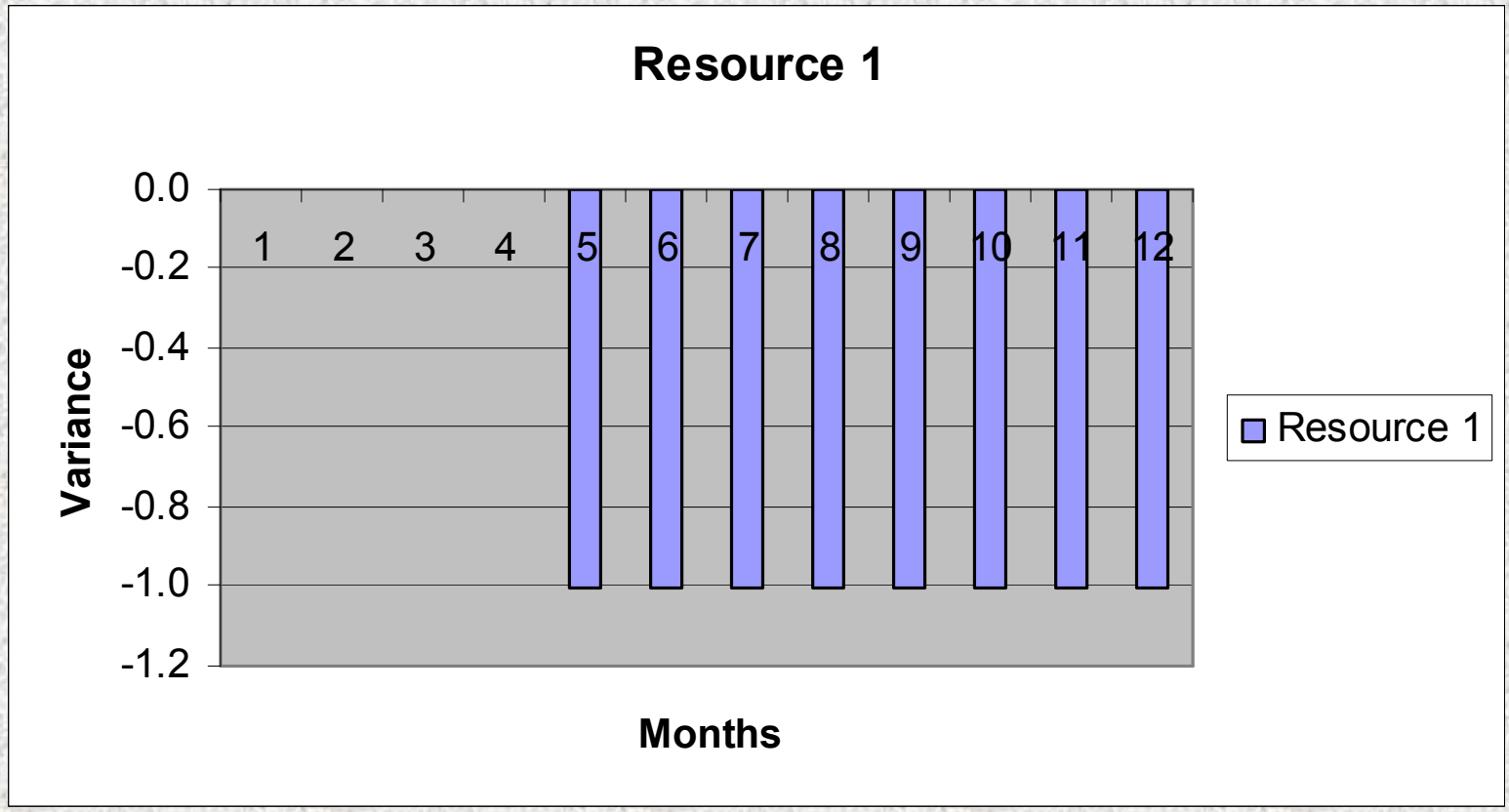
Product Line #1	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Assigned	Perf Model
Project A	1	1	1	1	0	0	0	0	0	0	0	0	1	2
Project B	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Project C	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Project D	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Project E	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Project F	0	0	0	0	0	0	0	0	0	0	0	0	0	2
Project G	0	0	0	0	0	0	0	0	0	0	0	0	0	2

Individual Performance Model

Model	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6
Engineer 1	0.00	0.00	1.00	1.00	1.00	1.00
Engineer 2	1.00	1.00	1.00	1.00	1.00	1.00
Engineer 3	1.00	1.00	0.25	0.25	0.25	0.10
Engineer 4	0.10	0.10	0.10	0.10	0.10	0.10

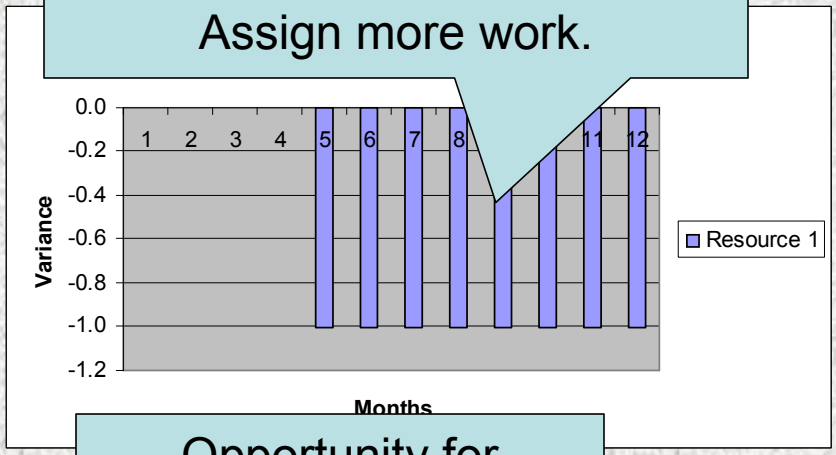
Resource 1 Worksheet

- Use EXCEL Chart Wizard to Level Resources

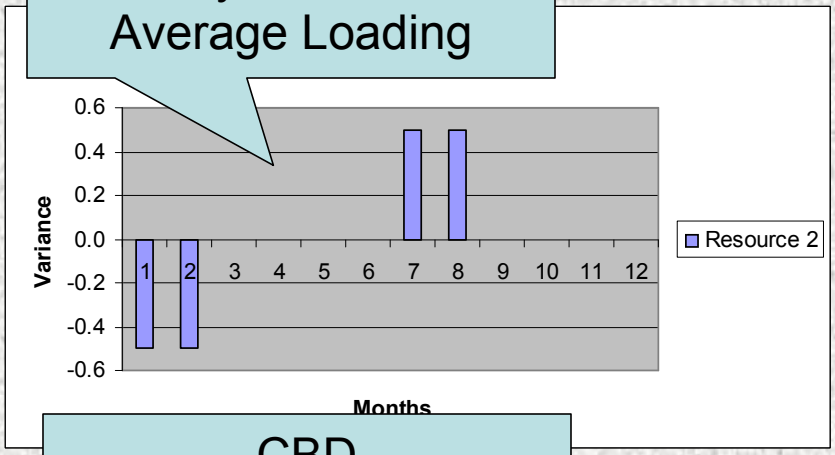


Analyze Loading on each Resource

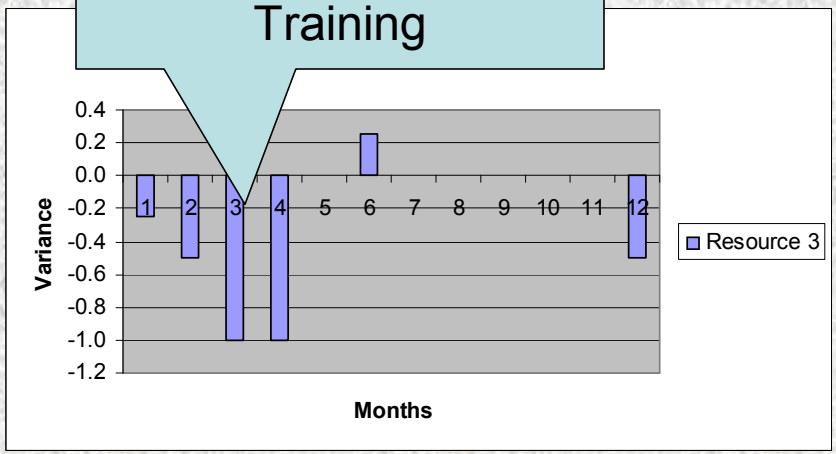
Under-utilized
Assign more work.



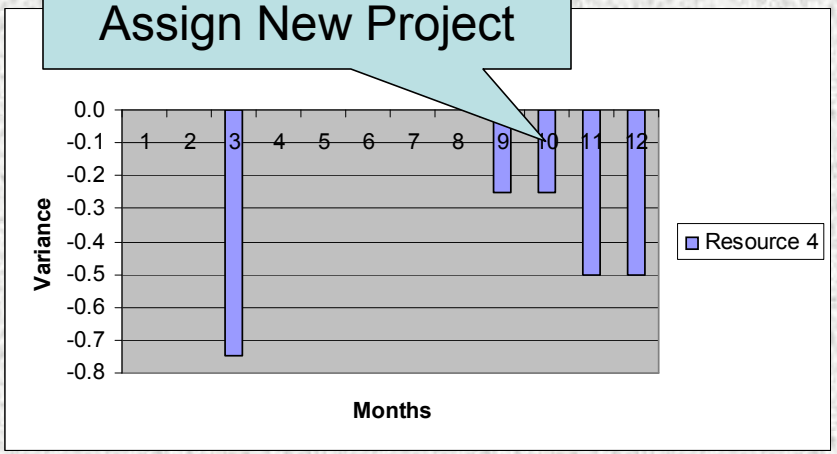
Probably OK based on
Average Loading



Opportunity for
Training



CBD
Assign New Project



Staffing Plan

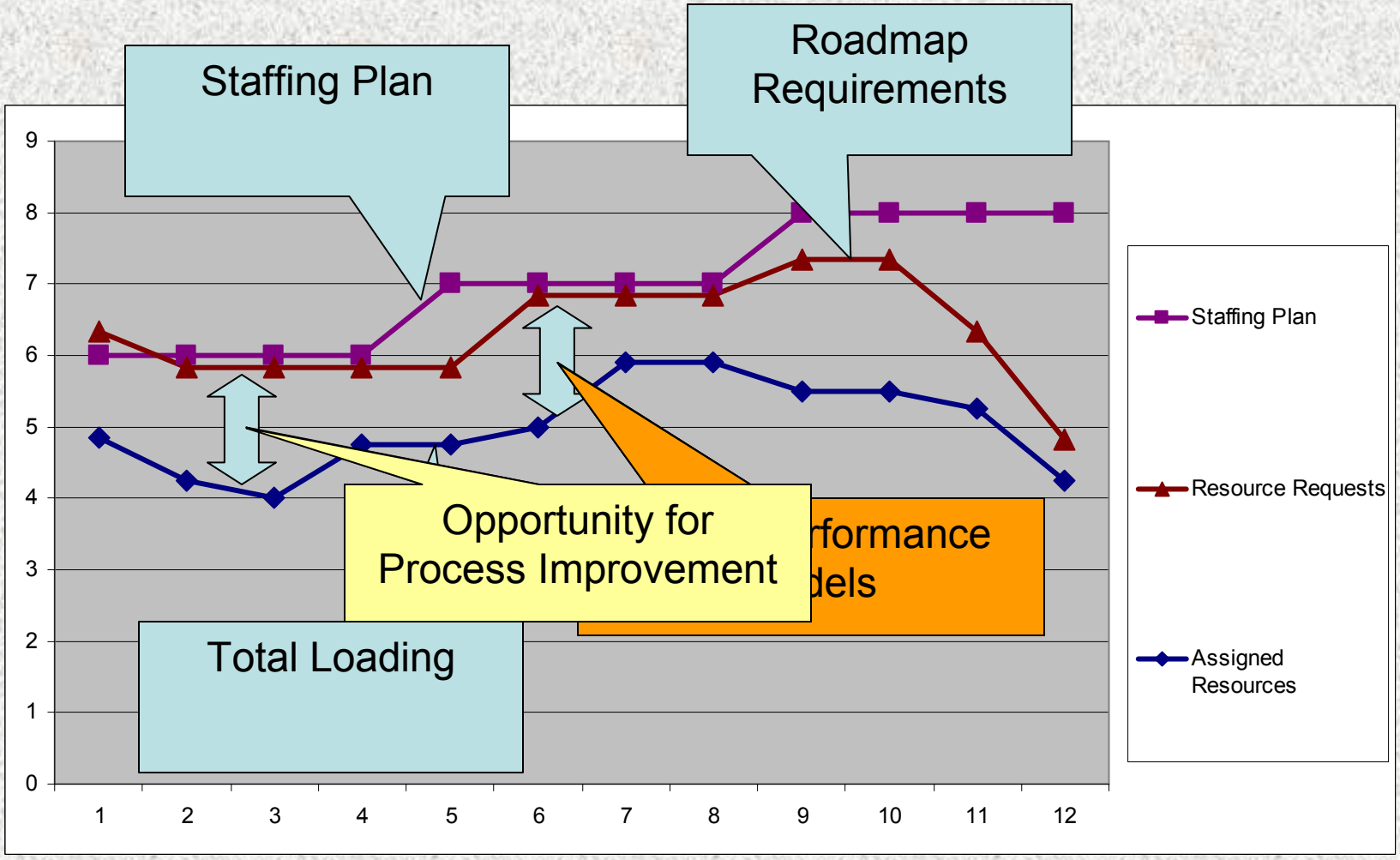
- This is the Current Headcount and Hiring Plan for the Year
- Can be linked to the Roadmap when leveling

						Jun	Jul	Aug	Sep	Oct	Nov	Dec
Resource 1					1	1	1	1	1	1	1	1
Resource 2	1	1			1							1
Resource 3	1	1	1		1							1
Resource 4	1	1	1		1							1
Resource 5	1	1	1		1	1	1	1		1	1	1
Resource 6	1	1	1	1	1	1	1	1		1	1	1
Resource 7	0	0	0	0	1	1	1	1	1	1	1	1
Resource 8	0	0	0	0	0	0	0	0	1	1	1	1
Resource 9	0	0	0	0	0	0	0	0	0	0	0	0
Resource “n”	0	0	0	0	0	0	0	0	0	0	0	0
Staffing Plan	**6**	**6**	**6**	**6**	**7**	**7**	**7**	**7**	**8**	**8**	**8**	**8**

Hire a new Engineer in May

Hire a new Engineer in September

Analyze Loading to the Roadmap



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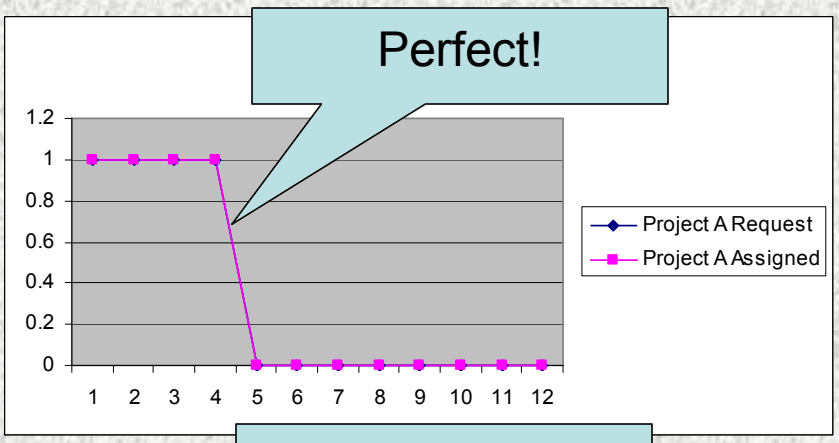
Project Assignments

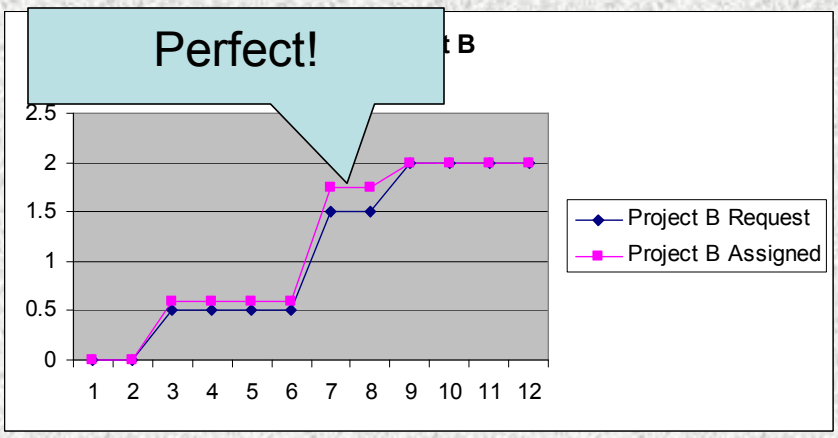
- Summary of the total resources assigned to the project

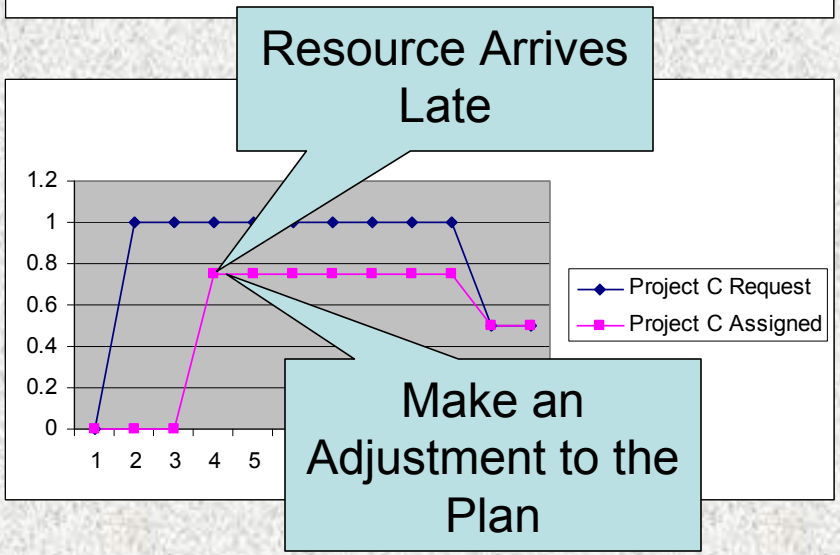
Resource 1

Product Line #1	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Project A	1	1	1	1	0	0	0	0	0	0	0	0
Project B	0	0	0.6	0.6	0.6	0.6	1.75	1.75	2	2	2	2
Project C	0	0	0	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.5	0.5
Project D	0	0	1	1	1	1	1	1	1	1	1	0.5
Project E	0	0	0	0	0.75	0.75	0.75	0.75	0.75	0.75	0.75	0.5
Project F	1.25	1.25	0	0	0	0	0	0	0	0	0	0
Total	**2**	**3**	**4.5**	**4.5**	**3.5**	**3.5**	**4.5**	**4.5**	**5**	**5**	**4.5**	**3.5**

Analyze Project Coverage







Monitoring the Resource Plan

- Maintain the Resource Plan based upon Project Execution
  - Resource Plan should drive Projects
  - Real-time Feedback
- Frequency
  - Monthly Goals (ACTIVE)
  - Weekly Progress Reviews (PASSIVE)
  - Quarterly Updates and Management Reviews

Monthly Goals

Review Progress and Update Roadmap - MARCH

Product Line #1	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Project A	4	4	4	5	6	0	0	0	0	0	0	0
Project B	0	0	1	1	1	1	2	2	3	3	4	4
Project C	0	1	1	2	2	3	3	4	4	5	6	6
Project D	0	0	1	1	2	2	3	3	4	4	5	6
Project E	0	0	1	1	2	2	3	3	4	4	5	6
Project F	5	5	5	0	0	0	0	0	0	0	0	0

Setup	
Start	Phase
1	4
3	1
2	1
3	1
3	1
1	5

Phase Length					
1	2	3	4	5	
0	0	0	3	1	1
2	2	2	2	2	
2	2	2	2	1	
2	2	2	2	1	
2	2	2	2	1	
2	2	2	2	3	0

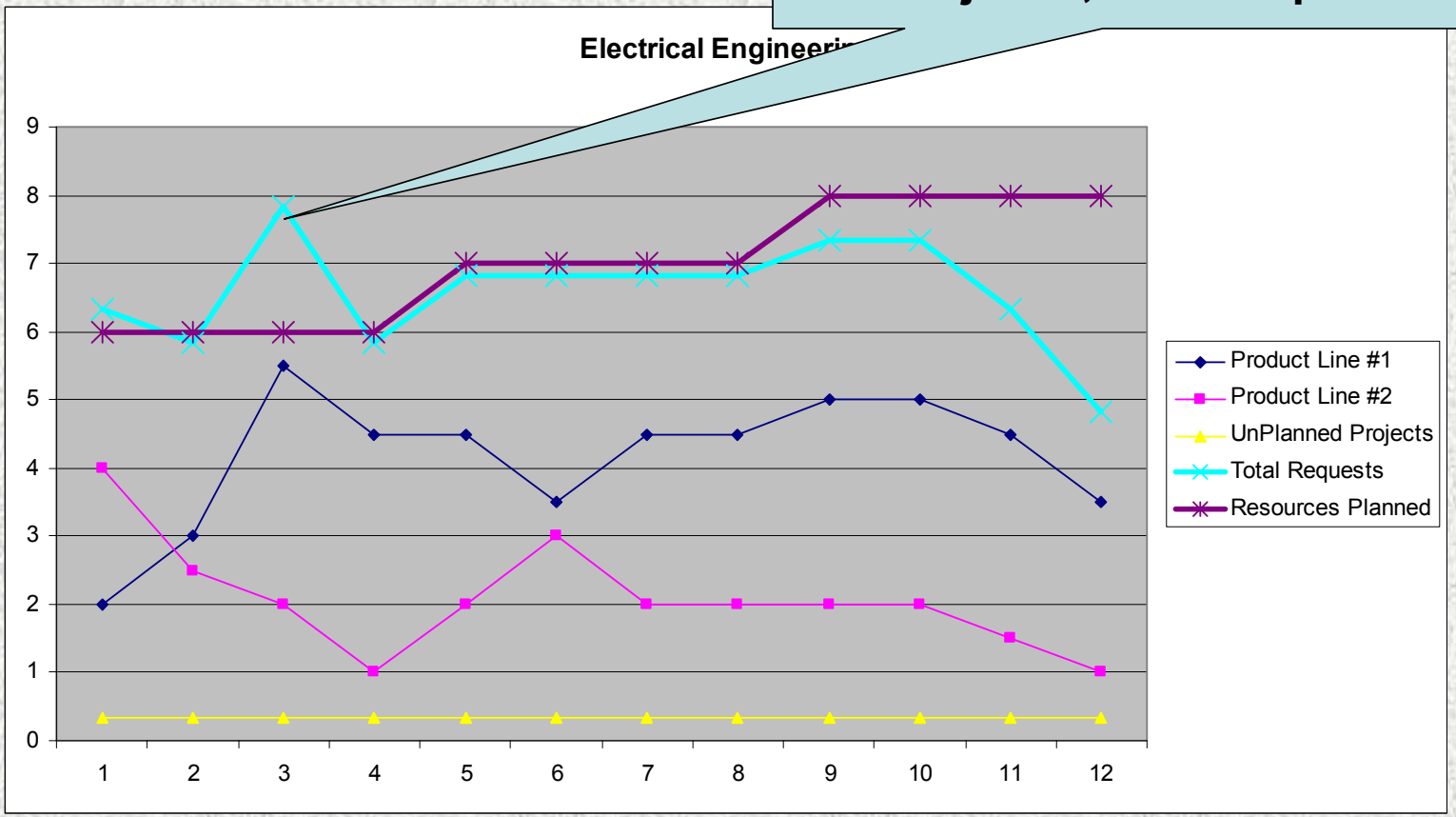
Project A, Phase 4 does not wrap up
Incremented from 2 to 3 months

Project F, Phase 5 does not wrap up
Incremented from 2 to 3 months

Monthly Goals

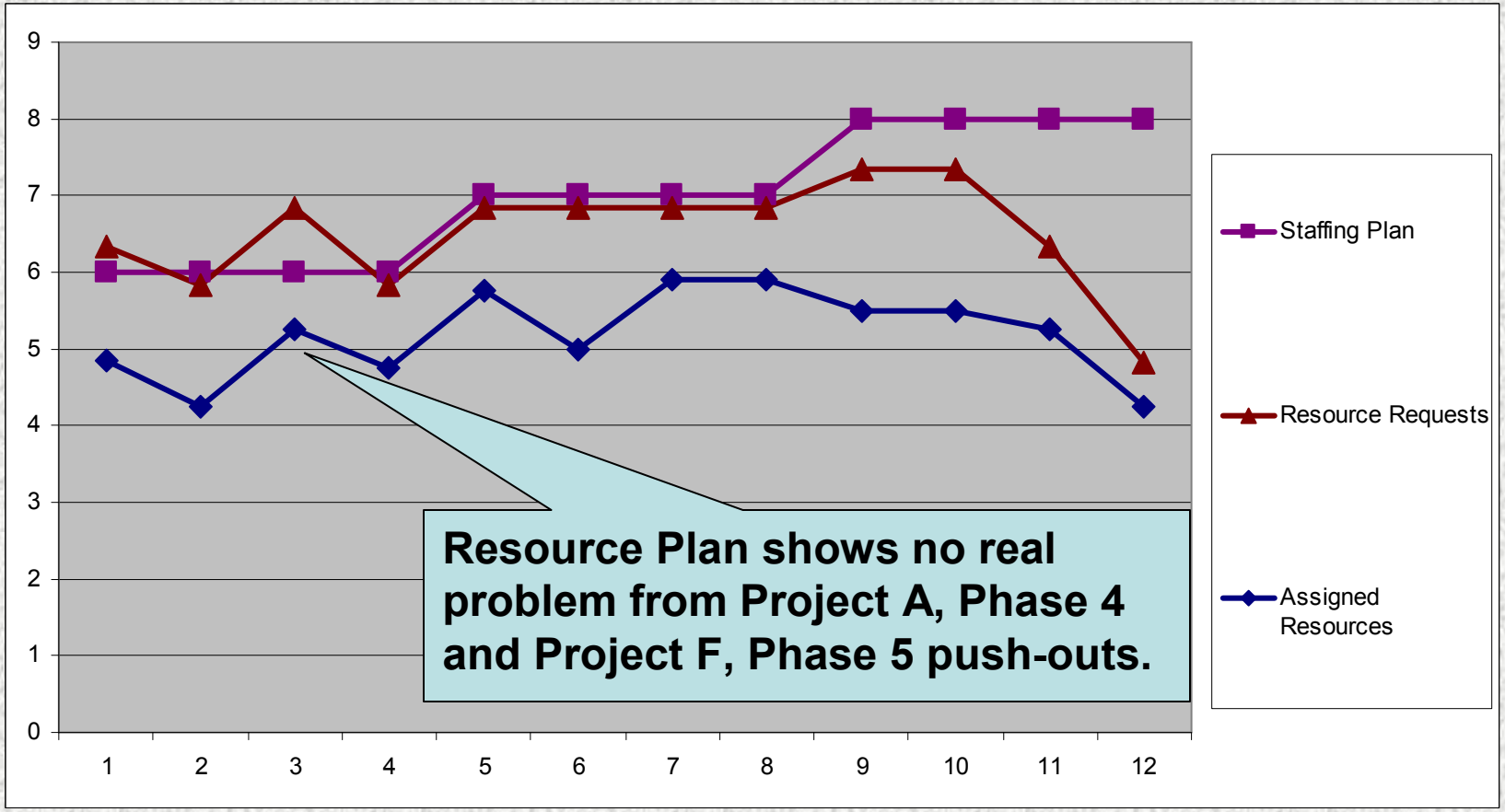
Impact of Schedule Push-outs On Roadmap

Increased resources required to recover from Project A, Phase 4 and Project F, Phase 5 push-outs.



Monthly Goals

Impact of Schedule Push-outs on Resource Plan



Monthly Goals

- Review progress against the previous monthly goals
- Identify the task and activities for the upcoming month and update goals.
- Identify the probability of completion.
- If probability of completion is low (<75%), identify roadblocks that cause low confidence.
- Proactively address roadblocks for low the confidence tasks/goals
- Save, Publish and Communicate the Monthly Plan

Weekly Meetings

- Review Progress with respect to the Monthly Plan and Goals
- Identify gaps and outline an Action Plan
- Follow through on the Plan

Quarterly Management Review

- Update the Roadmap and Level the Resource Plan
- Review changes and impact of the updated Resource Plan
- Review Project Backlog
- Review “Commitment Backlog Date”
- Identify concerns with the new plan
- Develop Action Plan

Conclusions

- An automated Roadmap, tied to resources, creates a viable plan before asking Vertical Managers to staff the Roadmap
- An automated Resource Plan allows Vertical Managers assign and level resources before resources are assigned to development projects.
- The Roadmap and Resource Plans can be proactively managed with traditional project management techniques.

Contact Information

- Contact Info:
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  - Don Borcherding
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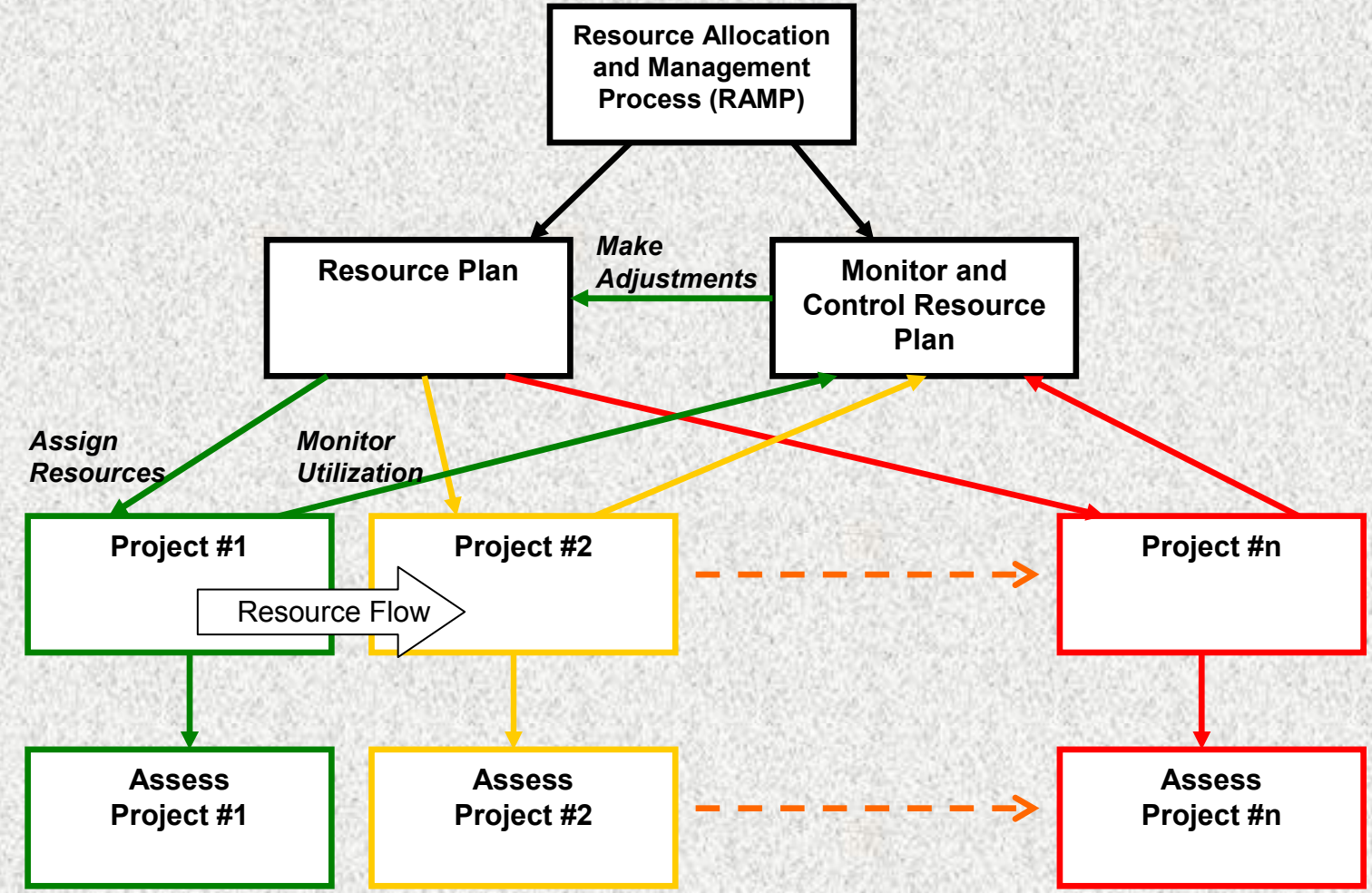
Institutionalizing Resource Planning and Management Part II

10-15-05

Agenda

- Background and Problem Statement
- Part I: Define a Resource Management Process
- **Part II: Managing the Second Project**
  - **Impact of the First Project on the Second**
  - **Process Improvements**
  - **Dealing with Interruptions**



Resource Mgmt - Root Cause
- More Training Required
- Unclear Responsibilities
- Gap in Skill Sets
- Overcommitted

Resource Mgmt – Symptoms
- Lack of Resources
- Resources were late
- Resources were frequently pulled back
- Resources were constantly interrupted

Root Cause
- Poor Project Execution
- Poor Process Execution

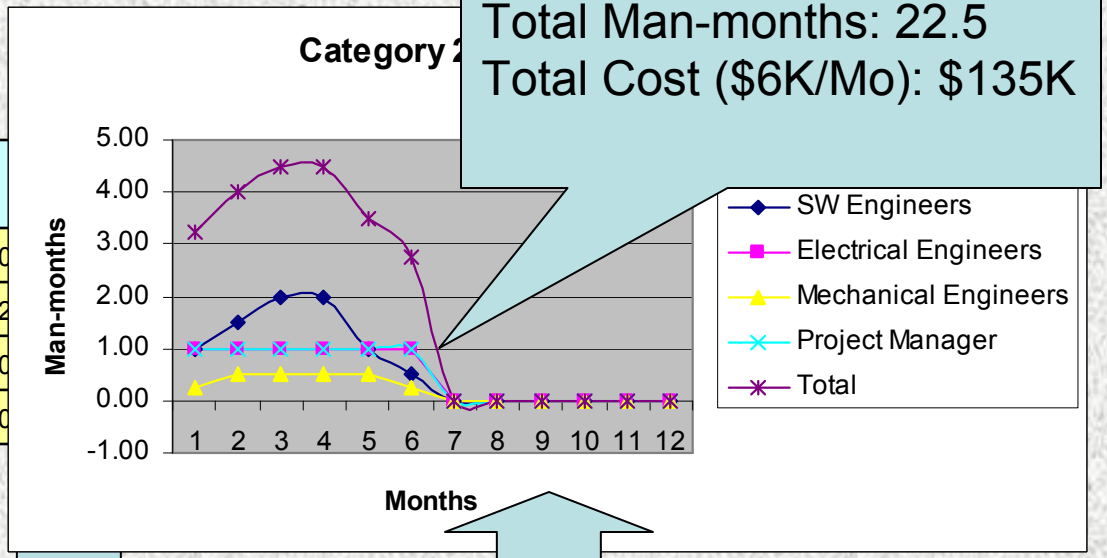
Getting Buy-in for Change

- Process Improvement is not always Supported
  - Sometimes considered a deterrent to meeting deadlines
  - Two groups need to buy-in
    - Management
    - Engineers
  - Use Models to show the COST OF DELAYS

Planning Project #1

Engineering Models

Category 2 Model	Phase
Electrical Engineering	1.0
Mechanical Engineering	0.2
Software Engineering	1.0
Project Manager	1.0

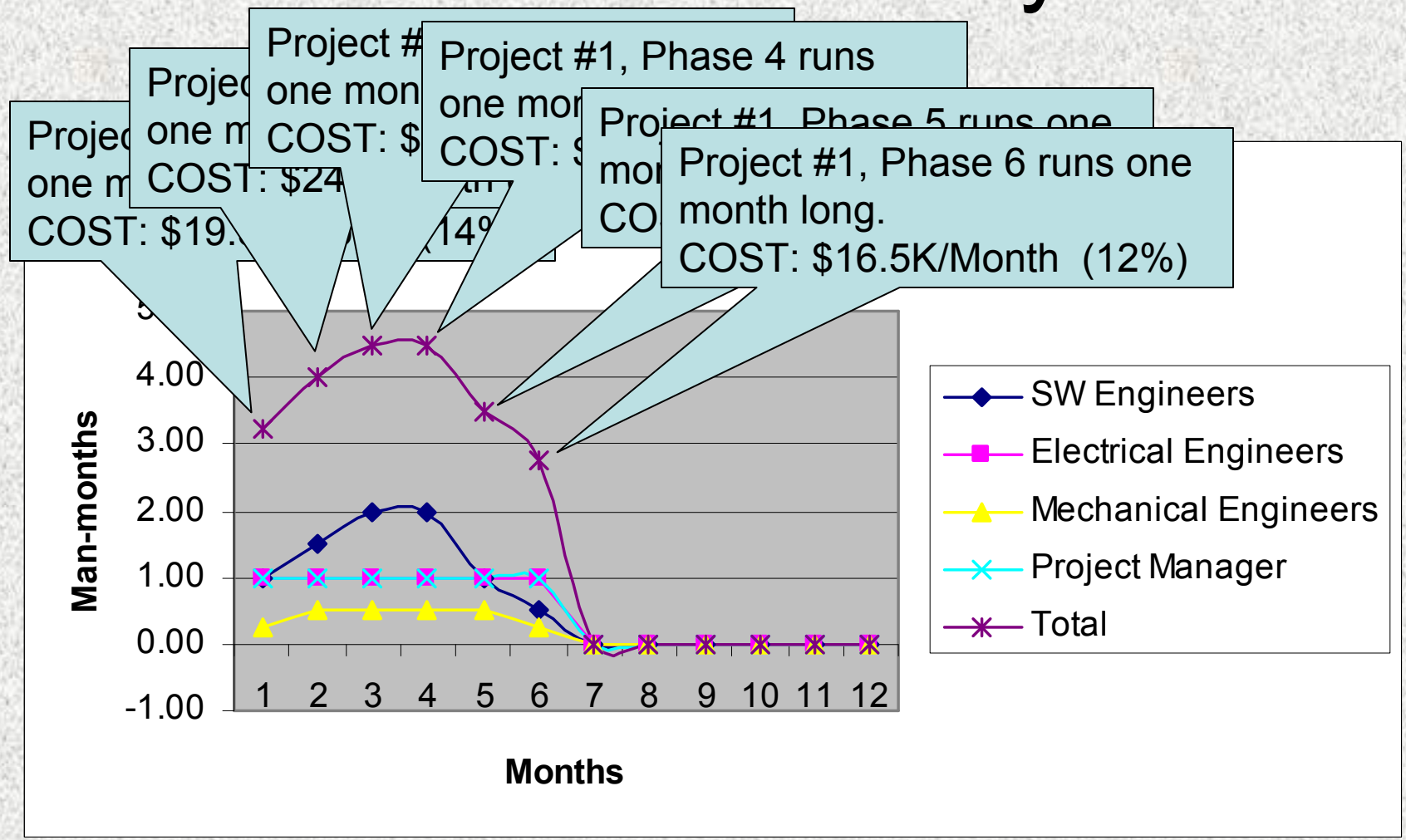


Total Man-months: 22.5
Total Cost ($6K/Mo): $135K

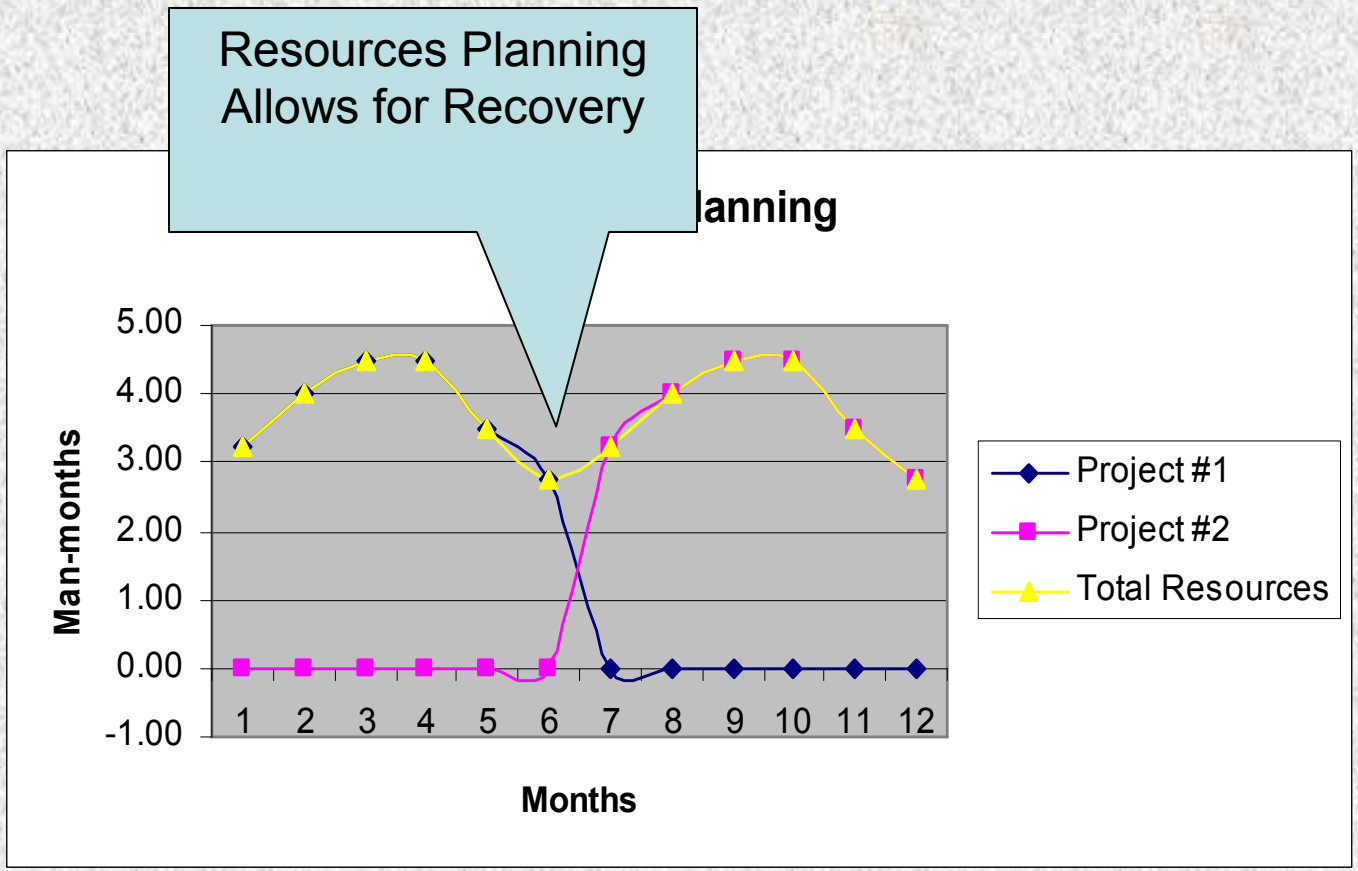
Small Embedded System

Category 2 Project Model	Ph 1	Ph 2	Ph 3	Ph 4	Ph 5	Ph 6							
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	TOTAL
SW Engineers	1.00	1.50	2.00	2.00	1.00	0.50	0.00	0.00	0.00	0.00	0.00	0.00	8.00
Electrical Engineers	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00
Mechanical Engineers	0.25	0.50	0.50	0.50	0.50	0.25	0.00	0.00	0.00	0.00	0.00	0.00	2.50
Project Manager	1.00	1.00	1.00	1.00	1.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00	6.00
Total	3.25	4.00	4.50	4.50	3.50	2.75	0.00	0.00	0.00	0.00	0.00	0.00	22.50

The Cost of Delays



Planning Project #2



Project Scenarios

- Three Scenarios
  - Project #1, Phase 1-4 are late
  - Project #1, Phase 5 and 6 are late
  - Project #1 requires redesign

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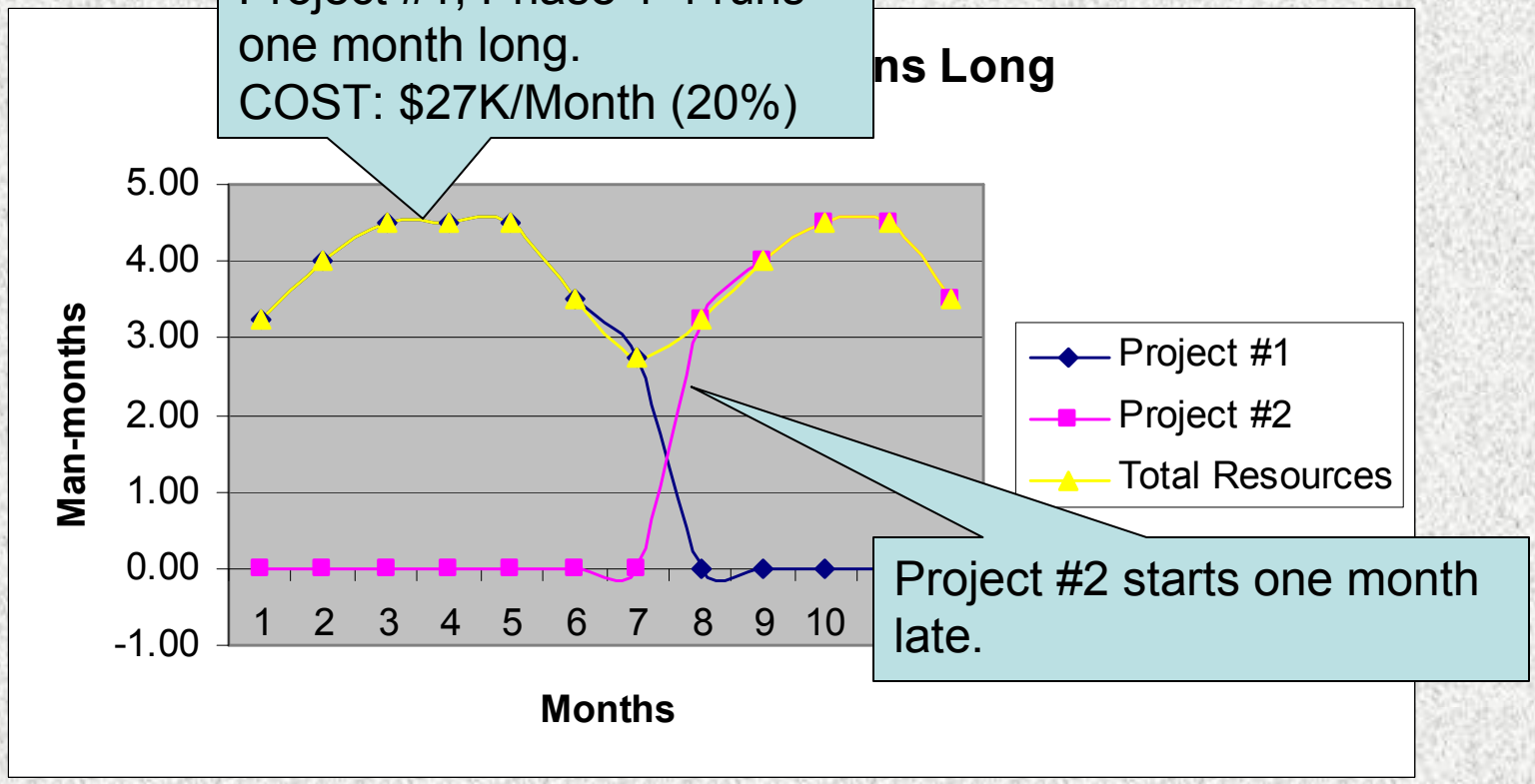
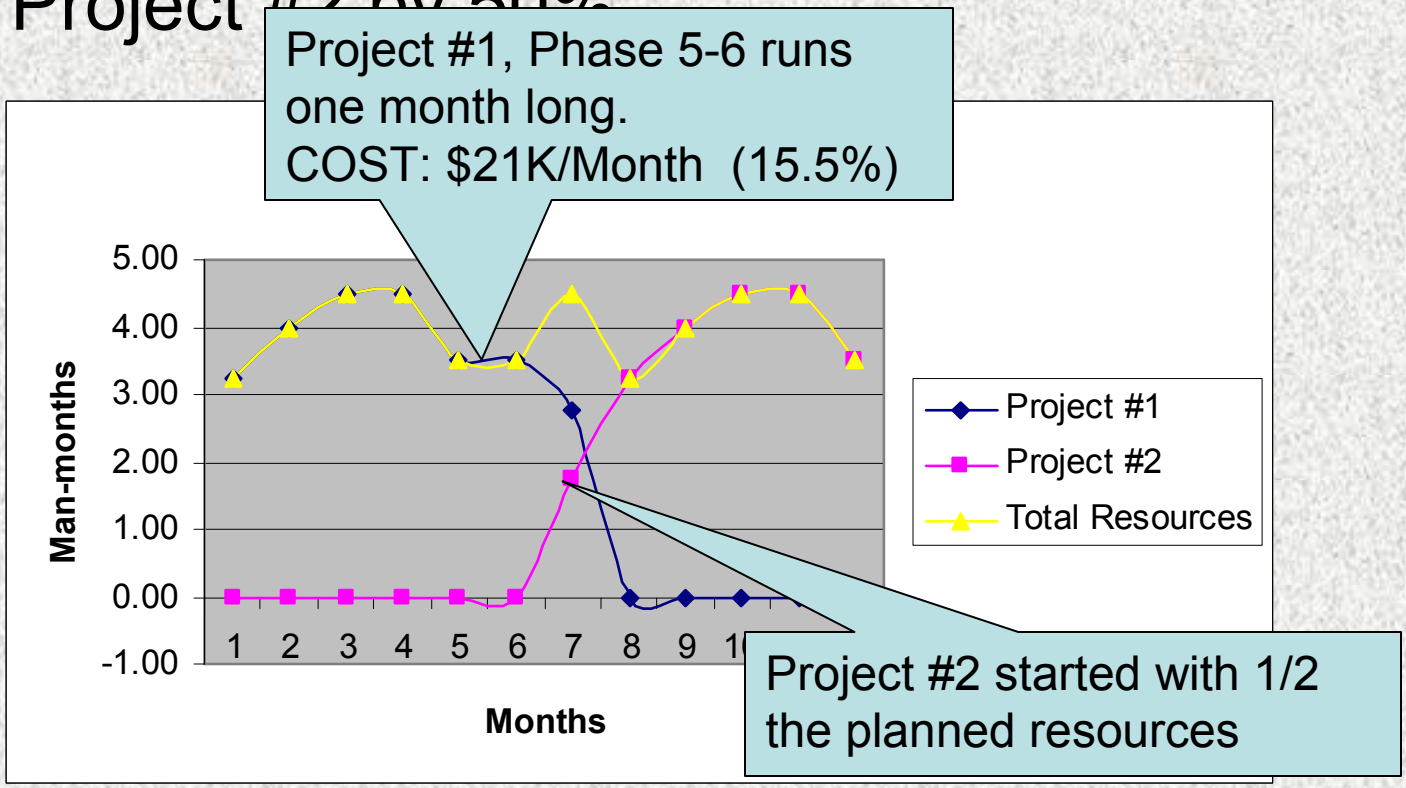
Effects of Project #1: Scenario 1

- A one month delay in Project #1, Phases 1 through 4 will delay Project #2 the same amount



Effects of Project #1: Scenario 2

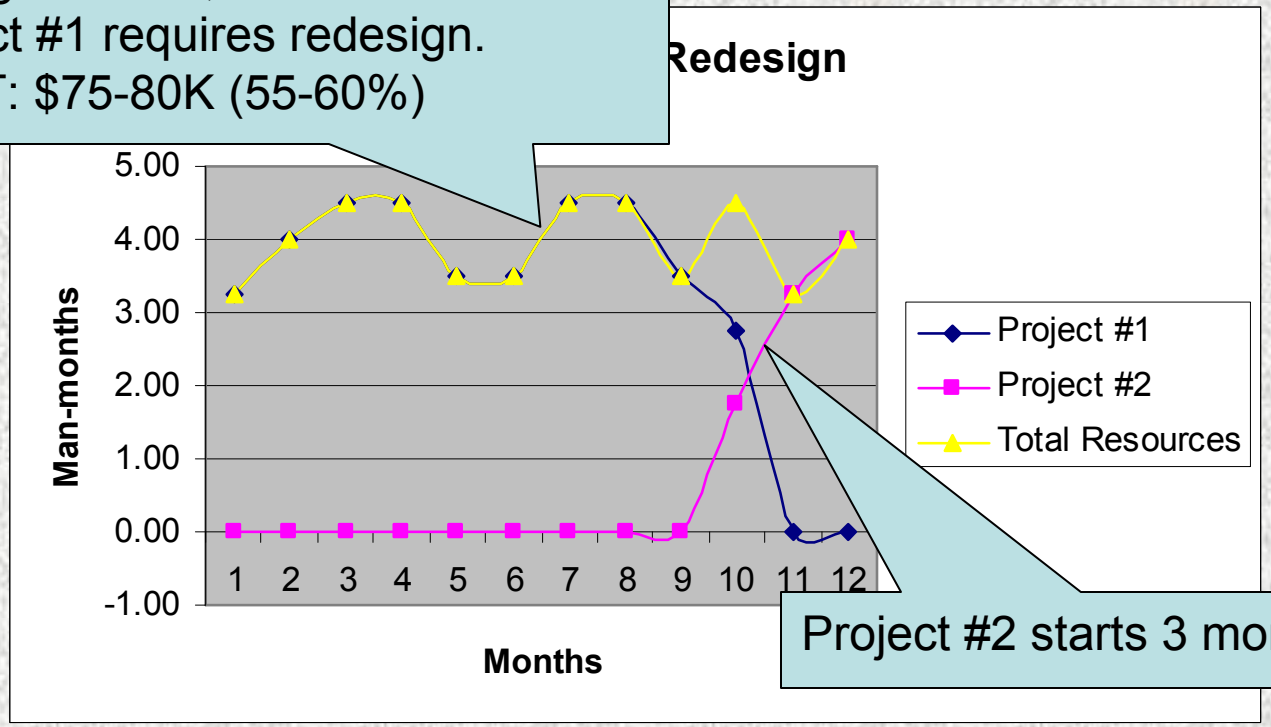
- A one month delay will in Project #1, Phase 5 and 6 will reduce the number of resources to start Project #2 by 50%



Effects of Project #1: Scenario 3

- Project #1 requires Redesign, Project #2 delayed 3 Months.

During Phase 5, It's determined Project #1 requires redesign.
COST: $75-80K (55-60%)



Project #2 starts 3 months late

Why Phase 1, 2 and 3 Push Out?

- Decomposition of Requirements
  - Added Requirements
  - Missing Requirements
- Underestimating
  - Estimates did not account for decomposition
  - Estimates did not use proper skill levels
- Proof of Concept (POC) Problems
  - Poor POC Results delay final requirements
  - When finalized, some redesign required

Why Phase 4 Pushes Out?

- Implementation Problems
  - Unable to work Independently (weak design)
  - Large number of coordination meetings
  - Poor execution (gaps in skill/training)
  - Inadequate tools and equipment
- Poor Vendor Selection
- Underestimated
  - More work than estimated (lines of code)
  - Estimated for wrong skill level
- Late Parts Procurement

Why Phase 5 and 6 Push Out?

- System/Product starts to come together
  - Uncover new requirements
  - Uncover missing requirements
  - Identify changes to original requirements
  - Vendor deliveries are late and don't integrate well

Why Product needs Redesign?

- Doesn't Meet Expectations
  - Invention
  - Errors in original requirements
  - Implementation drifts from original requirements
  - Vendor can not deliver

Where do you feel the impact?

The 7 Common Reasons impact the project late in the development.

Cause/Reason for Project #1 Delays	Phases 1-4			Redesign
Invention	Yes			Yes
Resources	**Yes**	Mayb	Maybe	No
Missing Requirements	Yes	**Yes**	Yes	Maybe
Added Requirements	Yes	**Yes**	Yes	Maybe
Requirements Not Traced	Yes	Yes	**Yes**	Yes
Development Process	**Yes**	Yes	Yes	Maybe
Underestimating	**Yes**	Yes	Yes	No
Parts Procurement	No	**Yes**	Yes	No
Vendor Selection	Yes	**Yes**	Yes	Maybe
Interruptions	**Yes**	Yes	Yes	No

Effects of Project #1

- Find the balance for Phase 1 through 4
  - Too many short cuts will lead to redesign and add significant cost to Project #1 and significantly impact the start of Project #2
  - Too much upfront work will delay and add cost to Project #1 and delay the start of Project #2

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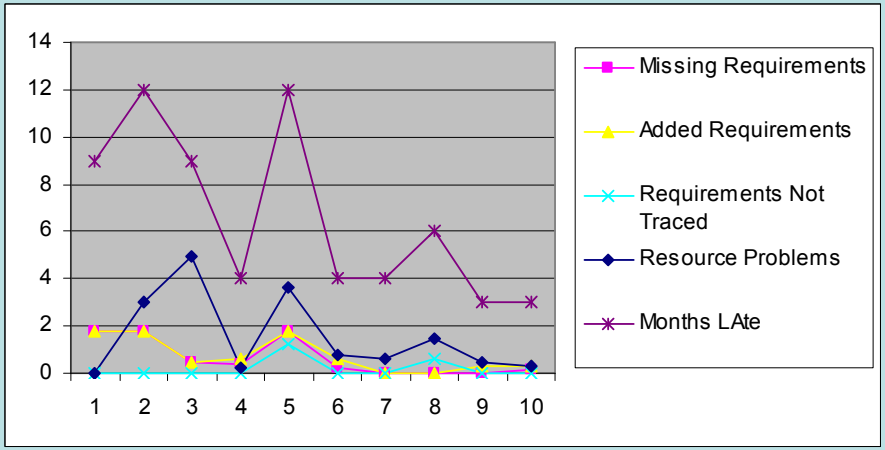
Case Study: 10 Projects

	SW Project #1	Ne	Ne	Ne	Im	Ne	SW	Ne	Ne	Ne	Average Percentage
Resource Problems	0										20
Vendor Selection	10										16
											15
											10.5
Added Requirements											10.5
Missing Requirements	20										7.5
Interruptions	20										5.5
Underestimating	0										7
Process	20	10	10	5	0	15	0	0	0	0	6
Requirements not Traced	0	0	0	0	**10**	0	0	10	0	0	2
Result	S	S	S	S	**R**	S	S	R	S	S	
Months Late	9	12	9	4	12	4	4	6	3	3	

Though a low occurrence, wher
were not traced, the result w

Resource and Requirement Problems correlated to late projects



Adding Requirements

- Problem
  - Phase 1-4: Requirements typically added by the development team as the product gets further broken down and analyzed.
  - Phase 5 and 6: New requirements get added…
    - By the team when the product starts to come together.
    - By Sales, Marketing and Customer as they start the demo/use the new product.
    - Adds significant delay.
  - Redesign: Maybe. If added requirement is a big change.

Missing Requirements

- Problem
  - Phase 1-4: Missed requirements typically found by the development team as the product gets further broken down and analyzed.
  - Phase 5 and 6: Missed requirements are found…
    - When the product starts to take shape and stakeholders see the product.
    - Adds significant delay
  - Redesign: Maybe. If missing requirement is a big oversight.

Requirements not Traced

- Problem
  - Phase 1-4: Derived requirements and subsequent designs may drift or alter Product Requirements.
  - Phase 5 and 6: If not traced, drifting requirements are found …
    - When the product verification and validation is performed.
    - Adds significant delay
  - Redesign: Yes. If requirements have departed significantly from the original requirements.

Dealing with Requirements

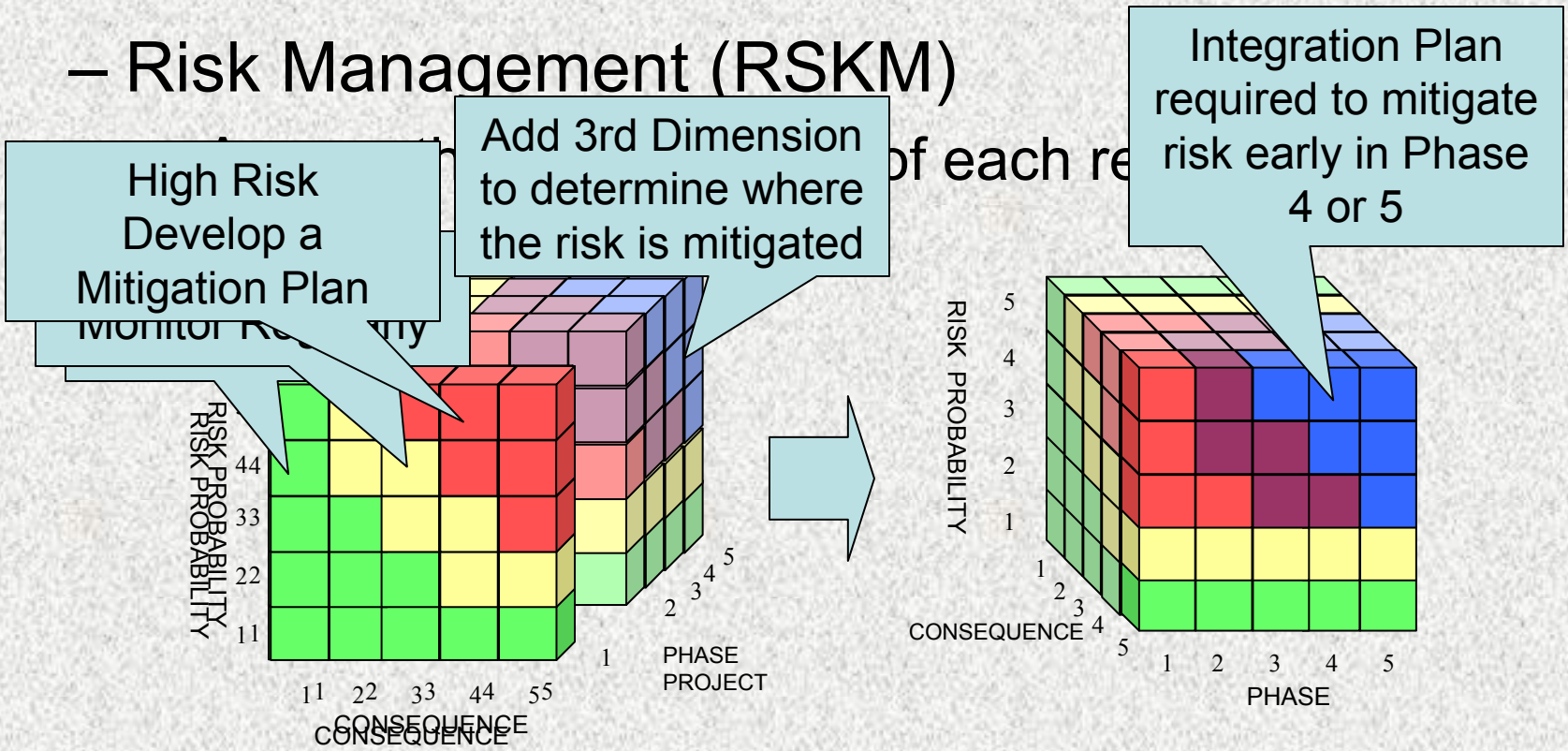
- Solution
  - Develop and document as complete a set of requirements upfront as you can
  - Requirements Development (RD)
    - SG1 - Develop Customer Requirement
    - SG2 - Develop Product Components
    - SG3 - Analyze and Validate Requirements
  - Find the balance
    - You may need to move forward without all the requirements

Dealing with Requirements

- Solution
  - Requirements Management (REQM)
    - Obtain Understanding of Requirements
    - Obtain Commitment to Requirements
    - Manage Requirement Changes
    - Maintain bi-directional Traceability
  - Use the Trace Matrix as the basis for all design reviews

Dealing with Requirements

- Solution
  - Risk Management (RSKM)



Dealing with Requirements

- Solution
  - Product Integration (PI)
  - Define Incremental Configurations
    - Define 2 to or more Configurations for Incremental Deliveries
    - Integrate high risk requirements in first configurations
      - Proof of Concept or Repeat POC results
      - System or Software Architectures
      - New protocols, outsourced technology
      - New user Interface or features
      - Installation Requirements
    - Integrate lower risk requirements second

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Case Study: 10 Projects

	SW Project #1	New Tool #1	New Feature #1	New Feature #2	Improvement #1	New Feature #3	SW Project #2	New Tool #2	New Feature #4	New Tool #3	Average Percentage
Resource Problems	0	25	55	5	30	20	15	25	15	10	20
Vendor Selection						15	35	25	30	25	16
Invention						10	25	20	20	10	15
Parts Procurement						15	15	20	20	25	10.5
Added Requirements			5	15	15	15	0	0	10	10	10.5
Missing Requirements		15	5	10	15	5	0	0	0	5	7.5
Interruptions	20	0	10	5	0	5	5	0	0	10	5.5
Underestimating	0	20	10	10	15	0	5	0	5	5	7
Process	20	10	10	5	0	15	0	0	0	0	6
Requirements not Traced	0	0	0	0	10	0	0	10	0	0	2
Result	S	S	S	S	R	S	S	R	S	S	
Months Late	9	12	9	4	12	4	4	6	3	3	

Underestimating went down as the Process Improved

Underestimating

- Problem
  - Phase 1-4: Underestimating is due to…
    - Missing key process steps
    - Aggressive or optimistic estimates
    - Tip of the ice berg. Decomposition reveals more work.
  - Phase 5 and 6: Underestimating is due to…
    - Poor Integration Planning.
    - Does not take into account requirement changes.
  - Redesign: Underestimating normally doesn't cause redesign.

Underestimating

- Solution
  - Project Planning (PP)
    - Establish the Scope of the Project (i.e., WBS)
    - Establish Estimates for Work Products (i.e., Lines of Code, Number of Requirements, PCB Complexity
    - Determine Estimates of Effort and Cost
    - Develop Models based on Past Estimates

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Underestimating

- Solution
  - Implement Process Templates for Estimating
  - Tie Estimates to the Process

Formatt developing Cha

Defines Responsib

Provi G

De

Makes sure nothing gets missed when estimating

Defines Links for Gantt Chart

ng

Task	*Task Name/ Paragraph*	*Task Responsibility*	*Tailor*	*Inputs*	*Task Description*	*Outputs*	*Est.*
3	Develop Product Requirements	Technical Leader	2, 3, 4	Customer Requirements	- Review Customer Requirements - Develop Functional Specification - Develop Performance Specs - Develop Operational Scenarios - Verify Industry Standards, Certification and Compliance Requirements - Develop Product Requirements - Analyze and Validate Requirements	Product Requirements	160 hrs

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Case Study: 10 Projects

	SW Project #1	New Tool #1	New Feature #1	New Feature #2	Improvement #1	New Feature #3	SW Project #2	New Tool #2	New Feature #4	New Tool #3	Average Percentage
Resource Problems	0	25	55	5	30	20	15	25	15	10	20
Vendor Selection	10	0	0	20	0	15	35	25	30	25	16
Invention	10	15	5	30	5	10	25	20	20	10	15
Parts Procurement	0	0	0	0	10	15	15	20	20	25	**10.5**
Added Requirements	20	15	5	15	15	15	0	0	10	10	10.5
Missing Requirements	20	15	5	10	15	5	0	0	0		7.5
Interruptions	20	0	10	5	0	5	5	0	0		5.5
Underestimating	0	20	10	10	15	0	5	0			7
Process	20	10	10								
Requirements not Traced	0	0	0								
Result	S	S	S								
Months Late	9	12	9	4	12	4	4	6	3	3	

As Requirements Management improved, Parts became a problem.

Parts Procurement

- Problem
- Late Parts will hold up Product Integration
  - Phase 1-4: Phase 1-4 may be delayed due to…
    - Technology and Vendor selection
    - Poor planning
    - Waiting for the entire design to be complete
  - Phase 5 and 6: Late Parts Procurement is due to…
    - Poor execution of Phase 1-4
    - Requirements change impacts material on order
  - Redesign: Late Parts normally don't cause redesign.

Parts Procurement

- Solution
  - Drive Parts to the Product Integration Plan
  - Use Bill of Material (BOM) as the WBS
    - Revision Levels used to track progress

BOM Level								Description	Part Number	Rev	ECO #	COMMENTS
0	1	2	3	4	5	6	7					
x								System Configuration-003	A32413-003	A	15023	Target 6/17/05
	x							Common Base	A32160-003	A	15024	
		x						COMPUTER, PC RACK	P56480	0		
			x					Kit, Electrical Components	P63419	0		Kit provided by Vendor
				x				PCB – Backplane	P63435	2		
				x				PCB – Processor	P63426	1		

Case Study: 10 Projects

	SW Project #1	New Tool #1	New Feature #1	New Feature #2	Improvement #1	New Feature #3	SW Project #2	New Tool #2	New Feature #4	New Tool #3	Average Percentage
Resource Problems	0	25	55	5	30	20	15	25	15	10	20
Vendor Selection	10	0	0	20	0	15	35	25	30	25	16
Invention	10	15	5	30	5	10	25	20	20	10	15
Parts Procurement	0	0	0	0	10	15	15	20	20		10.5
Added Requirements	20	15	5	15	15	15	0	0	10		10.5
Missing Requirements	20	15	5	10	15	5	0	0			7.5
Interruptions	20	0	10	5	0	5	5	0		0	5.5
Underestimating	0	20	10								
Process	20	10	10								
Requirements not Traced	0	0	0								
Result	S	S	S	S	R	S	S	R	S	S	
Months Late	9	12	9	4	12	4	4	6	3	3	

As Requirements Management improved, Vendor Selection became a problem.

Vendor Selection

- Problem
  - Phase 1-4: Vendor selection delays project due to…
    - Underestimating the evaluation/selection process
    - Underestimating the monitor and control.
    - Poor Vendor Execution
  - Phase 5 and 6: Vendor Deliveries delay the project due to…
    - Poor Integration Planning.
    - Not meeting requirements.
  - Redesign: Too often poor vendor selection requires redesign

Vendor Selection

- Solution
  - Supplier Agreement Management (SAM)
    - Determine Acquisition Type
    - Develop potential Supplier List
    - Evaluate potential Suppliers
    - Select Supplier and Establish Agreement

Vendor Selection

- Solution
  - Request for Proposal (RFP)

Request for Proposal Outline

1	*Introduction*
2	*Proposal Guidelines and Evaluation*
3	*Confidentiality*
4	*RFP Questions and Submittals*
5	*Corporate Profile*
6	*Geographic Location of Sites*
7	*Scope of Work*
8	*Requirements*
9	*Appendix A: Intent to Bid Form*
10	*Appendix B: Non-disclosure Form*
11	*Appendix C: Integration Guidelines*
12	*Appendix D: Coding Guidelines*
13	*Appendix E: Diagnostic Guidelines*
14	*Appendix F: Architecture Framework*
15	*Training Requirements*

Vendor Selection

- Solution
  - Decision Analysis and Resolution (DAR)

Selection Criteria	Alternative 1			Alternative 2			Alternative 3		
	Rating	Weight	Overall	Rating	Weight	Overall	Rating	Weight	Overall
Functionality	7	0.25	1.75	5	0.25	1.25	6	0.25	1.5
Performance	9	0.3	2.7	7	0.3	2.1	7	0.3	2.1
Cost	5	0.2	1.0	9	0.2	1.8	7	0.2	1.4
Schedule/Product Availability	5	0.1	0.5	7	0.1	0.7	5	0.1	0.5
Product Life/Expandability	7	0.05	0.35	7	0.05	0.35	7	0.05	0.35
Manufacturability	8	0.05	0.4	6	0.05	0.3	5	0.05	0.25
Serviceability	8	0.1	0.8	8	0.1	0.8	3	0.1	0.3
Reliability	4	0.05	0.2	5	0.05	0.25	5	0.05	0.25
Total		1.00	7.7		1.00	7.55		1.00	6.65

Getting Buy-in for More Change

- Two groups need to buy-in
  - Management
  - Engineers
- Use History to show the SAVINGS created by changing

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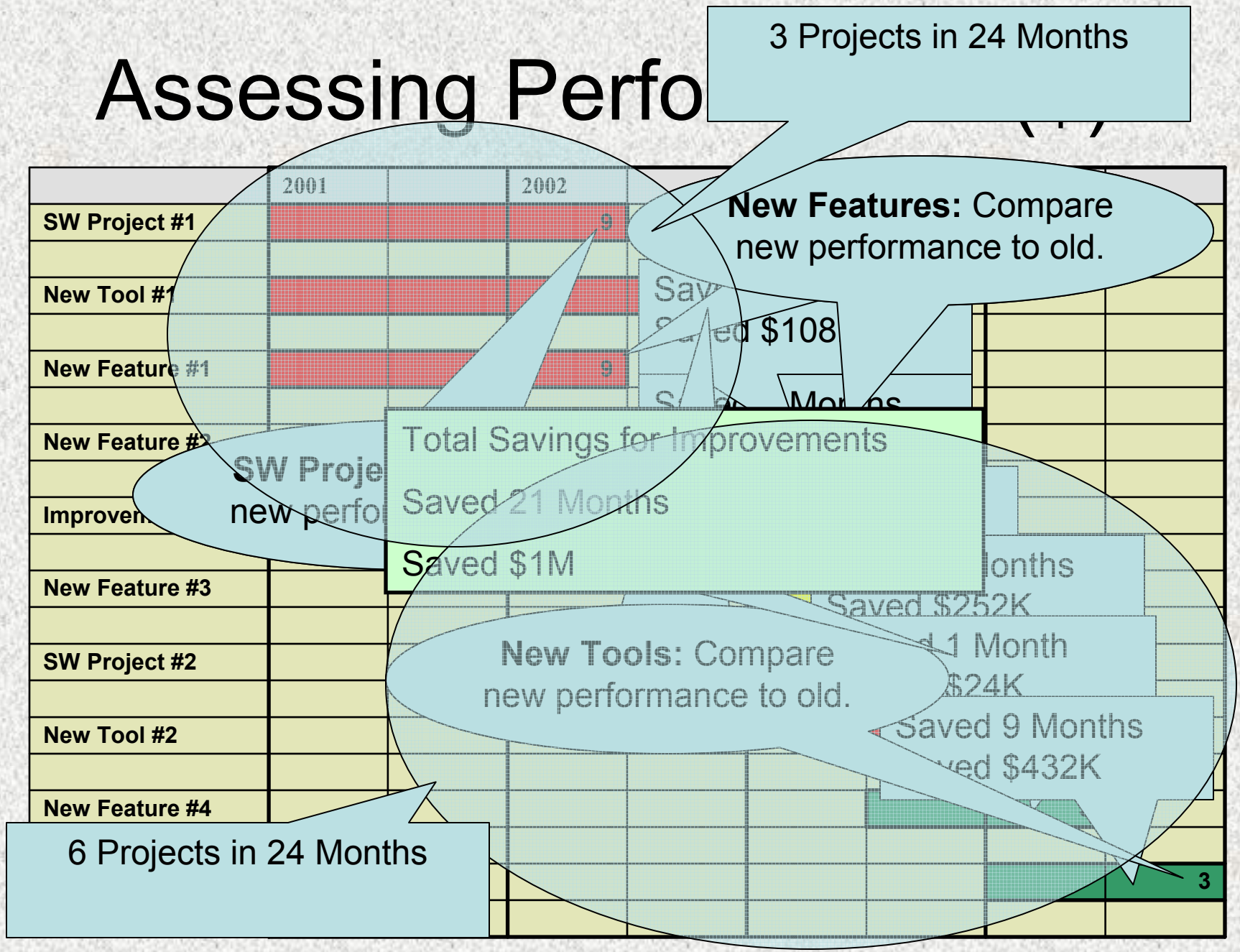
Assessing Perfo



Getting Started

- Don’t wait to start to gather data
- Capture this information at any time
  - Meet with projects groups and have then fill out the survey on the last few projects.
  - Data will be compiled from memory making it less reliable, but will serve as a starting point.
  - Compile metrics and identify an improvement plan.

Improving Process Mid-stream

Improving Process Mid-stream

- If Project was started with ad hoc Practices, Confront the 6 Problem Areas
  - Adding Requirements
  - Missing or Incomplete Requirements
  - Requirements not Traced
  - Project Underestimated
  - Parts Procurement (Integration Plan)
  - Vendor Selection

Improving Process Mid-stream

- Review the methods used to develop Requirements, Estimates, Parts Procurement and Vendor Selection
- Determine Gaps in the Methods
  - Old versus New
- Make Adjustments Appropriately
- Re-negotiate where possible

Project Monitoring and Control

- Begin new Monitor and Control Methods
  - Identify roadblocks that will cause goals to be missed
  - Proactively address roadblocks
  - Try to minimize multitasking, keep sequential
- Start Weekly Reviews and Adjustments
  - Adjust assignments for roadblocks/interruptions
- Anticipate Interruptions from Quarterly Revenue Goals

Dealing with Interruptions

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Case Study: 10 Projects

	SW Project #1	New Tool #1	New Feature #1	New Feature #2	Improvement #1	New Feature #3	SW Project #2	New Tool #2	New Feature #4	New Tool #3	Average Percentage
Resource Problems	0	25	55	5	30	20	15	25	15	10	20
Vendor Selection	10	0	0	20	0	15	35	25	30	25	16
Invention											5
Parts Procurement											0.5
Added Requirements											0.5
Missing Requirements	20	15		10	15		0	0		5	7.5
Interruptions	20	0	10	5	0	5	5	0	0	10	**5.5**
Underestimating	0	20	10	10	15	0	5	0	5		7
Process	20	10	10	5	0	15	0	0			6
Requirements not Traced	0	0	0								
Result	S	S	S								
Months Late	9	12	9								

First 3 Projects: Interruptions (8.

Next 3 Projects: Interruptions (3.

Next 4 Projects: Interruptions (3.75%)

Interruptions are reduced as execution improves.

Interruptions

- Two Way Street
  - Improved Execution Reduces Interruptions
  - Controlling Interruptions, Improves Execution
- Must do both!

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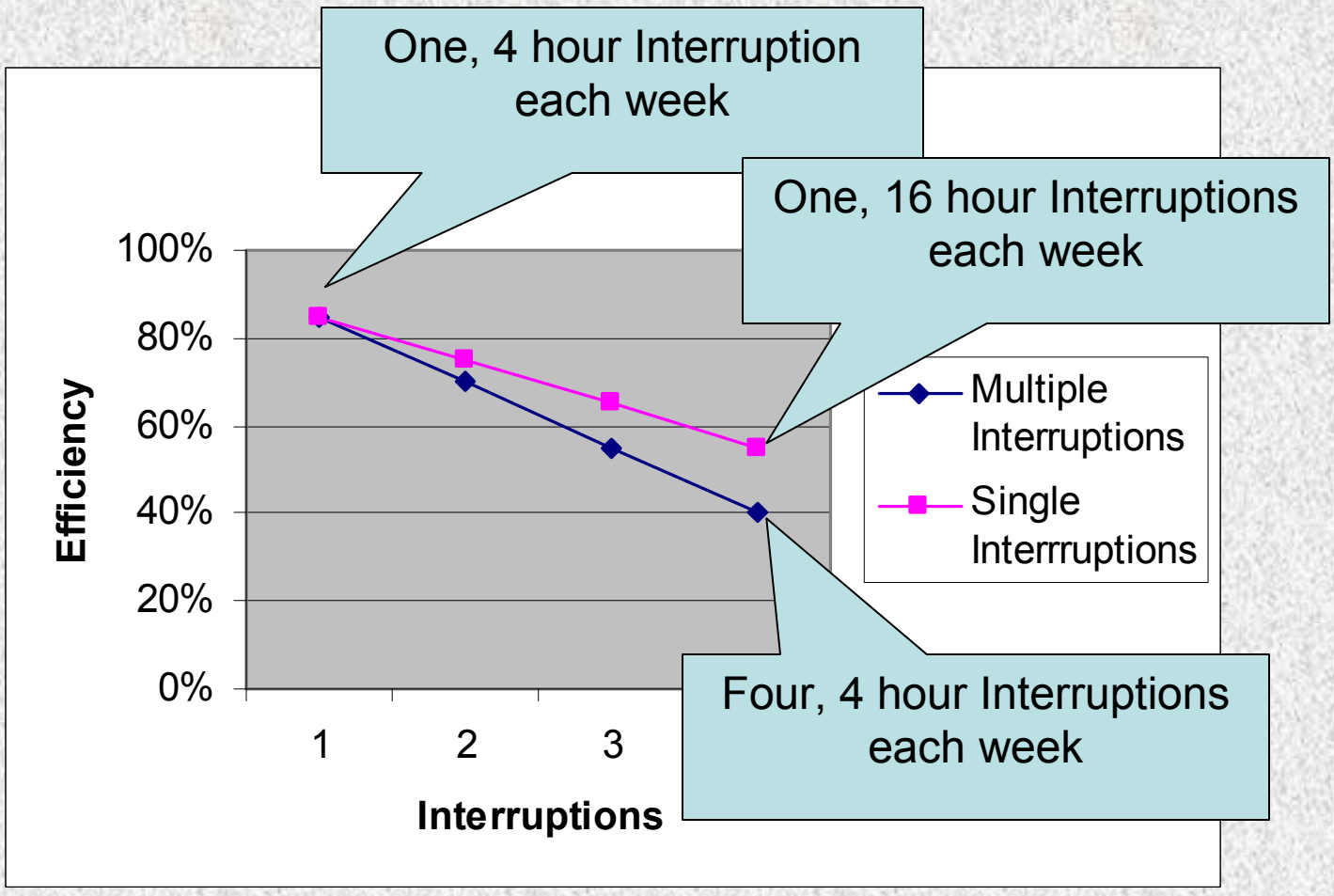
Interruptions



Planning for Interruptions

- Evaluate the Performance of Previous Project
  - Do you expect Interruptions?
- If so, Keep Problems from Escalating
  - Develop method to report problems
  - Establish an Escalation procedure
  - Develop a single point contact
  - Plan problems
  - Dealing with Interruptions

Reporting Problems

- Define how to report a problem
- Define the content of the report
  - Description of the problem
  - Steps to reproduce
  - Frequency of occurrence
  - Severity
  - S/N, SW Version , Revision
- Define responsibilities
- Expected results and response

Escalation Procedure

- Clearly defines
  - What an escalation is
  - What an escalation isn't
- Clearly define responsibilities
- Defines how to report the escalation
- Defines the expected results and response time

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Single Point Contact

- Communicates the new methods
- Reviews problems and confirms the report
- Contact for escalations
- Negotiates deliverables
- Owner of the plan
- Proactively reports status and delay

Planning for Problems

- Estimating the Scope of Interruptions
  - Uncover Hidden Problems
- Estimating the Effort of Interruptions
  - Use Category Estimates
- Identifying the Risk due to Interruptions
  - Define the Severity of the Problem
  - Define the Probability
  - Set Priority

Planning for Problems

- Plan Resources to Handle Interruptions
  - Carry a constant resource level in Resource Plan, at least.
  - Use Skills Inventory List to select alternates
- Plan for Recovery
  - Treat Interruptions as a Project
  - If they are planned, they are no longer interruptions

Dealing with Interruptions

- Structure Your Project to Deal with Interruptions
  - Establish Core and Floating Resources
  - Look for Commonality
  - Break Project into Smaller Tasks
  - Don’t let Interruptions hold up Material

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Interruptions will Occur

Unplanned Projects Roadmap

Unplanned Projects	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Escalation 1	3	0	0	0	0	0	0	0	0	0	0	0
Escalation 2	0	3	4	0	0	0	0	0	0	0	0	0
Escalation 3	0	3	3	0	0	0	0	0	0	0	0	0

Setup	
Start	Phase
1	3
2	3
2	3

Phase Length					
1	2	3	4	5	6
0	0	1	0	0	0
0	0	1	1	0	0
0	2	2	0	0	0

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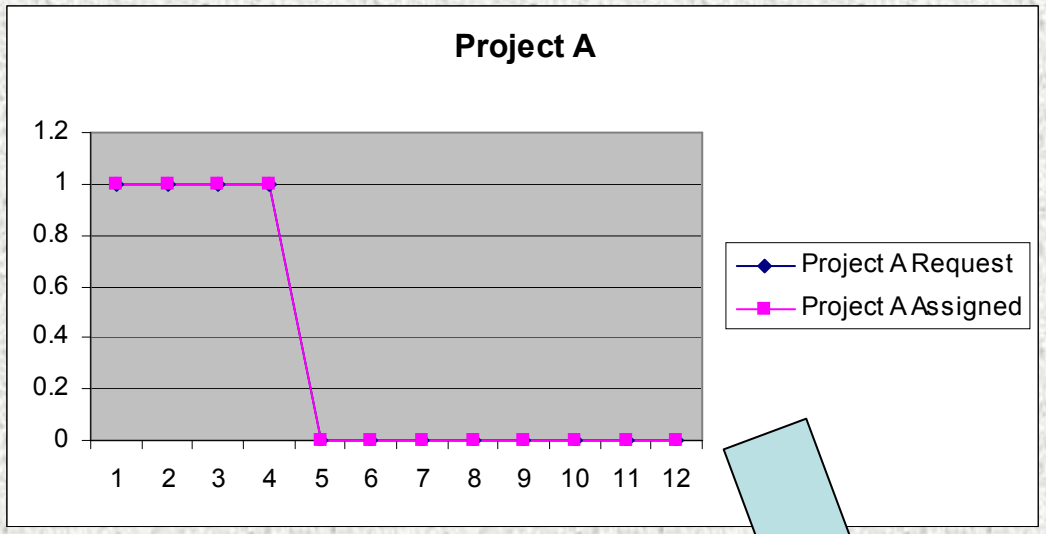
Assign Resource 1

Assign Resource 1 to the Escalations

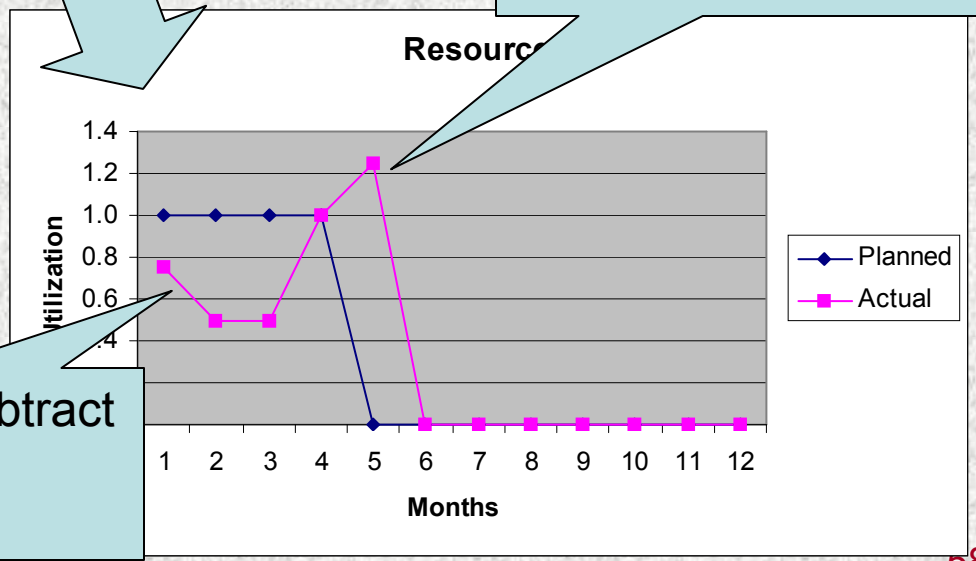
Unplanned Projects	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov		Assigned	Model
Escalation 1	0.25	0	0	0	0	0	0	0	0	0	0	0	1	2
Escalation 2	0	0.25	0.25	0	0	0	0	0	0	0	0	0	1	2
Escalation 3	0	0.25	0.25	0	0	0	0	0	0	0	0	0	1	2

Unplanned Model	Phase 1	Phase 2	Phase 3	Phase 4	Phase 5	Phase 6
Model 1	0.50	0.50	0.50	0.50	0.50	0.50
Model 2	0.25	0.25	0.25	0.25	0.25	0.25
Model 3	0.10	0.10	0.10	0.10	0.10	0.10
Model 4	0.10	0.10	0.10	0.10	0.10	0.10

Predict the Impact



Plan Predicts the Impact on the Project



Escalations Subtract from Plan

Conclusions

- Focus on process improvements that will reduce surprises late in the project
  - Requirements Development
  - Requirements Management
  - Risk Identification and Mitigation
  - Product Integration
  - Project Planning
    - Better Estimating and Material Management
  - Supplier Management

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Conclusions

- Use models from the Resource Plan to gain support for changes and improvements
  - Cost of Delays
  - Cost of Savings
- Plan Interruptions as a Project.
- Include Interruptions in the Roadmap as a “negative” and predict impact.

Contact Information

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Models for Product Quality

The Capability Maturity Model Integrated for Systems Engineering and Software Engineering, Version 1.1

Integrated Project Management (IPM): The CMMI and collaborative product development

Course Guide

Version 19 (Slides Version 19)

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About SSQC and Its Services

Since 1990, SSQC has specialized in supporting organizations in the definition and implementation of Software Engineering Practices, Software Quality Assurance and Testing, Business Process Reengineering, ISO 9000 Registration and CMM implementation. SSQC is an official SEI transition partner licensed to provide SCAMPI appraisal services and the SEI's *Introduction to Capability Maturity Model Integration.*

SSQC also offers HM^2, a unique, hybrid appraisal method that defines and correlates the position of an organization with respect to both ISO 9001 and the CMM. HM^2 grew out of SSQC's ground-breaking 1993 paper *Comparing, contrasting ISO 9001 and the SEI Capability Maturity Model*, which was published in IEEE **Computer.** The results of an HM2 assessment are a plan and framework for improving software engineering processes and for implementing the requirements of the two models.

The principals of Software Systems Quality Consulting are William J. Deibler and Robert C. Bamford.

William J. Deibler II has an MSc. in Computer Science and over 20 years experience in the computer industry, primarily in the areas of software and systems development, software testing, and software quality assurance. Bill has extensive experience in managing and implementing CMM- and ISO 9001-based process improvement in software engineering environments. Bill is an SEI Authorized CBA IPI Lead Assessor and SCAMPI Lead Appraiser for CMMI.

Robert C. Bamford has an MA in mathematics, and has managed training development, technical publications, professional services, and third-party software development. His over 20 years of experience include the facilitating the definition and implementation of management processes, designing and instructing courses, and managing engineering teams.

Bob and Bill have developed and published numerous training courses, auditing tools, research papers, and articles on interpreting and applying the ISO 9000 standards and guidelines and the SEI Capability Maturity Model for Software. Their articles have appeared in McGraw Hill's **Quality Systems Update**, **IEEE COMPUTER**, McGraw Hill's **ISO 9000 Handbook**, **CrossTALK**, and **Software Marketing Journal**. They were the principal authors and project editors of **A Guide to Software Quality System Registration under ISO 9001**.

They have presented research papers at numerous national and international conferences, including those sponsored by the American Society for Quality (ASQ), Pacific Northwest Software Quality (PNSQC), the Software Publishers Association (SPA), Software Technology Support Center (STSC), the Software Engineering Institute (SEI) and Software Research Inc. Their courses have been attended by software engineering professionals from many of the world's leading technology companies. Their courses have been sponsored for their members by professional associations, including the ASQ, CSU Long Beach's Software Engineering Forum for Training, Semiconductor Equipment and Materials International (SEMI), Software Engineering Institute (SEI), UC Berkeley and UC Santa Cruz.

They have been active United States TAG members in the ISO/IEC JTC1 SC7 - Software Engineering Standards subcommittee which is responsible for the development and maintenance of ISO 12207 and ISO 15504 (SPICE). Their software development clients have successfully achieved ISO registration and advanced CMM maturity levels.

They have also performed ISO 9000 registration and TickIT audits as external resources under contract to the British Standards Institution (BSi).

Relationship with the SEI

Since 1993, when SSQC received permission from the SEI to reproduce various SEI CMM 1.1 technical reports for resale to the public, SSQC has maintained a close relationship with the SEI. Since 1996, SSQC has offered a variety of presentations and tutorials at the annual SEI-sponsored conferences (SEPG) and symposia in both the US and Europe (ESEPG). SSQC has presented numerous tutorials and presentations at local SPINs in the Silicon Valley.

Since early 1999, SSQC courses, tutorials, presentations, and panels have been successfully promoting the CMMI transition efforts (both staged and continuous representations) at a variety of conferences to include ESEPG 1999-2002, SEPG 1999-2002, Quality Week 1999-2001, PNSQC 1999-2000.

Integrated Project Management (IPM)

The CMMI and collaborative product development

Getting started

- About the presenters
- Audience
  - Some level of familiarity with the Software CMM Version 1.1 or CMMI Version 1.1 (Staged or Continuous)
  - Maintaining SW CMM 1.1, migrating to CMMI, starting CMMI
- Experience breeds … , well, opinions, concerns, etc.

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Project management: prioritized issues

- Develop an individual list of the challenges your organization needs to address in **managing projects or programs**
  - On-going problems
  - Impending needs
- Prioritize individual list
- Develop a single prioritized list of five items as a team
- Pick a representative who will present list in 3 minutes
- Ensure tutorial addresses your concerns to greatest possible extent

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About the rest of the presentation

- Brief orientation
  - Structure of CMMI SE/SW v1.1 - staged and continuous
    - Process Areas, Goals, Practices, and Process Categories
  - A warning: Chasing levels
- Integrated Project Management (IPM) - The Specific Practices
  - Metrics, models, Key Performance Indicators
  - IPM and the Project Management Category Process Areas
    - Project Planning (PP)
    - Process Monitoring and Control (PMC)
    - Team exercise: Case study
    - Risk Management (RM)
- Integrated Product and Process Development (IPPD)
  - IPM and the Support Process Category Process Areas
- IPM and the Generic Practices
- Tools, tips, checklists and implementation opportunities

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Orientation to the CMMI

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The model

Capability Maturity Model Integration (CMMI), Version 1.1, CMMI for Systems Engineering, Integrated Product and Process Development, and Supplier Sourcing (CMMI-SE/SW/IPPD/SS, V1.1), Continuous Representation, CMU/SEI-2002-TR-011, Carnegie Mellon University, March 2002, available at:

www.sei.cmu.edu/publications/documents/02.reports/02tr011.html

Capability Maturity Model Integration (CMMI), Version 1.1, CMMI for Systems Engineering, Integrated Product and Process Development, and Supplier Sourcing (CMMI-SE/SW/IPPD/SS, V1.1), Staged Representation, CMU/SEI-2002-TR-012, Carnegie Mellon University, March 2002, available at:

www.sei.cmu.edu/publications/documents/02.reports/02tr012.html

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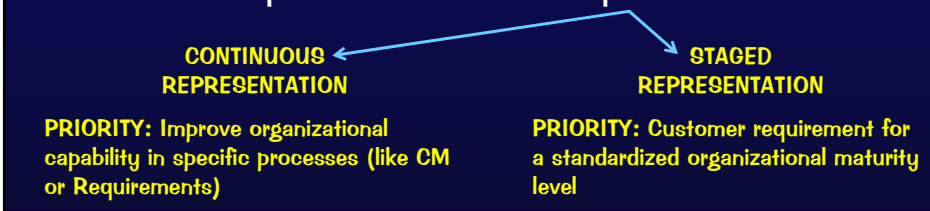
A few words about

Continuous and Staged

- CMMI is provided in two representations



- Your organization diligently studied the two representations and picked one (see the Introduction)
- Content – the individual requirements - is the same; the organization and nomenclature is different

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A few words about

Levels

- Staged supports *organizational maturity*
  - Level 2 through 5
- Continuous supports *process capability*
  - Levels 0 through 5
- Your organization diligently studied the current state of its development practices and established a realistic target for capability or maturity level
- Each increase in level adds requirements

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INTEGRATED PROJECT MANAGEMENT

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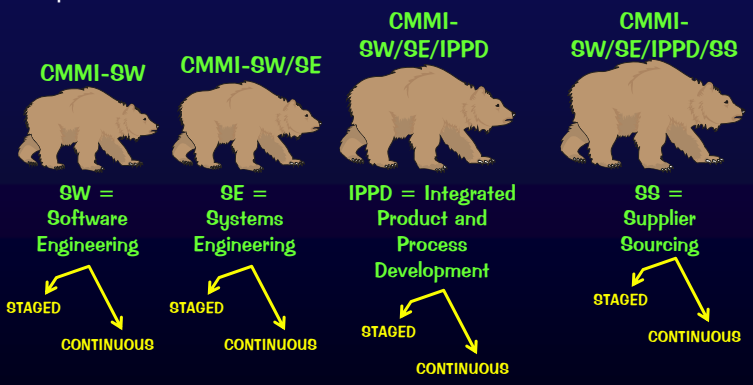
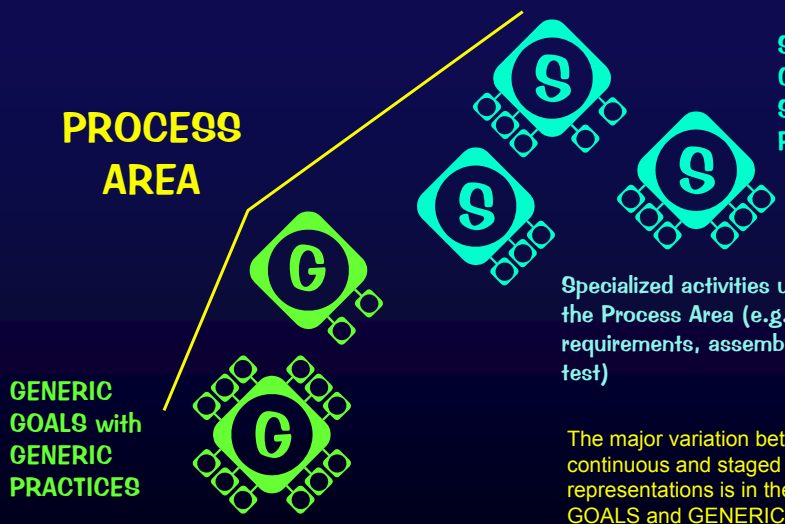
A few words about
Disciplines

- Each CMMI representation is provided in four versions based on disciplines



- Your organization diligently studied the four versions and picked one
- Each discipline adds requirements and/or clearly labeled guidance

Process Areas, Goals and Practices



Specialized activities unique to the Process Area (e.g., review requirements, assemble product, test)

Activities that enable the specific practices (e.g., plan process, train, measure performance, report progress)

The major variation between the continuous and staged representations is in the GENERIC GOALS and GENERIC PRACTICES included in a process area.

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Required, expected, informative

- Required CMMI components ...

  are essential to achieving process improvement in a given process area. These components are used in appraisals to determine process capability. **Specific** goals **and generic goals** are required model components. Goal achievement (or satisfaction) is … the basis upon which process area satisfaction and organizational maturity are determined.

- Expected CMMI components ...

  explain what **may** be done to satisfy a required CMMI component. Model users can implement the expected components explicitly or implement **equivalent alternative practices** to these components. **Specific and generic practices** are expected model components.

- Informative CMMI components ...

  help model users understand the required and expected components of a model. These components may contain examples, detailed explanations, or other helpful information. **Subpractices, notes, references, goal titles, practice titles, sources, typical work products, discipline amplifications, and generic practice elaborations** are informative model components.

The 25 CMMI Process Areas

CAR	Causal Analysis and Resolution
CM	Configuration Management
DAR	Decision Analysis and Resolution
IPM	Integrated Project Management for IPPD
ISM	Integrated Supplier Management
IT	Integrated Teaming
MA	Measurement and Analysis
OEI	Organizational Environment for Integration
OID	Organizational Innovation and Deployment
OPD	Organizational Process Definition
OPF	Organizational Process Focus
OPP	Organizational Process Performance
OT	Organizational Training
PI	Product Integration
PMC	Project Monitoring and Control
PP	Project Planning
PPQA	Process and Product Quality Assurance
QPM	Quantitative Project Management
RD	Requirements Development
RM	Requirements Management
RSKM	Risk Management
SAM	Supplier Agreement Management
TS	Technical Solution
VAL	Validation
VER	Verification

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CMMI Process Areas by Category

CATEGORY	Type	Process Area	
Process Management (PCM)	Basic	OPF	Organizational Process Focus
		OPD	Organizational Process Definition
		OT	Organizational Training
	Advanced	OPP	Organizational Process Performance
		OID	Organizational Innovation and Deployment
Project Management (PJM)	Basic	PP	Project Planning
		PMC	Project Monitoring and Control
		SAM	Supplier Agreement Management
	Advanced	IPM	Integrated Project Management for IPPD
		RSKM	Risk Management
		ISM	Integrated Supplier Management
		IT	Integrated Teaming
		QPM	Quantitative Project Management
Engineering (ENG)		RM	Requirements Management
		RD	Requirements Development
		TS	Technical Solution
		PI	Product Integration
		VER	Verification
		VAL	Validation
Support (SUP)	Basic	MA	Measurement and Analysis
		PPQA	Process and Product Quality Assurance
		CM	Configuration Management
	Advanced	DAR	Decision Analysis and Resolution
		OEI	Organizational Environment for Integration
		CAR	Causal Analysis and Resolution

Categories and interactions

CMMI, Section 5, *Four Categories of CMMI Process Areas*

Although we are grouping process areas this way to discuss their interactions, process areas often interact and have an effect on one another regardless of their defined group.

You must be aware of the interactions that exist among CMMI model components to apply the model in a useful and productive way.

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Employ established principles

CMMI, Section 1, *About CMMI Models*

Use professional judgment to interpret CMMI specific and generic practices. Although process areas depict behavior that should be exhibited in any organization, all practices must be interpreted using an in-depth knowledge of the CMMI model being used, the organization, the business environment, and the circumstances involved.

CMMI, Section 1, *Introduction*

CMMI models are not processes or process descriptions. The actual processes used in an organization depend on many factors, including application domain(s) and organization structure and size. In particular, the process areas of a CMMI model typically do not map one to one with the processes used in your organization.

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Employ established principles (cont.)

Before you begin using a CMMI model for improving processes, you MUST map your processes to CMMI process areas. This mapping enables you to control process improvement in your organization by helping you track your organization's conformance to the CMMI model you are using. It is not intended that every CMMI process area maps one to one with your organization's processes [sic]. (**CMMI**, *Section 2, Structural Overview*)

When using any CMMI model, you MUST interpret the practices so that they work for your organization. (**CMMI**, *Section 3, Common Terminology with Special Meaning,* under "*Adequate, Appropriate, As Needed")*

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The intended scope of CMMI

Within Engineering

The Engineering process areas are written in a general engineering terminology so any technical discipline involved in the product development process (e.g., software engineering, mechanical engineering) can use them for process improvement.
(CMMI, *Chapter 5*, *Four Categories of CMMI Process Areas*)

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Establish and Maintain

When using a CMMI model, you will encounter goals and practices that include the phrase “establish and maintain.” This phrase connotes a meaning beyond the component terms; it includes documentation and usage. For example, “Establish and maintain an organizational policy for planning and performing the organizational process focus process” means that not only must a policy be formulated, but it also must be documented and it must be used throughout the organization.
CMMI, Section 3, *Establish and maintain*

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Processes and process descriptions

A managed process

… is a performed process that is planned and executed in accordance with policy; employs skilled people having adequate resources to produce controlled outputs; involves relevant stakeholders; is monitored, controlled, and reviewed; and is evaluated for adherence to its process description. **(CMMI , Chapter 3)**

A defined process

… is a managed process that is tailored from the organization's set of standard processes according to the organization's tailoring guidelines; has a maintained process description; and contributes work products, measures, and other process-improvement information to the organizational process assets. **(CMMI, Chapter 3)**

A defined process clearly states: CMMI Continuous, Chapter 4, Capability Level 3, Defined

- Purpose
- Inputs
- Entry criteria
- Activities
- Roles
- Measures
- Verification steps
- Outputs
- Exit criteria

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Process description defined

The level of detail is not specified. Consider process complexity, operator skills and training, frequency of execution, and risk.

Process description
A documented expression of a set of activities performed to achieve a given purpose that provides an operational definition of the major components of a process. The documentation specifies, in a complete, precise, and verifiable manner, the requirements, design, behavior, or other characteristics of a process. It also may include procedures for determining whether these provisions have been satisfied. Process descriptions may be found at the activity, project, or organizational level.
(CMMI, Glossary)

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SEI commentary (and what appraisers look for)

The concept of documented procedure is handled by the generic goal that says that you perform a process according to a managed or defined process. The definition of a "managed process" includes documenting the process and procedures that you use. The term "according to a documented procedure" is not explicitly used in the model.

(CMMI FAQ, Feb. 2002, under "Model Interpretation")

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The intended scope of CMMI (cont.)

Beyond Engineering

- Numerous references to Support, Sustainment, Manufacturing

OPD SP 1.2-1 Establish Life-Cycle Model Descriptions

Establish and maintain descriptions of the life-cycle models approved for use in the organization.

Typically, the organization needs both product and project life-cycle models … for defining the phases of the project.

Product life-cycle models partition the product life cycle into phases for which activities and requirements can be defined to promote a complete solution, from initiating development of the product to its ultimate disposal.

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Chasing levels

Maturity levels are measured by the the achievement of the specific and generic goals that apply to each pre-defined set of process areas. [2000-TR-30, paragraph 2, p. 23]

Conformance with a process area means that in the planned and implemented processes there is an associated process (or processes) that addresses either the specific and generic practices of the process area or alternatives that clearly and unequivocally accomplish a result that meets the goal associated with that specific or generic practice. [2000-TR-30, paragraph 2, p. 26]

… trying to skip maturity levels is usually counter-productive. [2000-TR-30, paragraph 2, p. 24]

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Why Integrated Project Management (IPM)?

Shouldn't it wait until Level 3?

- For small organizations, small projects, level 3 PAs can be set as the initial goal
  - Support for cross-functional teams
  - Significant benefits in going beyond monitoring and control (Level 2)
- S/W CMM v1.1 - transition, inspiration
- Because sometimes skipping levels is productive
  - **Or, because sometimes not skipping levels is counterproductive**

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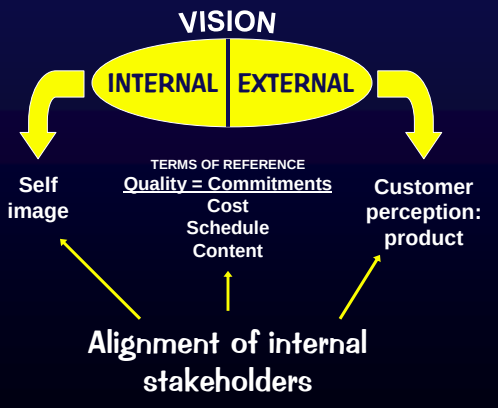
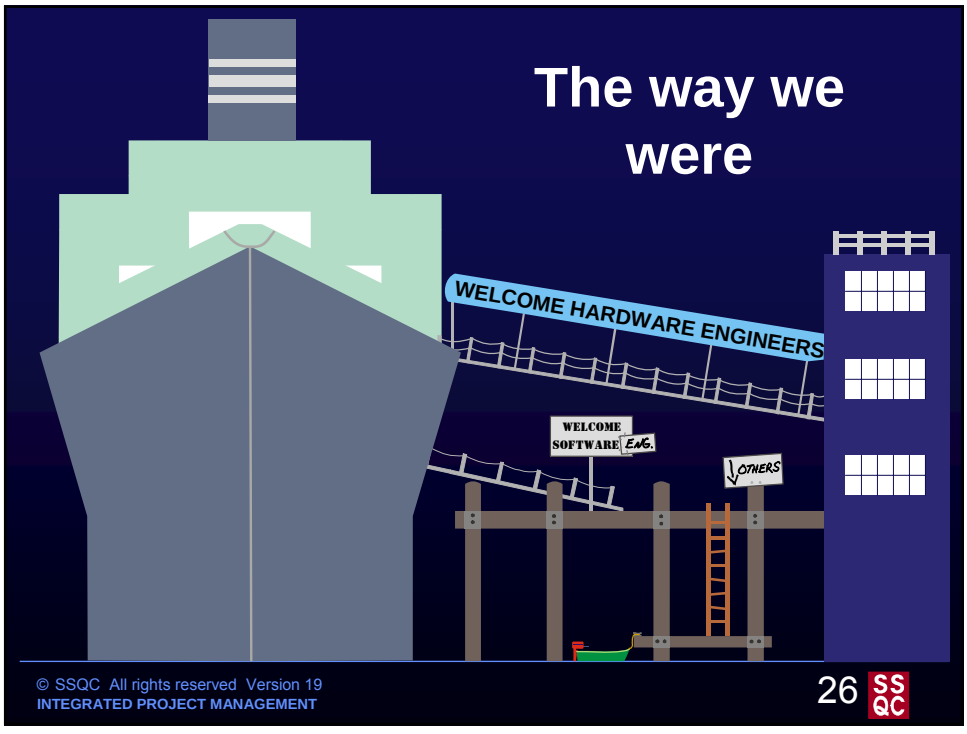
Importance TO PROCESS IMPROVEMENT
Support FOR VISION AND BUSINESS OBJECTIVES

Establish and manage the project and the involvement of relevant stakeholders according to an integrated and defined process
[v1.1, IPM, Purpose]

IPM is a cornerstone of process improvement. It enhances every Engineering, Support, and Project Management PA.

It enables continuous, systematic alignment of resources, activities, and business objectives - converging on customer value.





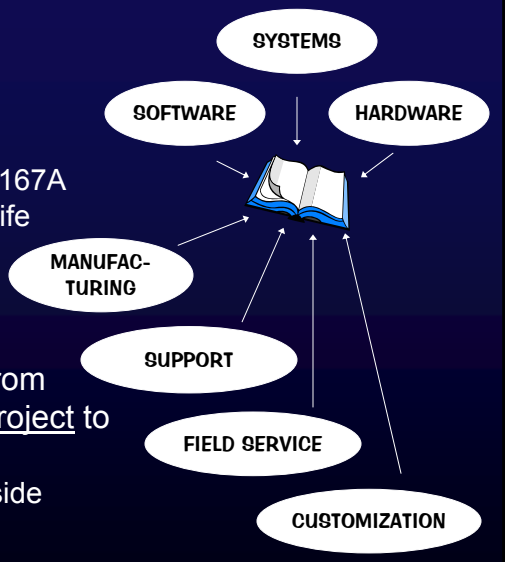
CMMI: Opportunities beyond S/W and the S/W CMM

Integrate engineering disciplines - one "book"

- Reduce influence and language of MIL-STD-2167A
- Appears more flexible, life cycle independent
- More content for engineering

IPPD - Expands scope from (software) engineering project to product delivery

- Inclusion of groups outside engineering is explicit



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Benefits TO THE ORGANIZATION

Since the defined process of each project is tailored from the organization's set of standard processes, variability among projects is typically reduced and projects can more easily share process assets, data, and lessons learned. [v1.1, IPM, Introductory Notes]

Reduced variability and a systematic multi-discipline view of product delivery translates directly into satisfying commitments to all stakeholders, including customers.

Enforced reuse of assets minimizes the cost of reinvention and lays a stable foundation for continuous improvement.

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Relationships and dependencies

WITHIN THE PROJECT MANAGEMENT CATEGORY

Integrated Project Management (IPM) ...

- Relies on Project Planning (PP) and Project Monitoring and Control (PMC) for basic project planning and management.
  - Adds requirements for systematic coordination.
  - Incorporates data to drive decisions.
- Integrates Supplier Agreement Management (SAM) to support outsourcing development.

IPM + PP + PMC

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IPM: Specific goals and practices

From OPD

SPECIFIC GOALS

SG 1 The project is conducted using a defined process that is tailored from the organization's set of standard processes.

SG 2 Coordination and collaboration of the project with relevant stakeholders is conducted.

SPECIFIC PRACTICES

SP1.1 Establish, maintain the project's defined process.

SP 1.2 Add to PP — Use the organizational process assets and measurement repository for estimating and planning the project's activities.

SP 1.3 Add to PP — Integrate the project plan and the other plans that affect the project to describe the project's defined process.

SP 1.4 Add to PMC — Manage the project using the project plan, the other plans that affect the project, and the project's defined process.

SP1.5 Contribute work products, measures, and documented experiences to the organizational process assets.

Send to OPF

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A critical specific practice

SPECIFIC PRACTICE

1.4 Manage the project using the integrated plans

- IMS, IMP, or ...
- New Product Introduction
- Support
- Manufacturing Engineering
- Training
- Technology Transfer
- Manufacturing Master Plan

WHY: **product delivery** is beyond any one group's capabilities, responsibilities

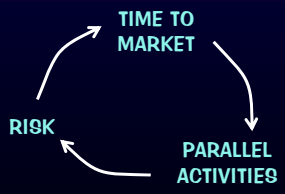
SIGNIFICANT INDICATOR(S):
SP1.3, SubPractice 5, peer reviews
SP1.4, SubPractice 2, thresholds

AFFECTED STAKEHOLDERS:
Project team (Mktg … Mfg)

RESISTANCE:
Accountability - being measured, reporting progress

SPECIAL APPRAISAL CONSIDERATIONS AND CHALLENGES: Prepare, prepare, and prepare - Ensure there is adequate preparation time to review the volume of documentation

RECOMMENDATIONS:
Pilot - pick your project wisely



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Specific practice 1.4, subpractice 2

2. **Monitor and control the project's activities and work products using the project's defined process, project plan, and other plans that affect the project.**

   This task typically includes the following:

   - Using the defined entry and exit criteria to authorize the initiation and determine the completion of the tasks
   - Monitoring the activities that could significantly affect the actual values of the project's planning parameters
   - Tracking the project's planning parameters using measurable thresholds that will trigger investigation and appropriate actions
   - Monitoring product and project interface risks
   - Managing external and internal commitments based on the plans for the tasks and work products of implementing the project's defined process.

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Project management

- Models - predict
- Metrics - track
- Key performance indicators

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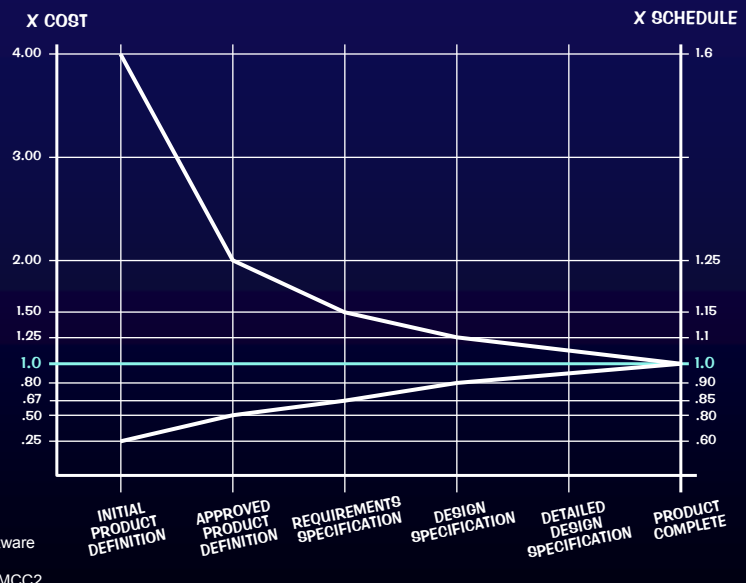
SP 1.2 Use the organizational measurement repository

Model variation: set management expectations



Based on S. McConnell, "Software Project Survival Guide", page 7, MCC2

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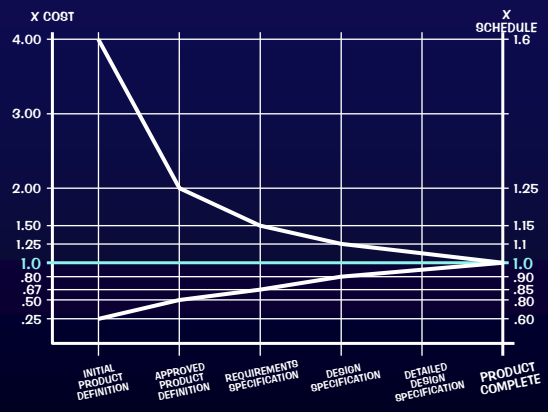
Manipulating the estimates for software

Myth 2: There is a way to get precise, valid estimates



What is possible: defined variance

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Software estimation accuracy

Requirements hazy, general purpose of new software clear

Detailed design done

CONCEPT ORIENTED ESTIMATE	FUNCTION ORIENTED ESTIMATE	IMPLEMENTATION ORIENTED ESTIMATE
± 50%	± 25%	± 10%

William Roetzheim, *Estimating Software Costs [Part 1 of 4]*, **Software Development**, Vol. 8, No. 10, October 2000

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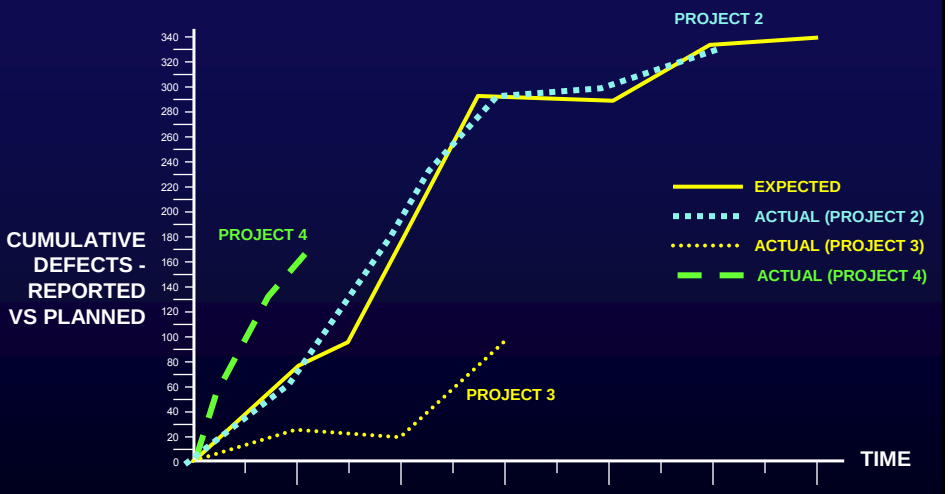
SP 1.2 Use the organizational measurement repository

Model performance: defects



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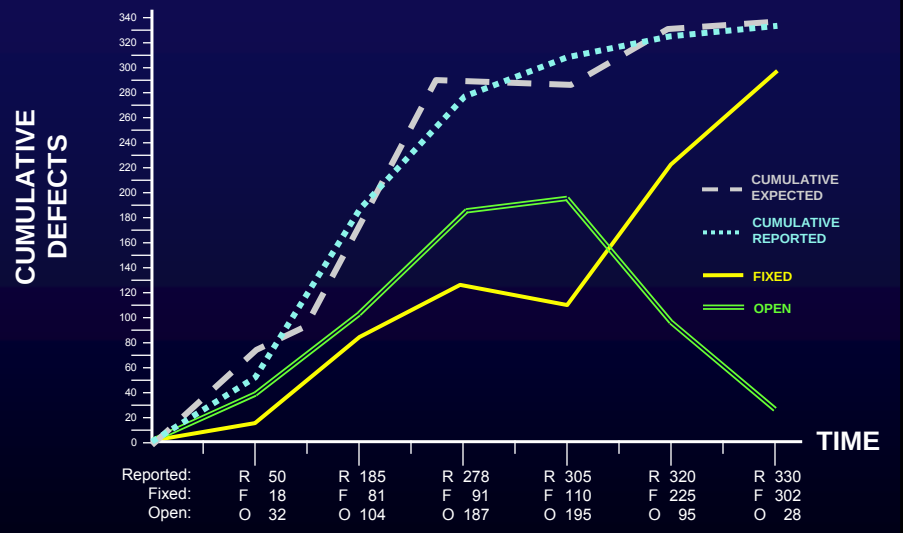
SP 1.2 Use the organizational measurement repository

Planning and Tracking performance: defects



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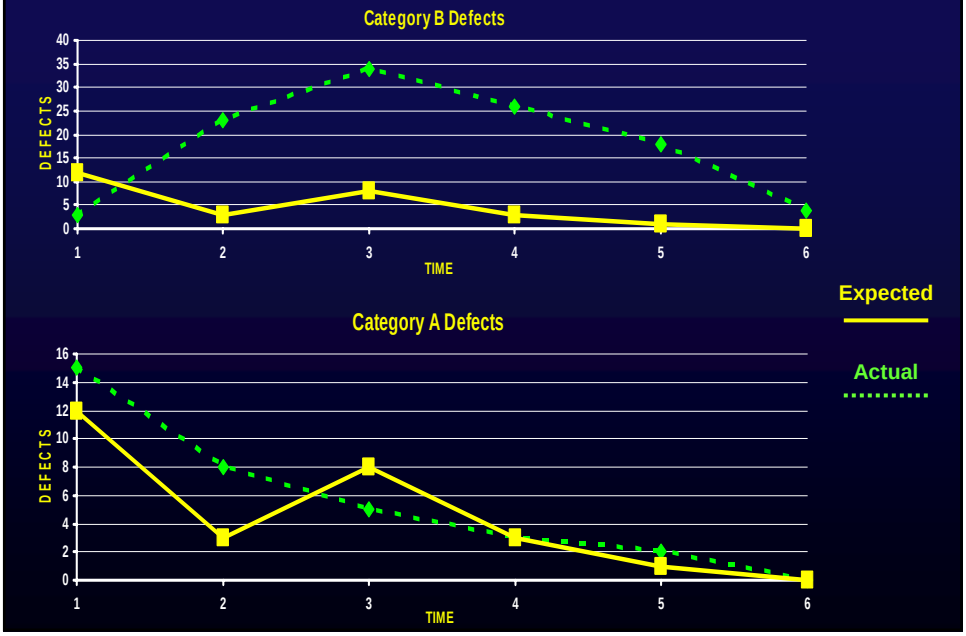
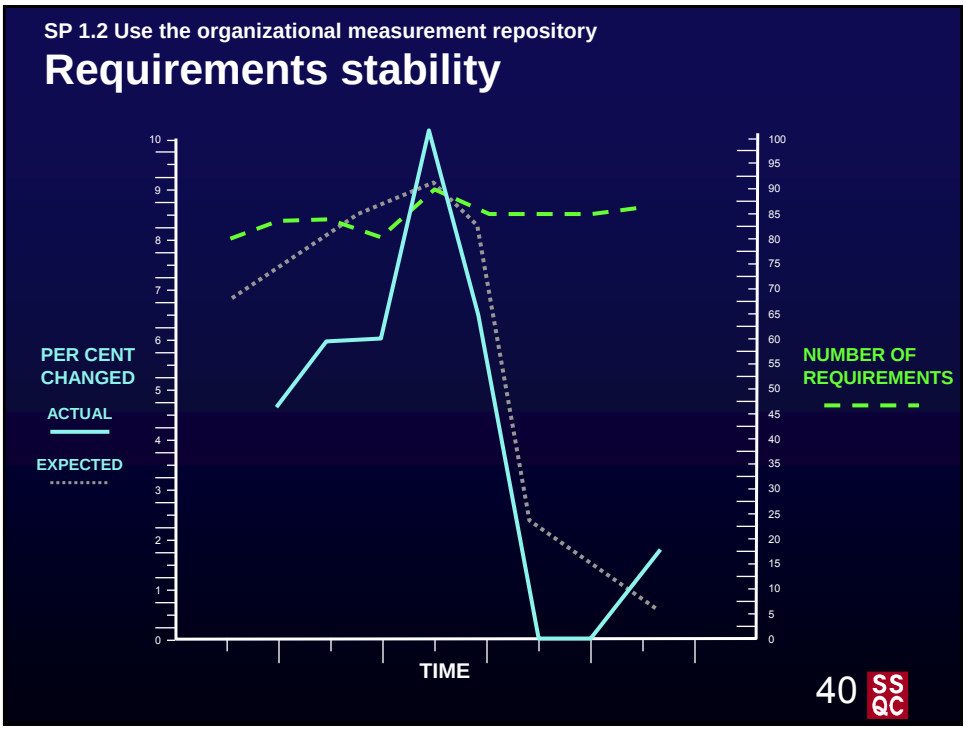
SP 1.2 Use the organizational measurement repository

Defects by severity



SP 1.2 Use the organizational measurement repository

Requirements stability



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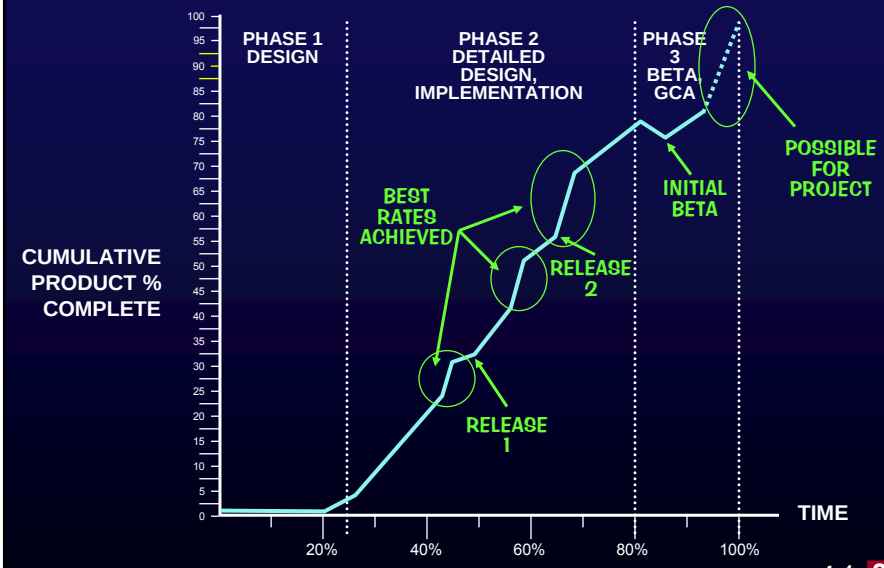
Tracking performance: product complete
(Part 2 – with project data)



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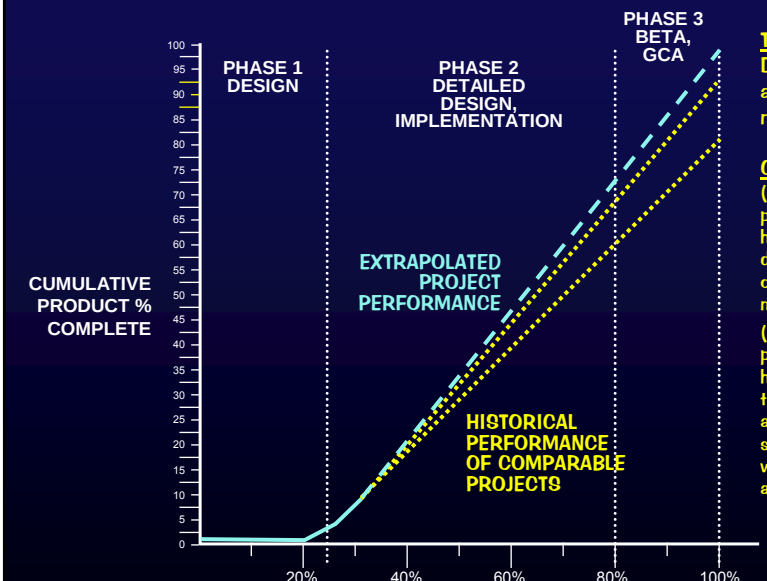
Tracking performance: product complete
(Part 1 – early in the project)



The goal:
Decision support and data-driven management

Cautions:
(1) Managing a project using only historical data is like driving a car using only the rear view mirror.

(2) Managing a project without historical data is like trying to arrive at an appointment in a strange city on time – without asking anyone for help.

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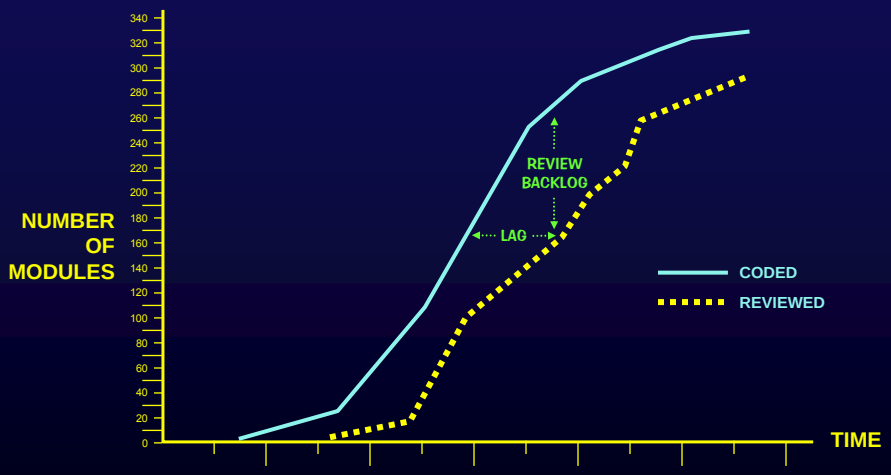
Tracking performance: reviews



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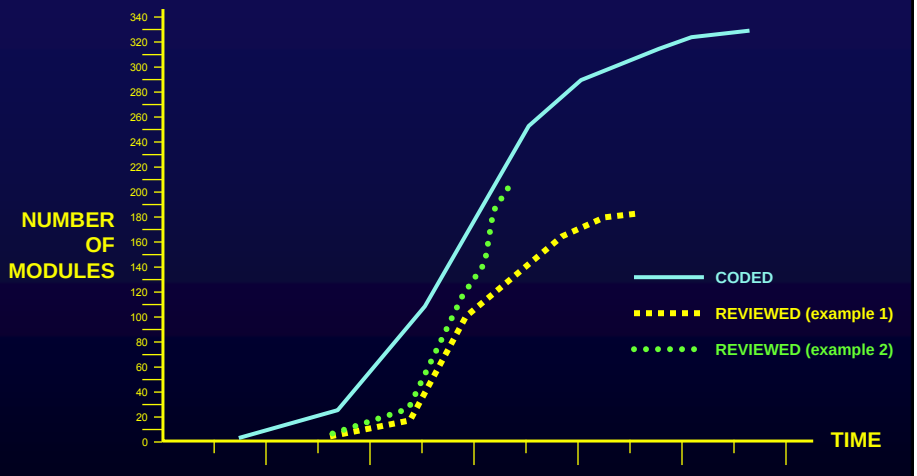
Tracking performance: reviews (cont.)



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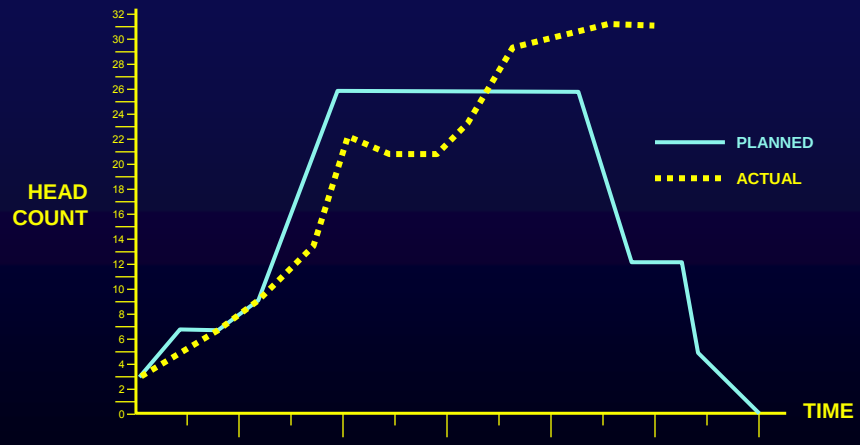
Tracking head count against the plan



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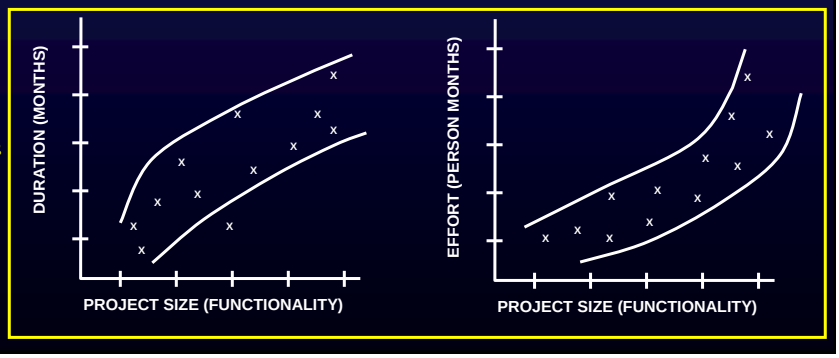
Manipulating the estimates for software

Myth 1: Add staff, compress the schedule

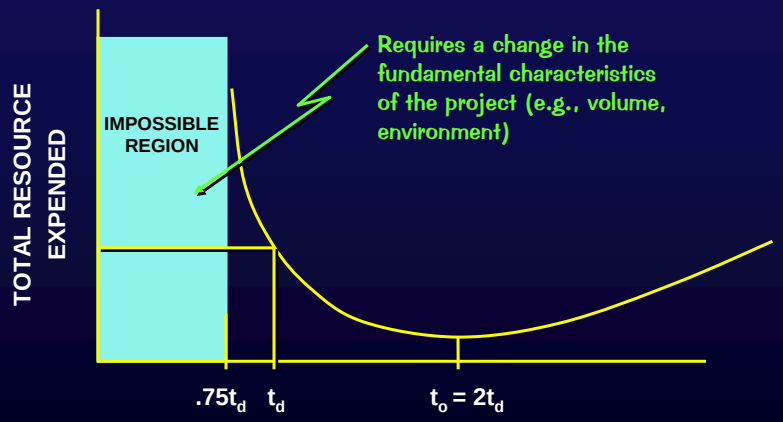
- Brooks' Law: manpower and time not interchangeable
- Based on a nominal schedule, 2x staff:
  - 20% faster
  - 6x defects
  - Coordination complexity = $(n^2-n)/2$
- Supported by core metrics: Size, Time, Effort, Defects (Anita Carleton, CAR1)
- GATHER DATA - Measure, learn from experience

Representing Experience

Michael Mah, MAH1



Myth 1: Add staff ... (cont.)



Roetzheim, ROE1; DOD1;
DeMarco, Controlling Software Projects,
Yourdon Press, New York, 1982

t_d = Calculated time of first delivery (from selected Rayleigh Curve or Boehm formula)

t_o = Cost optimal time (least effort and cost)

Manipulating the estimates for software

Myth 3: Reuse will save us

- To build in reusability: 2x effort
  - Per class library - from 20 to 40 days
  - Design, inspection, documentation
- Library maintenance
  - Coordinating obsolescence
- Learning curve (6 to 12 months)
  - Library consultant per 4 projects
  - Maintain, communicate, advise, mentor

PAG1, Meilir Page-Jones

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Manipulating the estimates for software

Myth 4: Assume we'll make it up later (somehow)

Arbitrarily cut time from activities that are further out (and for which estimates are inherently less accurate and defensible)

- Projects over budget when only 15% complete usually complete with overruns
- Actual completion costs will not improve by more than 10% of the current percent overrun
- For commercial projects
  - 10% late ~ 30% loss in profit
  - 50% cost overrun ~ 3% loss in profit

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IPM: Specific goals and practices (cont.)

SPECIFIC GOALS

SG 1 The project is conducted using a defined process that is tailored from the organization's set of standard processes.

SG 2 Coordination and collaboration of the project with relevant stakeholders is conducted.

SPECIFIC PRACTICES

SP2.1 Manage the involvement of the relevant stakeholders in the project.

SP 2.2 Participate with relevant stakeholders to identify, negotiate, and track critical dependencies.

SP 2.3 Resolve issues with relevant stakeholders.

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A critical specific practice

2.2 Manage [critical] dependencies

WHY: make dependencies continuously visible, mitigate or prevent impact

SIGNIFICANT INDICATOR(S):
SP2.2, SubPractice 5 - document the critical dependencies and commitments

AFFECTED STAKEHOLDERS:
Project team (Mktg … Mfg)

RESISTANCE:
Exposure - versus milestone chicken (*or* R = v / π)

SPECIAL APPRAISAL CONSIDERATIONS AND CHALLENGES: Look carefully at SubPractice 6 - track and take action

RECOMMENDATIONS: Pick a pilot project with a strong manager who under-stands the big picture; ensure team focuses on critical dependencies - avoid blame, focus on solutions

- Identify
- Inform
- Manage - SP 2.2.6
  - On or near critical path; or risk
  - Track and take corrective and preventive action
  - Evaluate the effects of late and early completion for impacts on future activities and milestones

I wish someone had told me …

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Specific practice 2.2, subpractice 5

5. Document the critical dependencies and commitments.

Documentation of commitments typically includes the following:

- Describing the commitment
- Identifying who made the commitment
- Identifying who is responsible for satisfying the commitment
- Specifying when the commitment will be satisfied
- Specifying the criteria for determining if the commitment has been satisfied

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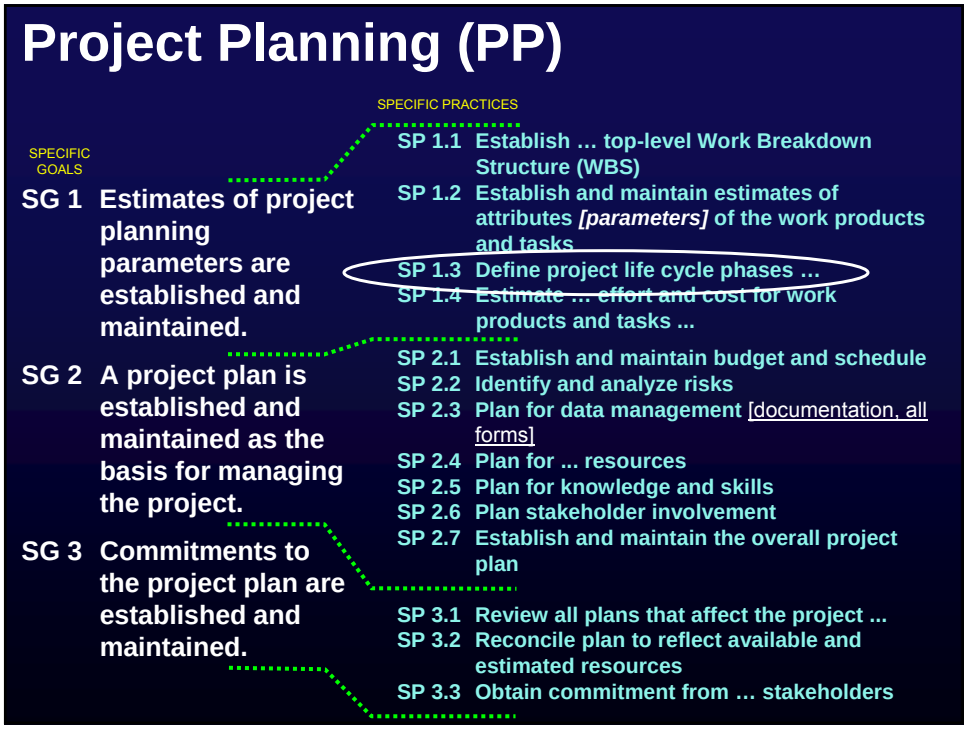
Project Planning (PP)



Life cycles and life cycles

From Project Planning (PP), Specific Practice 1.3

Define the project life-cycle phases upon which to scope the planning effort.

The determination of a project's life-cycle phases provides for planned periods of evaluation and decision making. These are normally defined to support logical decision points at which significant commitments are made concerning resources and technical approach. Such points provide planned events at which project course corrections and determinations of future scope and cost can be made.

For Software Engineering

The determination of project phases for software typically includes selection and refinement of a software development model to address interdependencies and appropriate sequencing of software project activities.

For Systems Engineering

Identify the major product phase (e.g., concept exploration, development, etc.) for the current state of the product ...

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Life cycles and life cycles (cont.)

More from Project Planning (PP), Specific Practice 1.3

The project life cycle consists of phases that need to be defined depending on the scope of requirements, the estimates for project resources, and the nature of the project. Larger projects may contain multiple phases, such as concept exploration, development, production, operations, and disposal. Within these phases, subphases may be needed. A development phase may include subphases such as requirements analysis, design, fabrication, integration, and verification. Depending on the strategy for development, there may be intermediate phases for the creation of prototypes, increments of capability, or spiral model cycles.

Understanding the project life cycle is crucial in determining the scope of the planning effort and the timing of the initial planning, as well as the timing and criteria (critical milestones) for re-planning.

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Life cycles and life cycles (cont.)

Guidance from IPM Specific Goal 1

The project's defined process must include those processes from the organization's set of standard processes that address all processes necessary to develop and maintain the product. The product-related life-cycle processes, such as the manufacturing and support processes, are developed concurrently with the product.

From Chapter 3

A “product life cycle” is the period of time, consisting of phases, that begins when a product is conceived and ends when the product is no longer available for use. ... A product life cycle could consist of the following phases: (1) concept/vision, (2) feasibility, (3) design/development, (4) production, and (5) phase out.

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Life cycles and life cycles (cont.)

From the Glossary

Integrated Product and Process Development	A systematic approach to product development that achieves a timely collaboration of relevant stakeholders throughout the product life cycle to better satisfy customer needs.

Guidance from RD Specific Practice 1.2

For Integrated Product and Process Development

Relevant stakeholders representing all phases of the product's life cycle should include business as well as technical functions. In this way, concepts for all product-related lifecycle processes are considered concurrently with the concepts for the products.

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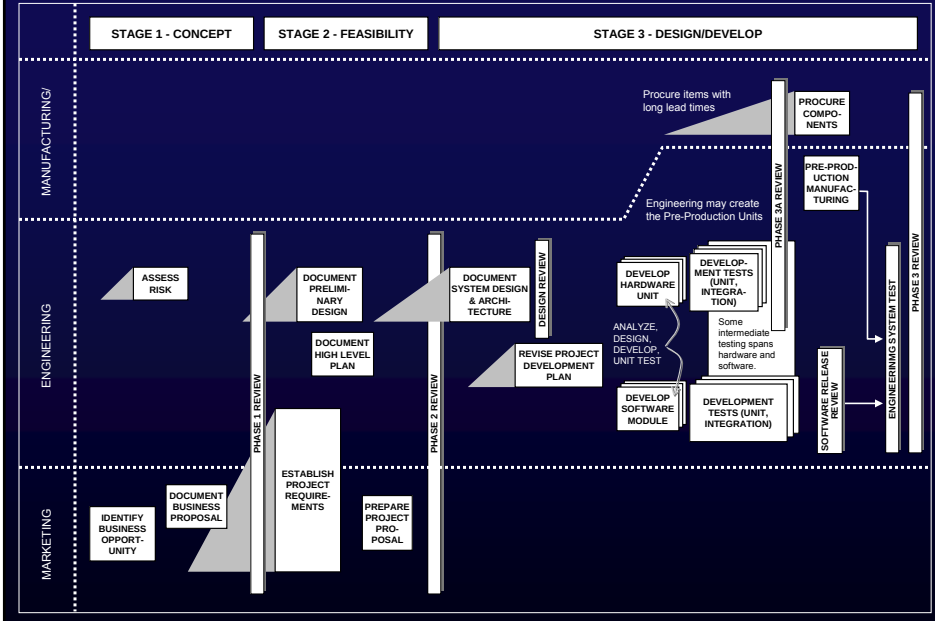

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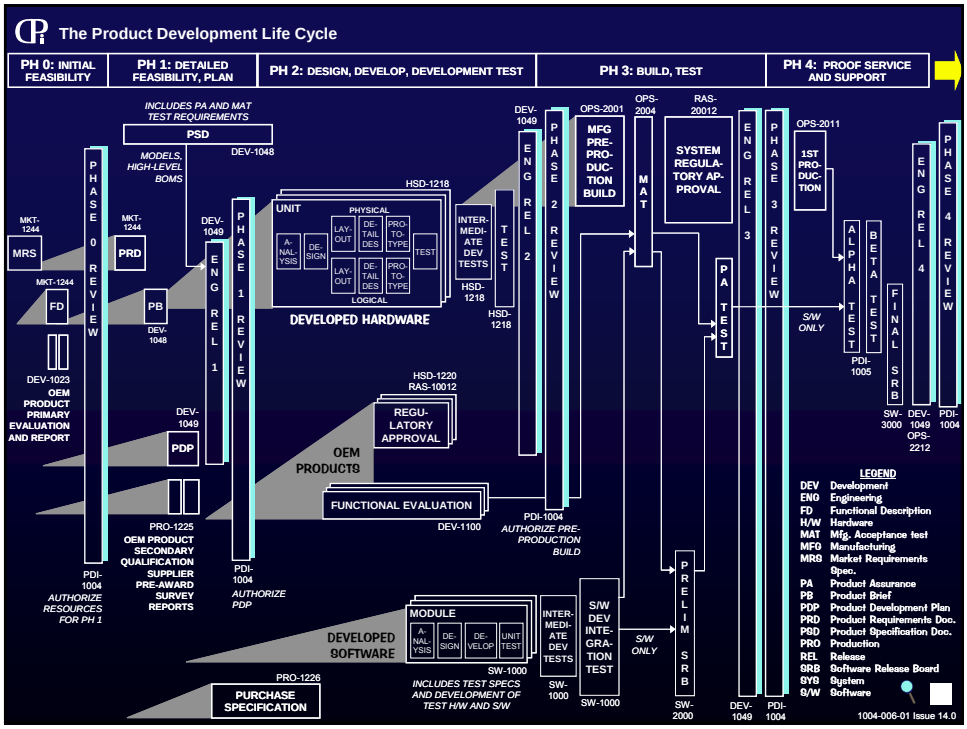
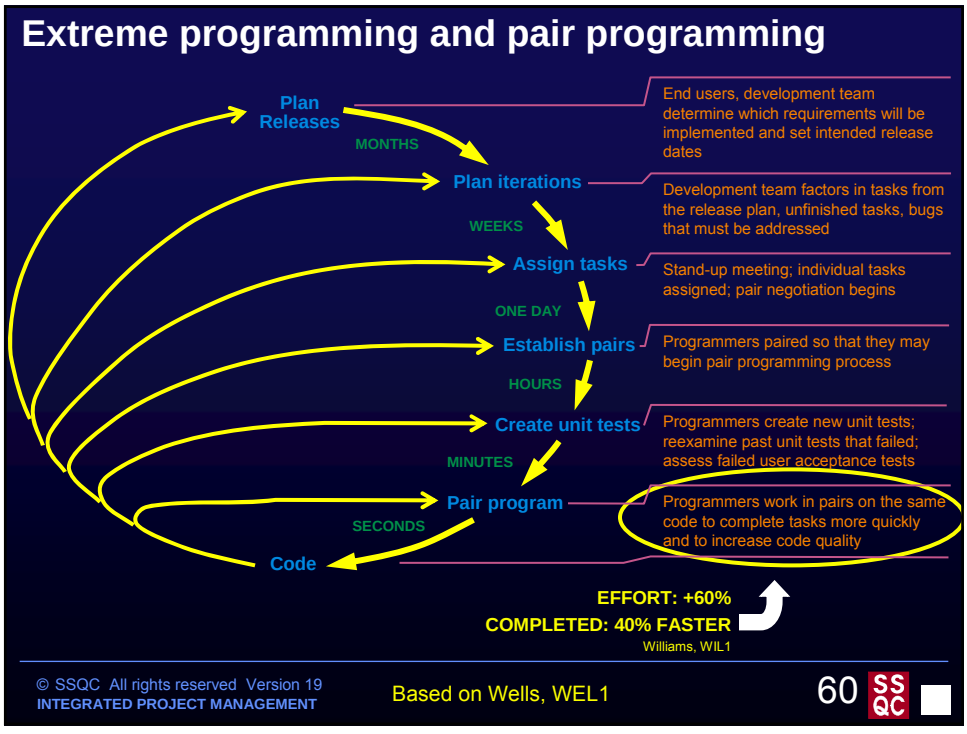

The Product Development Life Cycle
PH 0: INITIAL FEASIBILITY
PH 1: DETAILED FEASIBILITY, PLAN
PH 2: DESIGN, DEVELOP, DEVELOPMENT TEST
PH 3: BUILD, TEST
PH 4: PROOF SERVICE AND SUPPORT
INCLUDES PA AND MAT TEST REQUIREMENTS
PSD
DEV-1048
MODELS, HIGH-LEVEL BOMS
MKT-1244
MRS
PRD
FD
PB
DEV-1048
DEV-1023
OEM PRODUCT PRIMARY EVALUATION AND REPORT
PDP
PHASE 0 REVIEW
PDI-1004 AUTHORIZE RESOURCES FOR PH 1
PRO-1225 OEM PRODUCT SECONDARY QUALIFICATION SUPPLIER PRE-AWARD SURVEY REPORTS
ENG REL 1
PHASE 1 REVIEW
PDI-1004 AUTHORIZE PDP
HSD-1218
UNIT
PHYSICAL
LOGICAL
A-NAL-YSIS
DE-SIGN
LAY-OUT
DE-TAIL DES
PRO-TO-TYPE
TEST
DEVELOPED HARDWARE
INTER-MEDI-ATE DEV TESTS
HSD-1218
TEST
HSD-1220 RAS-10012
REGU-LATORY APPROVAL
OEM PRODUCTS
FUNCTIONAL EVALUATION
DEV-1100
PDI-1004 AUTHORIZE PRE-PRODUCTION BUILD
DEV-1049
ENG REL 2
PHASE 2 REVIEW
OPS-2001
MFG PRE-PRO-DUC-TION BUILD
OPS-2004
MAT
RAS-20012
SYSTEM REGULA-TORY AP-PROVAL
PA TEST
PRELIM SRB
SW-2000
MODULE
A-NAL-YSIS
DE-SIGN
DE-VELOP
UNIT TEST
SW-1000
INTER-MEDI-ATE DEV TESTS
SW-1000
S/W DEV INTE-GRA-TION TEST
SW-1000
S/W ONLY
INCLUDES TEST SPECS AND DEVELOPMENT OF TEST H/W AND S/W
PRO-1226
PURCHASE SPECIFICATION
DEVELOPED SOFTWARE
ENG REL 3
PHASE 3 REVIEW
DEV-1049
PDI-1004
OPS-2011
1ST PRO-DUC-TION
ALPHA TEST
BETA TEST
S/W ONLY
PDI-1005
FINAL SRB
SW-3000
ENG REL 4
DEV-1049 OPS-2212
PHASE 4 REVIEW
PDI-1004
LEGEND
DEV Development
ENG Engineering
FD Functional Description
H/W Hardware
MAT Mfg. Acceptance test
MFG Manufacturing
MRS Market Requirements Spec.
PA Product Assurance
PB Product Brief
PDP Product Development Plan
PRD Product Requirements Doc.
PSD Product Specification Doc.
PRD Production
REL Release
SRB Software Release Board
SYS System
S/W Software
1004-006-01 Issue 14.0


Extreme programming and pair programming
Plan Releases
MONTHS
End users, development team determine which requirements will be implemented and set intended release dates
Plan iterations
WEEKS
Development team factors in tasks from the release plan, unfinished tasks, bugs that must be addressed
Assign tasks
ONE DAY
Stand-up meeting; individual tasks assigned; pair negotiation begins
Establish pairs
HOURS
Programmers paired so that they may begin pair programming process
Create unit tests
MINUTES
Programmers create new unit tests; reexamine past unit tests that failed; assess failed user acceptance tests
Pair program
SECONDS
Programmers work in pairs on the same code to complete tasks more quickly and to increase code quality
Code
EFFORT: +60%
COMPLETED: 40% FASTER
Williams, WIL1
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Based on Wells, WEL1
60
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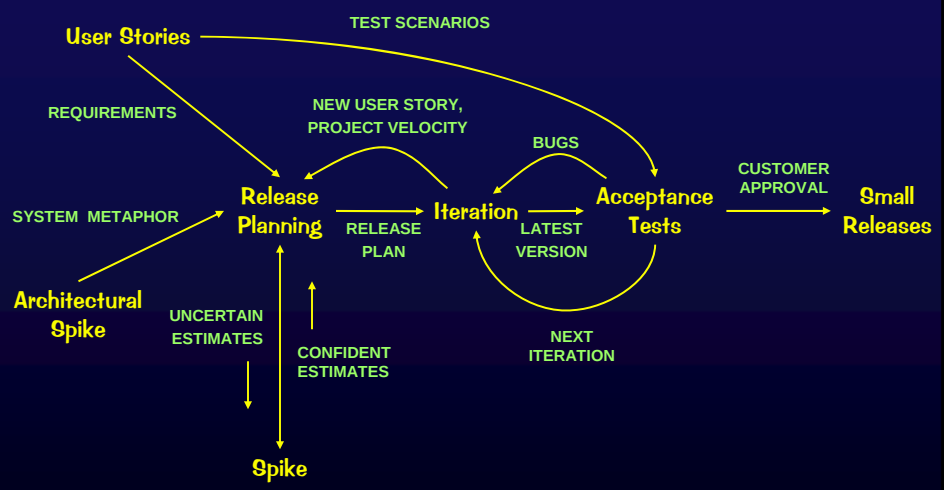
Extreme programming - as a process flow



Wells, WEL2

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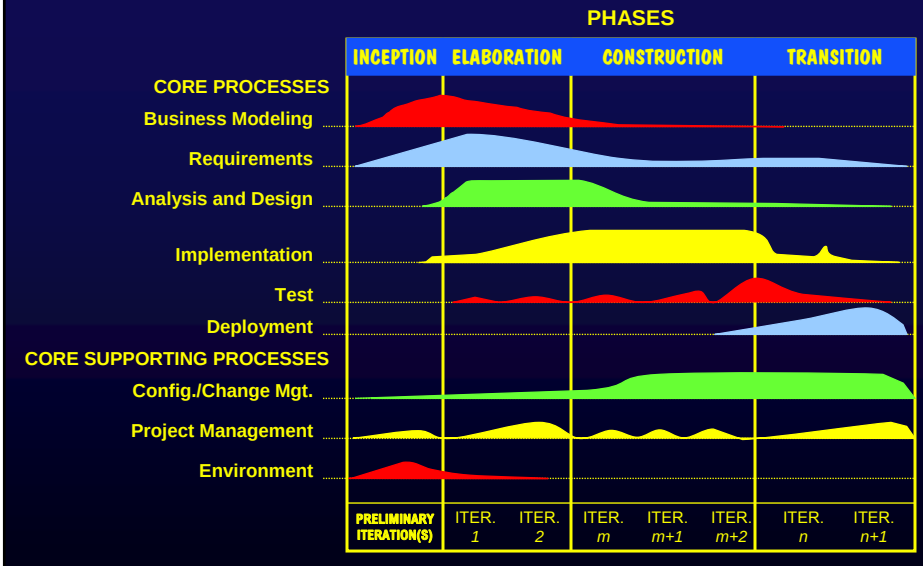
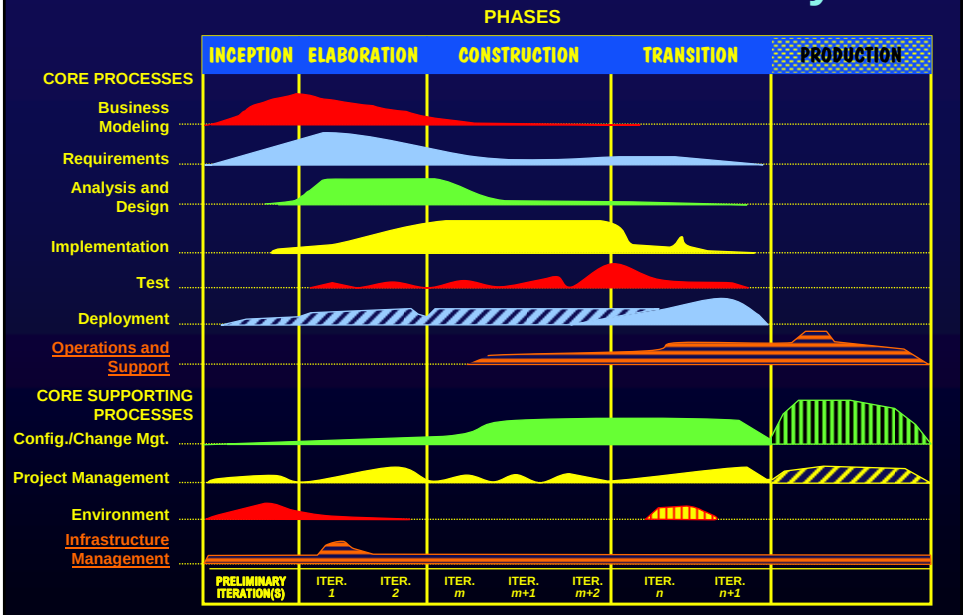
Unified Process Life Cycle



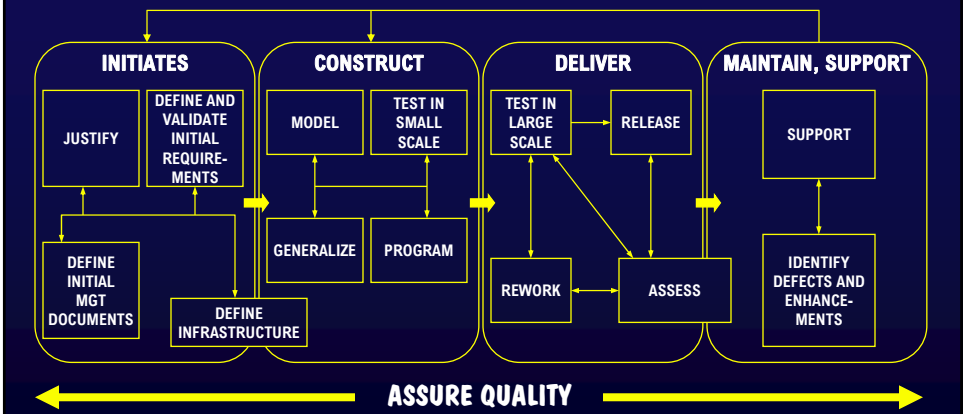
Scott Ambler, *Enhancing the Unified Process*, **Software Development** , Vol. 7, No. 10, Oct. 1999, p.33

Enhanced Unified Process Life Cycle



Scott Ambler, *Enhancing the Unified Process*, **Software Development** , Vol. 7, No. 10, Oct. 1999, p.33

The Object-Oriented Process (OOSP) Life Cycle



- Manage the project
- Train and educate
- Manage people
- Manage risk
- Manage reuse
- Manage metrics
- Manage deliverables
- Manage infrastructure

Scott Ambler, *Enhancing the Unified Process*, **Software Development** , Oct. 1999, p.33

Project Monitoring and Control (PMC)

SPECIFIC GOALS	SPECIFIC PRACTICES
SG 1 Actual performance and progress of the project are monitored against the project plan.	Monitor actuals against the plan: SP 1.1 Parameters SP 1.2 Commitments SP 1.3 Risks SP 1.4 Data management SP 1.5 Stakeholder involvement SP 1.6 Periodically review progress, performance, issues SP 1.7 Review accomplishments and results at selected milestones
SG 2 Corrective actions are managed to closure when the project's performance or results deviate significantly from the plan.	SP 2.1 Collect and analyze the issues and determine the corrective actions necessary to address the issues. SP 2.2 Take corrective action on identified issues. SP 2.3 Manage corrective actions to closure … *complete … effective*.

NOTE The word *dependency* does not appear in Project Monitoring and Control.

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Integrated Product and Process Development (IPPD)

- With IPPD you get:
  - Two new specific goals for Integrated Product Management (IPM)
  - Two new Process Areas (PA)s
  - Amplification in various other Process Areas
  - Only 64 more pages

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IPPD: Specific goals for Integrated Project Management (IPM)

SPECIFIC GOALS

SG 1 The project is conducted using a defined process that is tailored from the organization's set of standard processes.

SG 2 Coordination and collaboration of the project with relevant stakeholders is conducted.

SG 3 The project is conducted using the project's shared vision.

SG 4 The integrated teams needed to execute the project are identified, defined, structured, and tasked.

SPECIFIC PRACTICES

SP3.1 Identify expectations, constraints, interfaces, and operational conditions applicable to the project's shared vision.

SP 3.2 Establish and maintain a shared vision for the project.

SP 3.3 Resolve issues with relevant stakeholders.

IPPD: Specific goals for Integrated Project Management (IPM) (cont.)

SPECIFIC GOALS

SG 1 The project is conducted using a defined process that is tailored from the organization's set of standard processes.

SG 2 Coordination and collaboration of the project with relevant stakeholders is conducted.

SG 3 The project is conducted using the project's shared vision.

SG 4 The integrated teams needed to execute the project are identified, defined, structured, and tasked.

SPECIFIC PRACTICES

SP 4.1 Determine the integrated team structure that will best meet the project objectives and constraints.

SP 4.2 Develop a preliminary distribution of requirements, responsibilities, authorities, tasks, and interfaces to teams in the selected integrated team structure.

SP 4.3 Establish and maintain teams in the integrated team structure.

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Case Study: AJ OY

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Integrated Product and Process Development (IPPD) - Beyond IPM

- Two new Process Areas
  - Level
  - Category
  - Goals
- Implementation considerations and recommendations
  - Tools and techniques
  - A road map

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Integrated Product and Process Development (IPPD): Process Areas

Maturity Level 2: Managed	Maturity Level 3: Defined
▪ Requirements Management ▪ Project Planning ▪ Project Monitoring and Control ▪ Supplier Agreement Management ▪ Measurement and Analysis ▪ Process and Product Quality Assurance ▪ Configuration Management	▪ Requirements Development ▪ Technical Solution ▪ Product Integration ▪ Verification ▪ Validation ▪ Organizational Process Focus ▪ Organizational Process Definition ▪ Organizational Training ▪ Integrated Project Management **for IPPD** ▪ Risk Management ▪ **Integrated Teaming** ▪ Decision Analysis and Resolution ▪ **Organizational Environment for Integration**

Maturity Level 4: Quantitatively Managed	Maturity Level 5: Optimizing
▪ Organizational Process Performance ▪ Quantitative Project Management	▪ Organizational Innovation and Deployment ▪ Causal Analysis and Resolution

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Integrated Product and Process Development (IPPD): Process categories

Category	Type	Level	Process Area
Process Management	Basic	3	Organizational Process Focus
		3	Organizational Process Definition
		3	Organizational Training
	Advanced	4	Organizational Process Performance
		5	Organizational Innovation and Deployment
Project Management	Basic	2	Project Planning
		2	Project Monitoring and Control
		2	Supplier Agreement Management
	Advanced	3	Integrated Project Management **for IPPD**
		3	Risk Management
		3	**Integrated Teaming**
		4	Quantitative Project Management
Engineering		2	Requirements Management
		3	Requirements Development
		3	Technical Solution
		3	Product Integration
		3	Verification
		3	Validation
Support	Basic	2	Measurement and Analysis
		2	Process and Product Quality Assurance
		2	Configuration Management
	Advanced	3	**Organizational Environment for Integration**
		3	Decision Analysis and Resolution
		5	Causal Analysis and Resolution

Organizational Environment for Integration (OEI)

SPECIFIC GOALS

SG 1 An infrastructure that maximizes the productivity of people and affects the collaboration necessary for integration is provided.

SG 2 People are managed to nurture the integrative and collaborative behaviors of an IPPD environment.

Integrated Teaming (IT)

SPECIFIC GOALS

SG1 A team composition that provides the knowledge and skills required to deliver the team's product is established and maintained.

SG2 Operation of the integrated team is governed according to established principles.

SW/SE/IPPD/SS

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Suggestions and comments: tools and techniques for integrated teams

- Periodic project reviews
  - The Key Deliverables Review (KDR)
    - Risk Management
- Milestone/Phase reviews
  - Checklists
- Earned Value as an approach
- Planning and replanning
  - Granularity

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KDRs - The simple truth

KDR REPORT - 01/14 - PHLM Project

WBS/DESCRIPTION	ORIGINAL	START LAST	CURRENT	ACTUAL
1 Requirements baselined	01/07		01/21	01/13
2 System design baselined	01/31		2/6	
3 Control subsystem	7/4			
3.1 Design baselined	3/07	3/21	3/14	
3.2 Prototype completed	5/4			
3.3 Prototype concept test completed	7/4			
4 Propulsion subsystem	9/15			
4.1 Design baselined	2/18		2/25	
4.2 Prototype completed	7/21			
4.3 Prototype concept test completed	9/15			
5 Control/Propulsion Integrated	12/01			
6 Control/Propulsion Integration Test	12/31			

COMMENTS
2 Resources not available to take advantage of early completion of 1
3.1 Adjusted for 1 week slip in 1
Expect to make up time and not slip subsequent steps by adding 1 engineer to project.

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How do you already incorporate risk prevention and mitigation into your projects?

A COMMENT

Some activities, which are not perceived as having intrinsic importance, may be parts of a mitigation strategy (cross training, reviews, investigation of alternatives).

If the mitigation strategy is not clearly communicated and managed, there is a significant risk that the mitigation will be OBE*.

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* OBE Overcome by Events

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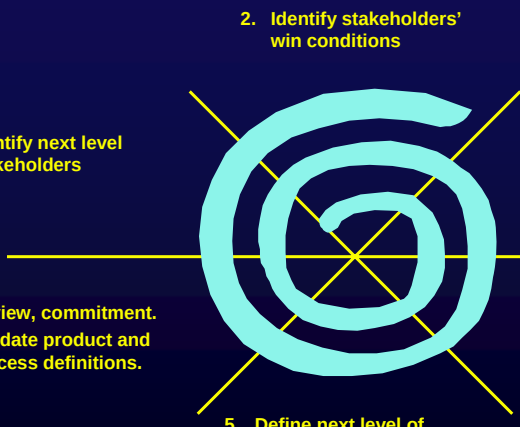
Risk and the new spiral model - the win-win elaboration



[BOE1]

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Top 10 Risks

1989	1995
1. Personnel shortfalls	1. Personnel shortfalls
2. Schedules and budgets	2. Schedules, budgets, process
3. Wrong software functions	3. COTS, external components
4. Wrong user interface	4. Requirements mismatch
5. Gold plating	5. User interface mismatch
6. Requirements changes	6. Architecture, performance, quality
7. Externally-furnished components	7. Requirements changes
8. Externally-performed tasks	8. Legacy software
9. Real-time performance	9. Externally-performed tasks
10. Straining computer science	10. Straining computer science

Barry Boehm

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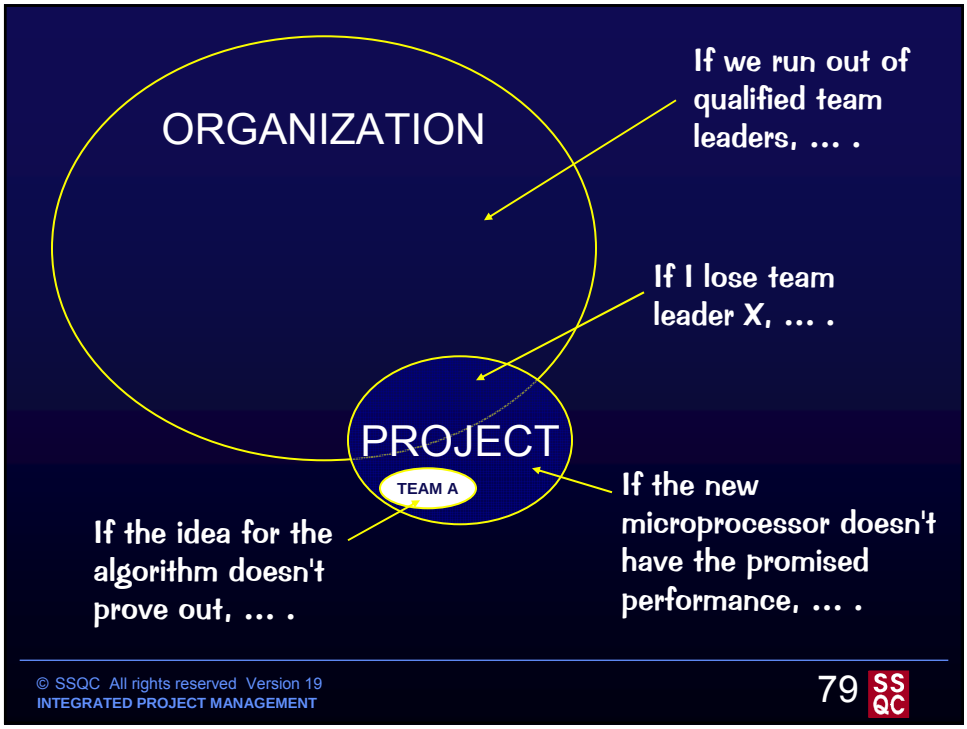
ORGANIZATION
If we run out of qualified team leaders, ...
If I lose team leader X, ...
PROJECT
TEAM A
If the idea for the algorithm doesn't prove out, ...
If the new microprocessor doesn't have the promised performance, ...
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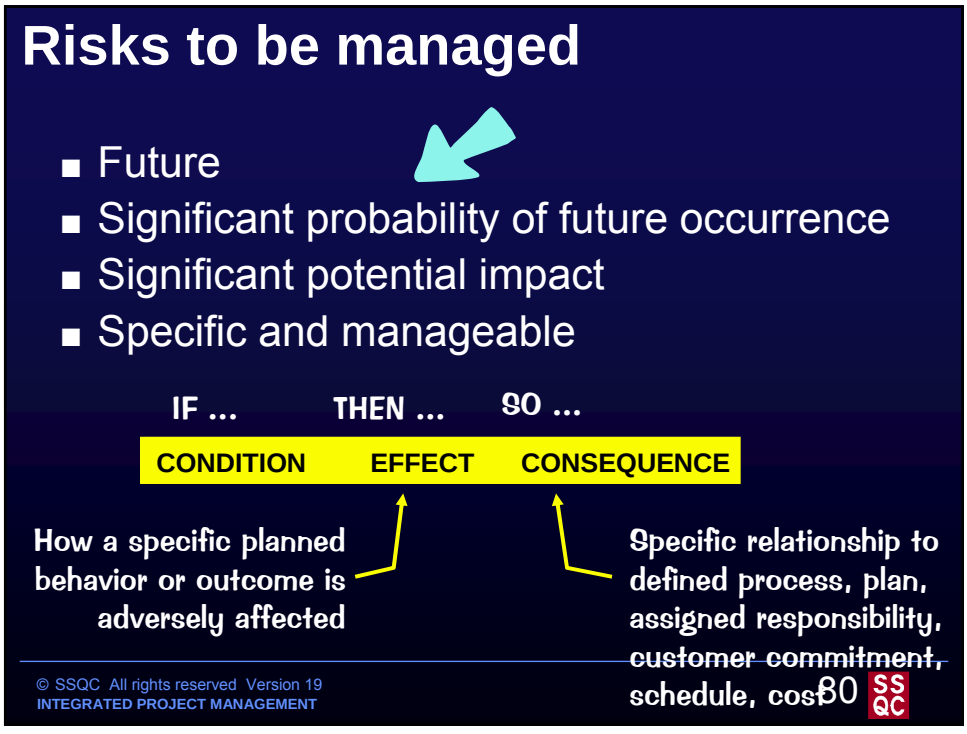
Risks to be managed
Future
Significant probability of future occurrence
Significant potential impact
Specific and manageable
IF ...
THEN ...
SO ...
CONDITION
EFFECT
CONSEQUENCE
How a specific planned behavior or outcome is adversely affected
Specific relationship to defined process, plan, assigned responsibility, customer commitment, schedule, cost
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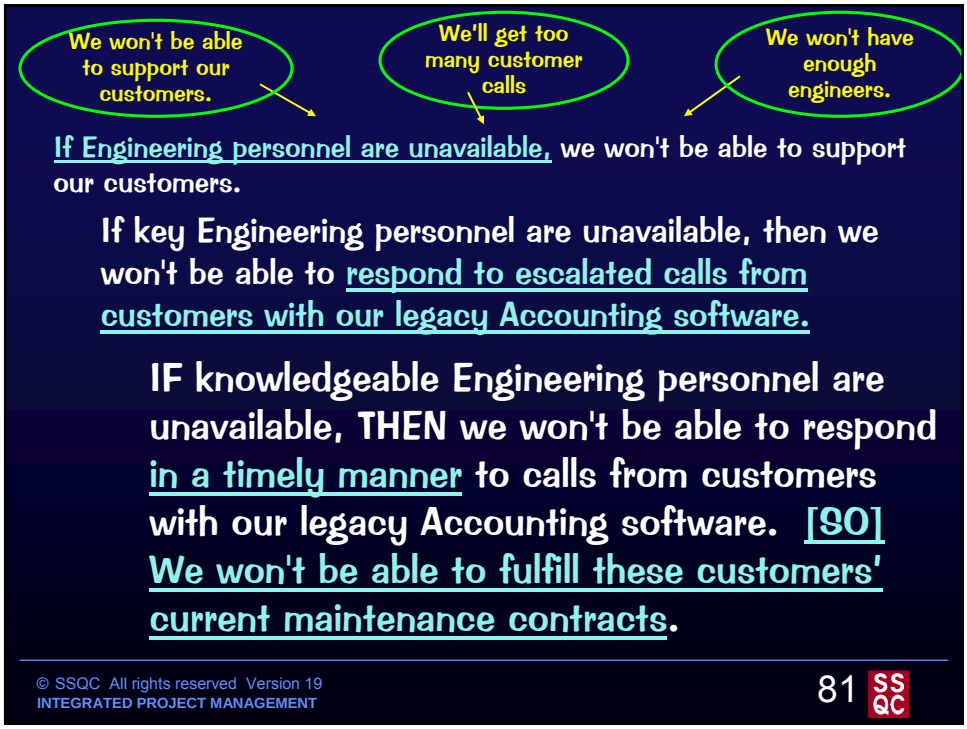
We won't be able to support our customers.
We'll get too many customer calls
We won't have enough engineers.
If Engineering personnel are unavailable, we won't be able to support our customers.
If key Engineering personnel are unavailable, then we won't be able to respond to escalated calls from customers with our legacy Accounting software.
IF knowledgeable Engineering personnel are unavailable, THEN we won't be able to respond in a timely manner to calls from customers with our legacy Accounting software. [SO] We won't be able to fulfill these customers' current maintenance contracts.
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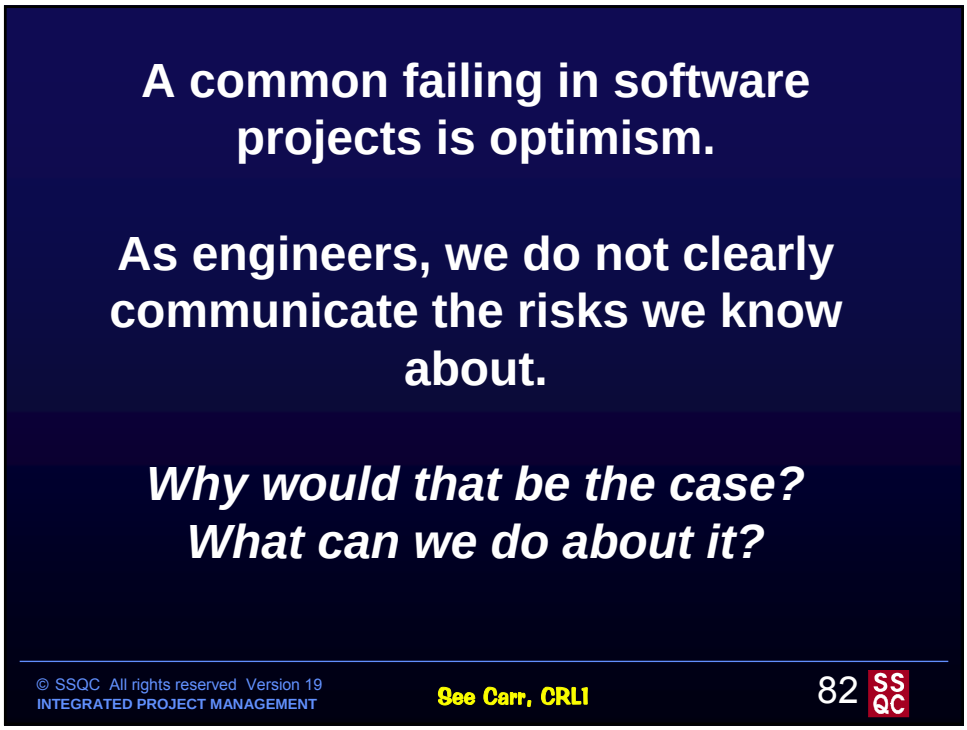
A common failing in software projects is optimism.
As engineers, we do not clearly communicate the risks we know about.
Why would that be the case?
What can we do about it?
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See Carr, CRLI
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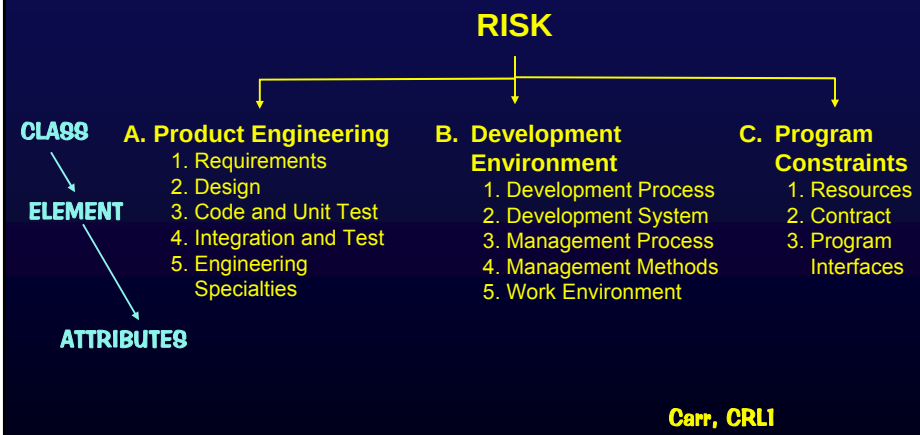
Formal risk identification

- Systematic investigation



Carr, CRL1

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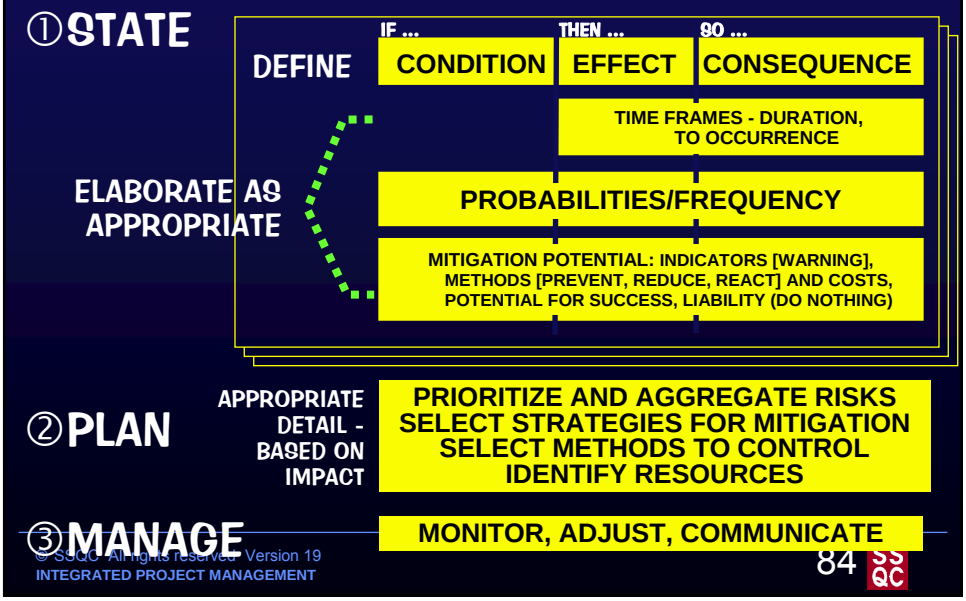
Formal Risk Analysis



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Elaborate as appropriate

#	Condition	Effect	Consequence	Impact	Prob	REL RISK
1	If knowledgeable engineering personnel are unavailable	We won't be able to respond in a timely manner to escalated calls from customers with our legacy Accounting software	So we won't be able to fulfill these customers' current maintenance contracts.	LO (1) MED (5) HI (7) V HI (9)	LO (1) MED (5) HI (7) V HI (9)	45

When we release the next version of the new accounting package and if we get the WPI outsource contract, we will be really stretched in engineering

Last year Support received 20 calls about the accounting package, 3 were escalated to Engineering, one required a patch, which took 2 weeks.

We don't quote response times in our maintenance contracts, but these are loyal customers who only call with obscure problems, when they need help. We have 16 customers with our legacy package. None of them are candidates to upgrade and all are happy with what they have.

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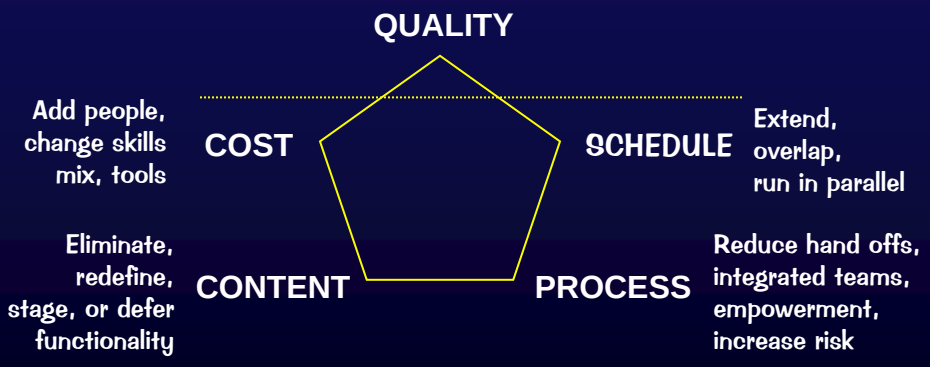
Plan: Variables and mitigation techniques



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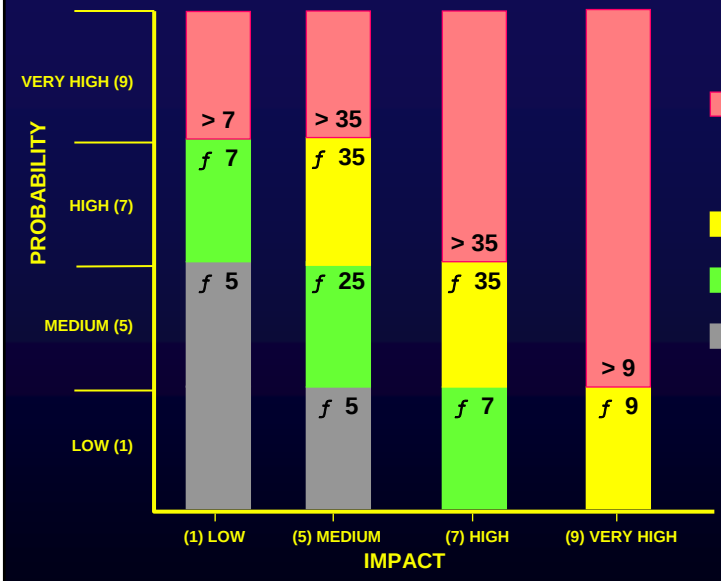
Manage risks: levels of response and thresholds



Establish levels of response for different types of projects based on past experience ("should have")

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Report to executive management: the risk profile

Impact	REACT	Observe: OBS	Monitor: MON	Mitigation in progress: MIP	Total
LOW	-	-	11	2	-
MED	2	17	8	0	27
HIGH	0	8	4	7	19
V. HIGH			6	1	7

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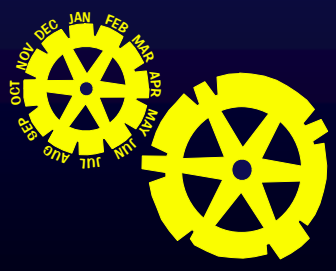
Tracking performance against the plan: Earned Value

- Assumes regular time or effort reporting
  - Sufficient detail to identify work product and activity
- System(s) to report
  - Cost or effort against plan
  - Completion of work against plan



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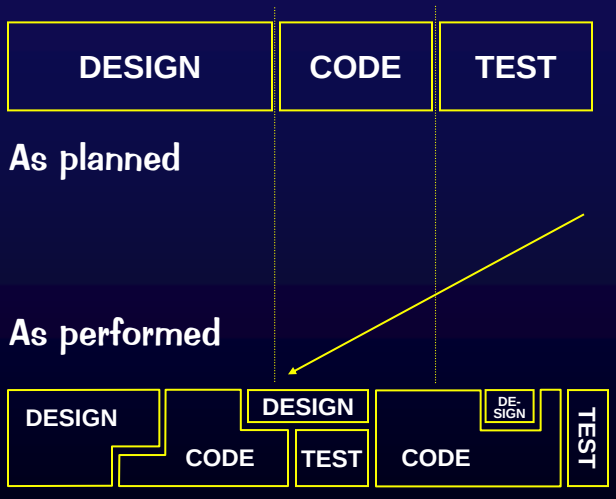
Planning versus reality



Q May I please see the design.

A Well, we just pulled it back to do some more work on it, but we're way ahead of schedule on the code and we're about to start some testing.

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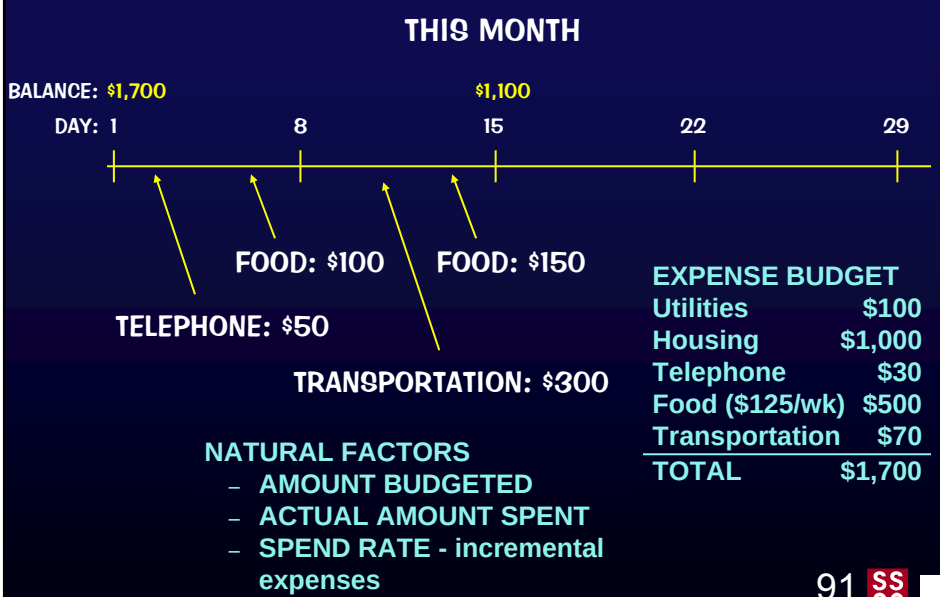
A familiar example: *How am I doing?*



EXPENSE BUDGET	
Utilities	$100
Housing	$1,000
Telephone	$30
Food ($125/wk)	$500
Transportation	$70
TOTAL	$1,700

NATURAL FACTORS
- AMOUNT BUDGETED
- ACTUAL AMOUNT SPENT
- SPEND RATE - incremental expenses

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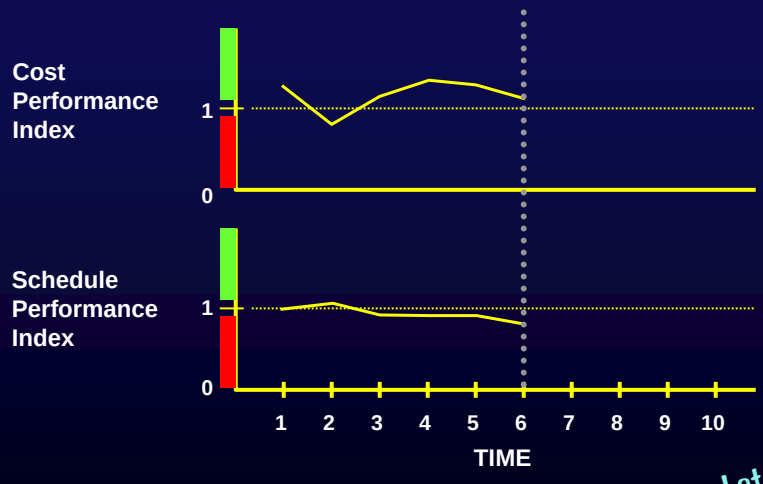
Performance indices



Monitor Late Starts

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INTEGRATED PROJECT MANAGEMENT

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A Better KDR - Monitor late starts

DEFERRED START REPORT - 01/14

WBS	DESCRIPTION	START ORIGINAL	START LAST	START CURRENT	START ACTUAL	RISK
12.1	Beta Algorithm Detailed Design	01/07		01/21		HI
15.1	Alpha Algorithm Test Specification	01/07		01/14	01/13	
15.1	Fault Tree Test Specification	01/07	01/14	01/21		LO
19.1	High Performance Beta Plan	12/01	01/14	01/21		HI

COMMENTS ON HIGH RISK ITEMS

12.1 The assigned engineer has still not been released from the previous assignment. Current release date is 1/15. Another engineer has been assigned as a back up, but is just starting to learn the class library.

19.1 Marketing has still not identified a target customer. This is not a significant issue since the generic high-performance beta plan only needs to be tailored for the specific customer's configuration.

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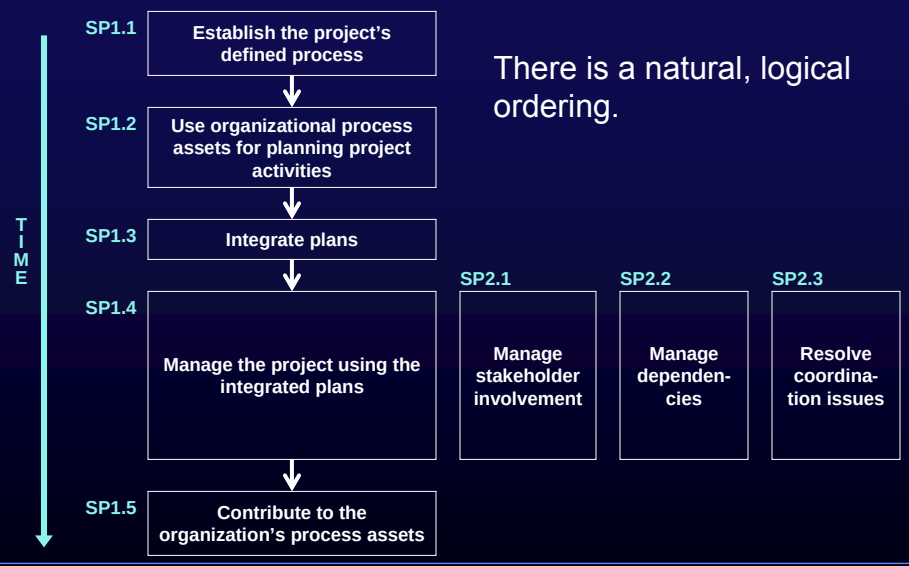
IPM: Required ordering? *No, but …*



There is a natural, logical ordering.

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Examining the Generic Practices through 3.2

GG2 The [Integrated Project Management] process is institutionalized as a managed process	2.1	Establish an organizational policy
	2.2	Plan the process
	2.3	Provide resources
	2.4	Assign responsibility
	2.5	Train people
	2.6	Manage configurations
	2.7	Identify and involve relevant stakeholders
	2.8	Monitor and control the process
	2.9	Objectively evaluate adherence
	2.10	Review status with higher level management
GG3 The [Integrated Project Management] process is institutionalized as a defined process	3.1	Establish a defined process
	3.2	Collect improvement information

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Examining the Generic Practices through 3.2

GG2	2.1	Establish an organizational policy
	2.2	Plan the process
	2.3	Provide resources
	2.4	Assign responsibility
	2.5	Train people
	2.6	Manage configurations
	2.7	Identify and involve relevant stakeholders
	2.8	Monitor and control the process
	2.9	Objectively evaluate adherence
	2.10	Review status with higher level management
GG3	3.1	Establish a defined process
	3.2	Collect improvement information

☑ Address in Project Planning policy: require processes be followed

… or in a general policy that requires that processes be followed

☑ Address as tasks in Project Planning procedures for planning and re-planning throughout life cycle – augmented for Integrated Project Management activities

MORE ON GP 2.2 LATER

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Examining the Generic Practices through 3.2 (cont.)

GG2	2.1	Establish an organizational policy
	2.2	Plan the process
	2.3	Provide resources
	2.4	Assign responsibility
	2.5	Train people
	2.6	Manage configurations
	2.7	Identify and involve relevant stakeholders
	2.8	Monitor and control the process
	2.9	Objectively evaluate adherence
	2.10	Review status with higher level management
GG3	3.1	Establish a defined process
	3.2	Collect improvement information

Two stages of training

- During implementation and roll-out
  - Address development and delivery of initial training in Integrated Project Management portion of CMMI implementation plan
  - Identify role-based skills needs
  - Address development and piloting of on-going training capability as part of implementation plan
- On-going, post-implementation delivery
  - Address in "operator" skills requirements in Project Planning procedures
    - Add role-based skills needs to procedures [team related skills]
    - Identify sources of training
    - Assign responsibility for providing (e.g., immediate manager)
- See Organizational Training (OT) Process Area

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Examining the Generic Practices through 3.2 (cont.)

GG2	2.1	Establish an organizational policy
	2.2	Plan the process
	2.3	Provide resources
	2.4	Assign responsibility
	2.5	Train people
	2.6	Manage configurations
	2.7	Identify and involve relevant stakeholders
	2.8	Monitor and control the process
	2.9	Objectively evaluate adherence
	2.10	Review status with higher level management
GG3	3.1	Establish a defined process
	3.2	Collect improvement information

☑ Address as tasks in the Project Planning procedures

- Identify, control [revise, update], status, audit
- Configuration management of planning work products
- Examples of the work products of the project planning process include:
  - Estimates and assumptions
  - Historical data
  - Models
  - WBS
  - Plans
  - Schedules
  - Team charters
  - IPT processes
  - IPT hierarchy (SEIT, IIPT) – responsibility and authority
- See the Configuration Management (CM) Process Area

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Examining the Generic Practices through 3.2 (cont.)

GG2	2.1	Establish an organizational policy
	2.2	Plan the process
	2.3	Provide resources
	2.4	Assign responsibility
	2.5	Train people
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	2.10	Review status with higher level management
GG3	3.1	Establish a defined process
	3.2	Collect improvement information

☑ Address in tasks for planning, review and approval in Project Planning procedures (change requests, artifacts)

☑ Address as tasks in Project Planning procedures for planning the planning and replanning process (GP 2.2) and reporting (phase dependent)

- Based on selected product life cycle
- Consider whether planning tools can automatically produce relevant measures
  - Change requests - status, progress
  - Plan content - per cent complete
  - Effort expended in planning and replanning activities

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Examining the Generic Practices through 3.2 (cont.)

GG2	2.1	Establish an organizational policy
	2.2	Plan the process
	2.3	Provide resources
	2.4	Assign responsibility
	2.5	Train people
	2.6	Manage configurations
	2.7	Identify and involve relevant stakeholders
	2.8	Monitor and control the process
	2.9	Objectively evaluate adherence
	2.10	Review status with higher level management
GG3	3.1	Establish a defined process
	3.2	Collect improvement information

☑ Address as tasks in Project Planning procedures (phase dependent, periodic)

... and as part of the Process and Product Quality Assurance (PPQA) process(es)

- Provide checklists to support objective evaluation of Project Planning work products and activities – as augmented by IPM work products and activities

☑ Address as tasks for review of activities by higher-level management in Project Planning procedures

... and as part of the standard reporting in the Project Monitoring and Control (PMC) Process Area

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Examining the Generic Practices through 3.2 (cont.)

GG2	2.1	Establish an organizational policy
	2.2	Plan the process
	2.3	Provide resources
	2.4	Assign responsibility
	2.5	Train people
	2.6	Manage configurations
	2.7	Identify and involve relevant stakeholders
	2.8	Monitor and control the process
	2.9	Objectively evaluate adherence
	2.10	Review status with higher level management
GG3	3.1	Establish a defined process
	3.2	Collect improvement information

- ☑ Define in scope statement in the Project Planning policy or procedures
- ☑ Tailoring
  - Include a tailoring section in the Project Planning procedures
    - Options
    - Eligibility or selection criteria
  - Include as "if" statements in procedure
  - Allow for substitutions and exemptions
    - Contract or business requirements

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Examining the Generic Practices through 3.2 (cont.)

GG2	2.1	Establish an organizational policy
	2.2	Plan the process
	2.3	Provide resources
	2.4	Assign responsibility
	2.5	Train people
	2.6	Manage configurations
	2.7	Identify and involve relevant stakeholders
	2.8	Monitor and control the process
	2.9	Objectively evaluate adherence
	2.10	Review status with higher level management
GG3	3.1	Establish a defined process
	3.2	Collect improvement information

- ☑ Define output and tasks in the Project Planning procedures
  - Process change requests
    - Submission (how, who to?), evaluation, approval
    - Identify process owner(s)
  - Ensure that the Project Planning processes and, if appropriate, the tool automatically generate suitable data to support management's information needs
    - Change requests - status, progress
    - Plan content - per cent complete
    - Effort expended in Project Planning (and replanning) activities
  - Integrated Project Management (IPM) SP 1.5: contribute work products and measures ...

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Generic Practice 2.2 Revisited

GG2 The [Integrated Project Management] process is institutionalized as a managed process

GP 2.2 Establish and maintain the plan for performing the process.

The plan typically includes the following:

- Process description[s]
- Standards for the work products and services of the process[es]
- Requirements for the work products and services of the process (quality, time, etc.)
- Dependencies
- Resources
- Responsibility and authority
- Training needed
- Work products to be placed under configuration management, level of management
- Measurement
- Involvement of stakeholders
- Activities for monitoring and control
- Objective evaluation activities for processes and work products
- Management review activities for process and work products

- GG 2 and GP 2.2 apply to and appear in every Process Area
- For Project Planning, GP 2.2 addresses PLAN THE PLAN
  - May not be a project yet
  - Incorporate planning for IPM tasks and activities

Schedule: when in life cycle and what level

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GP 2.2 and the other GPs

GP 2.2 Establish and maintain the plan for performing the process.

The plan typically includes the following:

- Process description[s]
- Standards for the work products and services of the process[es]
- Requirements for the work products and services of the process (quality, time, etc.)
- Dependencies
- Resources
- Responsibility and authority
- Training needed
- Work products to be placed under configuration management, level of management
- Measurement
- Involvement of stakeholders
- Activities for monitoring and control
- Objective evaluation activities for process and work products
- Management review activities for process and work products

	2.1	Establish an organizational policy
	2.2	Plan the process
	2.3	Provide resources
	2.4	Assign responsibility
	2.5	Train people
	2.6	Manage configurations
GG2	2.7	Identify and involve relevant stakeholders
	2.8	Monitor and control the process
	2.9	Objectively evaluate adherence
	2.10	Review status with higher level management
	3.1	Establish a defined process
GG3	3.2	Collect improvement information

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Generic Practice 2.2 Revisited (cont.)

Generic Practice 2.2, Subpractice 3

3. Define and document the plan for performing the process.

   This plan may be a stand-alone document, embedded in a more comprehensive document, or distributed across multiple documents. In the case of the plan being distributed across multiple documents, ensure that a coherent picture is preserved of who does what. Documents may be hardcopy or softcopy.

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Tools and tips

- No shortage of tools (free and otherwise) for collaboration,
- BUT ...
  - Process first
  - Tools second

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Start-up checklist for Integrated Project Management

1. Define product life cycles
   - Define and align subordinate life cycles and functional area processes
2. Define interfaces with internal organizations
   - Establish risk management process (critical dependencies)
   - Establish change management process
   - Apply appropriate metrics
3. Align organization with life cycle
4. Align working environments and collaboration tools
5. Ensure training takes place

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Typical implementation opportunities - Business acquisition and proposal

1. Define interfaces with internal organizations
2. Requirements analysis - capability
3. Requirements definition
4. Requirements change management
5. Estimation

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Typical implementation opportunities - Development

1. Engineering lifecycle definition
2. Requirements management
3. Planning and project management
   - Estimation
   - Verification and validation

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4. Configuration management
   - Controls for change
5. Maintenance
   - Lifecycle scaleability
   - External problem resolution

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Typical implementation opportunities - Manufacturing

1. Define interface with Engineering/Development
2. Planning to ensure capability to meet commitments
   - New business (resources and training)
   - New types of product (process engineering)
3. Integrate quality functions
4. Automate systems to greatest extent practical

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Typical implementation opportunities - Services and Support

1. Define interfaces with internal organizations
2. Planning to ensure capability to meet commitments
   - New business (resources and training)
   - New types of service (process engineering)
3. Automate systems to greatest extent practical

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Vignettes

1. The Devil's Advocate	MOTIVATION of Senior Engineer	IMPACT of Senior Engineer's Actions	YOUR ACTION (Project Engineering Manager)
There is a senior engineer who is well-respected by his peers for his technical acumen, but who raises objection after objection to any proposed course of action. His objections are always supported by an overwhelming army of facts. His background and experience make him essential to the project team. **You are a Project Engineering Manager, to whom the senior engineer reports. What can you do?**	Control, risk avoidance, fear, or reinforced behavior. Behavior has been reinforced rewarded because he has been right some of the time (even a stopped clock is right twice a day) – and then he will earn the reputation as wise. When he's wrong, people will think he was cautious, which is not bad, either.	Influence on the team – prevent progress, change, waste time	Educate – if appropriate in conjunction with performance review. Look for alternative expertise. Determine whether team takes him seriously Take (some) objections seriously but do not let them divert you from the selected course of action – apply risk management techniques – reward constructive behavior Focus on external goal as a given – "if we listen to him we'll do nothing" – prioritize – substantiate most important Seek out peer input Listen, ignore, give specific assignments to which he can commit – will micromanaging work?

2. The Pressure Cooker	MOTIVATION of Engineer	IMPACT of Engineer's Actions	YOUR ACTION (Project Engineering Manager)
There is an engineer who dependably produces world-class work products, but who works best under pressure. He spends a great deal of time thinking about the assignment, working on problems, helping other people. As a result, the bulk of his truly brilliant work is produced just before the deadline. **You are a Project Engineering Manager, to whom the engineer reports. What can you do?**	Fear (of starting) Established pattern – he's been rewarded a number of times because he hasn't had to do any rework when major changes have occurred.	Unable to participate fully in intermediate discussions - design reviews. He always gets done on time – never early, available for additional assignment. Sometimes runs late – short cuts. Unable to transfer work to someone else if something better comes along for this person	Educate. More detailed intermediate deliverables.

3. Teflon	MOTIVATION of Engineers	IMPACT of Engineers' Actions	YOUR ACTION (Project Manager)
Engineers immediately label any schedule slippage or cost overrun as due to changes over which they have no control. Requirements changed. The design evolved based on experience with the product. People resigned and were replaced with less experienced engineers. People were added. Resources were temporarily reassigned to emergencies. Assigned resources were not available when they were supposed to be. They were held up on other projects that were (also) running longer than anticipated. **You're the Project Manager, to whom the engineering project managers come with their explanations. What can you do?**	Teflon = responsibility doesn't stick Defensive – bad estimates – lack of skill, learning curve, overly aggressive estimates Avoid responsibility Tell the truth – feels helpless Likes stability, dislikes change.	Shotgun approach does not get to the cause of the problem – and lead to correction. Creates an impossible problem – how to get on track with something new while finishing up other stuff that is off track	Ensure processes allow for changes Data Defined reserve Better requirements impact analysis – ensure resources available for requirements analysis Track time mentoring – new employee process Risk management

4. Sinatra	MOTIVATION of Engineer	IMPACT of Engineer's Actions	YOUR ACTION (Project Engineering Manager)
Based on a flash of inspiration, the software engineer saw a better way to implement the requirement. Not only was less code required, the code was less complex, more maintainable, offered better exception handling, and seemed to represent a more effective basis for any future enhancements that might be required. The simplicity of the new solution made it appear feasible to scrap what had been done and still finish the new code on time, by the end of the week. And he did. **You are a Project Engineering Manager, to whom the engineer reports. What can you do?**	Sinatra after Frank: My Way Control, truly brilliant insight, self-aggrandizement	Testing, documentation (internal), previous reviews, interfaces	Reward insight – technical quality Educate on dependencies and risk Evaluate change method – could the new insight have been incorporated into the project in time? How come no-one noticed what was going on?

5. Cleo - the view from the top	MOTIVATION of Software Manager	IMPACT of Software Manager's Actions	YOUR ACTION (VP of Engineering)
The software manager told the Vice-President (VP) of Engineering that, after some investigation, it appeared the software could not be ready as early as the new hardware. The software manager proposed an alternative date for system test that would slip the product release by 2 months (on a 9 month project). The VP's response was that a two month slip was unacceptable and that the software manager needs to find a way to bring his part of the project in line with the hardware schedule. **You are the Vice-President of Engineering. What else can you do?**	CLEO = Cleopatra, Queen of de Nile (Denial) Telling the truth – has lots of data Sandbagging – with or without data – self-protection or laziness Doesn't really know any better than the VP since there is no historical data Poor manager – promoted for technical competence – actually believes this is true Can't take the pressure Frustrated – put it off Pressured into unrealistic schedule – can later blame it on the VP – looks good	Project will be late If not do anything else, nothing will improve	Look at plan – try to improve – ask SPM to explain detail to you Agreement on goals – budget, etc. – more degrees of freedom Look at plan – support your people by presenting a revised schedule for project Get help – peers of SPM – senior members of Technical Staff or outside review. Train Fire – hire someone else (a toady) Take schedule seriously – actually monitor and correct as project evolves. Is it far enough out to matter? Fiction OK?

6. Cleo - the other side	MOTIVATION of VP Engineering	IMPACT of VP Engineering's Actions	YOUR ACTION (Software Manager)
The software manager told the Vice-President (VP) of Engineering that, after some investigation, it appeared the software could not be ready as early as the new hardware. The software manager proposed an alternative date for system test that would slip the product release by 2 months (on a 9 month project). The VP's response was that a two month slip was unacceptable and that the software manager needs to find a way to bring his part of the project in line with the hardware schedule. **You are the Software Manager. What can you do?**	Lack of technical knowledge – fear Control Pressure from above – job is on line Personality conflict Preconception from hardware background	Project will be late If not do anything else, nothing will improve SPM will fake up a plan that meets needs Lack of support from SPM	Agreement on goals and constraints (e.g., budget, technology, tools, resources) Look at plan – try to improve Ask for help in planning – from a peer Look at plan – back people by sticking to proposed schedule with VP Revise plan with high-risk assumptions, corner-cutting – someone else will be late anyway – plus the project will change so many times no-one will hold you accountable for this schedule anyway (FICTION) Ask for Training Stand up – tell him to try to find someone else who can

7. Cleo, Part II - no problem	MOTIVATION of Software Manager	IMPACT of Software Manager's Actions	YOUR ACTION (Project Manager)
The software manager told the Vice-President (VP) of Engineering that, after some investigation, it appeared the software could not be ready as early as the new hardware. The software manager proposed an alternative date for system test that would slip the product release by 2 months (on a 9 month project). The VP's response was that a two month slip was unacceptable and that the software manager needs to find a way to bring his part of the project in line with the hardware schedule. ***The software manager went back and did some backward planning. By overlapping previously sequential activities and replacing some estimates with the best case numbers, the software manager was able to tweak Microsoft project into producing a plan that ended close enough to the hardware date to satisfy the VP of Engineering.*** **You are the Project Manager (responsible for delivering the hardware and software). What can you do?**	Lack of planning or technical knowledge – fear Fear for job Desire to please Disgust Capitulation Resignation Who cares about plans – things change so much no-one will hold me accountable, anyway. Personality conflict	Project will be late If not do anything else, nothing will improve	Look at plan – ask how changes were made – what basis Don't look for easy solution. Examine constraints – ask why – particularly why didn't you do it this way the first time. Look at revised and original plan. Get help – peers Take schedule seriously – in for long haul – not just for one project. Give him enough rope to hang himself. Blame him, replace him, project will be late anyway.

8.	MOTIVATION of _____	IMPACT of _____'s Actions	ACTION of (x)_____
You are the (x)_____. What can you do?			

Risk Scenarios

The Forbes Project

The Forbes Project is developing a new product, which the VP of R&D promised the User Group as being available by the end of the year. It is now March 1st.

The Forbes Project requires the development of an algorithm which is based on a branch of Mathematics that is understood by only one engineer in the company. That engineer is currently developing an algorithm for another project and is committed full time to that other project for the next 4 months.

Development of the algorithm for the Forbes Project is planned to start in 4 months, so it will be ready for integration in 6 months.

The Port

To ensure the viability of its popular, cutting-edge product, MicroTome, the company has set up a project to port MicroTome from the DOS operating system to Windows NT. The project's charter is to duplicate the functionality exactly, but incorporate a real GUI, and make a few minor (well-defined) enhancements.

The charismatic project manager, Paul Miller, (PM) also plans to deliver a well-documented, object-based product that will be easily maintainable. The PM has set an aggressive schedule for the team, starting with training in Object-Oriented Techniques, C++, and GUI design. The team is made up of senior engineers who are familiar with the domain and the current product and who have excelled in maintaining the structured code in the DOS-based product.

Risk Taxonomy (see CRL1)

	CLASS		
	A. Product Engineering	**B. Development Environment**	**C. Program Constraints**
ELEMENT ATTRIBUTES	**1. Requirements** a. Stability b. Completeness c. Clarity d. Validity e. Feasibility f. Precedent g. Scale	**1. Development Process** a. Formality b. Suitability c. Process Control d. Familiarity e. Product Control	**1. Resources** a. Schedule b. Staff c. Budget d. Facilities
ELEMENT ATTRIBUTES	**2. Design** a. Functionality b. Difficulty c. Interfaces d. Performance e. Testability f. Hardware Constraints g. Non-Developmental Software	**2. Development System** a. Capacity b. Suitability c. Usability d. Familiarity e. Reliability f. System Support g. Deliverability	**2. Contract** a. Type of Contract b. Restrictions c. Dependencies
ELEMENT ATTRIBUTES	**3. Code and Unit Test** a. Feasibility b. Testing c. Coding/Implementation	**3. Management Process** a. Planning b. Project Organization c. Management Experience d. Program Interfaces	**3. Program Interfaces** a. Customer b. Associate Contractors c. Subcontractors d. Prime Contractor e. Corporate Management f. Vendors g. Politics
ELEMENT ATTRIBUTES	**4. Integration and Test** a. Environment b. Product c. System	**4. Management Methods** a. Monitoring b. Personnel Management c. Quality Assurance d. Configuration Management	
ELEMENT ATTRIBUTES	**5. Engineering Specialties** a. Maintainability b. Reliability c. Safety d. Security e. Human Factors f. Specifications	**5. Work Environment** a. Quality Attitude b. Cooperation c. Communication d. Morale	

Case Study – AJ Oy

BACKGROUND

Arvid Johnson Oy (AJ) is a large, established, and well-respected company based in Finland. One of AJ's products is KAL2 (for *Kalevala 2*), a system for automated inspection of discrete parts for form and finnish. KAL2 includes a highly-efficient and intelligent robotic feeder and handler that selects and orients the part, a multi-mode holographic scanner, and PC-based analytical software that interprets the scanner data. The division of AJ responsible for KAL2 has pioneered and its employees hold numerous patents in robotics, in thermal and optical imaging, in ultrasonography, and in the pattern recognition algorithms embedded in the feeder, handler, and scanner firmware.

KAL2 is a worldwide product marketed and supported by sales subsidiaries responsible for a country or major market.

HARDWARE

KAL2 hardware design and manufacturing are in Finland. Major hardware projects may take from 18 to 30 months. Once the hardware detailed design is done and an accurate availability date is determined (typically at least 12 months in the future), the software organization is notified to begin analysis and planning. AJ's goal is to ensure that any required software or software changes are planned for the quarterly release that will correspond with the hardware availability date. Defects in released hardware are rare and are the responsibility of the Hardware Engineering organization in Tampere, Finland. AJ's strategy is to address hardware defects through software changes whenever practical.

SOFTWARE AND SERVICE

For software, AJ KAL2 Division Engineering has established Centres of Software Engineering Excellence (CSWEE) in major technology centers around the world. The CSWEEs range in size from 30 to 230 software engineers and test personnel and 10 to 20 telephone support engineers. In almost all cases, these software development centers have been created and staffed through the acquisition of subcontractors and competitors. Software releases for KAL2 occur four times each calendar year. Software releases typically alternate between maintenance releases and releases with new functionality. If necessary, this pattern is adjusted to accommodate new hardware availability.

In the United States, the sales subsidiary, responsible for the Americas, and the CSWEE are collocated in Costanoa California.

MANAGING KAL2

Changes to the core software and hardware product for KAL2 are approved by a KAL2 R&D Board of Governors that meets quarterly in Helsinki. The Board includes the Directors of the Engineering Centres of Excellence, of the Hardware Engineering organization, and of the sales subsidiaries. New core development projects are typically planned and funded at the January meeting. The other three meetings deal with reviewing proposals for consideration at the next January meeting, monitoring progress on approved programs, and setting priorities for approved programs based on changes in the marketplace.

Software bug fixes are handled by a technical committee made up of the Directors of the Engineering Centres of Excellence. Lately, the field organization (and some customers) have discovered that enhancements can be processed quickly if they are approved as bugs.

THE CSWEE'S

Each CSWEE receives funding from three sources:

- AJ KAL2 R&D funds core product development.
- AJ KAL2 sales subsidiaries fund projects to develop ***minor***, market-specific features.
- Customers fund the development of special features for KAL2, which may include the integration of third-party hardware.

At each CSWEE, a team of software engineers, headed by a senior software engineer, is formed for each project, which may last from 1 to 9 months. Each project begins with the current version of KAL2 (or with the version the customer currently has installed). The team leader works with the funding sales subsidiary, and, as appropriate, with customers to complete the project and to secure any add-on work that might be identified in the course of the project.

The US-CSWEE currently has 2 core development projects and 16 non-core projects in progress. The largest project in the US CSWEE is jointly funded by the Americas and the Mediterranean sales subsidiaries. This project grew out of a proposal that was rejected for inclusion in the core product.

THE QUESTION

You are an internal process consultant from AJ OY. Relate the goals of Integrated Project Management (IPM), Project Planning (PP), and Process Monitoring and Control (PMC) to opportunities, situations, or potential problems you might encounter at the Costanoa CSWEE. How could implementing practices to satisfy a goal address the associated situation or problem or seize the associated opportunity to benefit the organization? The audience for your comments is senior management.

For your convenience, worksheets, with the goals and specific practices - and with room for recording potential issues and benefits - are found starting on page 71.

HUOM - WARNING - ATTENTION - ACHTUNG

Do not overtighten. Not all goals necessarily offer benefits to AJ OY. If, after a reasonable amount of individual reflection and team discussion, there does not appear to be a benefit worth presenting, move on.

Integrated Project Management (IPM)

Specific Goals (SG) and Practices (SP)	Opportunity, Situation, or Potential Problem	Benefit
SG 1 The project is conducted using a defined process that is tailored from the organization's set of standard processes. **SP 1.1** Establish and maintain the project's defined process. **SP 1.2** Use the organizational process assets and measurement repository for estimating and planning the project's activities. **SP 1.3** Integrate the project plan and the other plans that affect the project to describe the project's defined process. **SP 1.4** Manage the project using the project plan, the other plans that affect the project, and the project's defined process. **SP 1.5** Contribute work products, measures, and documented experiences to the organizational process assets.		
SG 2 Coordination and collaboration of the project with relevant stakeholders is conducted. **SP 2.1** Manage the involvement of the relevant stakeholders in the project. **SP 2.2** Participate with relevant stakeholders to identify, negotiate, and track critical dependencies. **SP 2.3** Resolve issues with relevant stakeholders.		
SG 3 The project is conducted using the project's shared vision. **SP 3.1** Identify expectations, constraints, interfaces, and operational conditions applicable to the project's shared vision. **SP 3.2** Establish and maintain a shared vision for the project.		
SG 4 The integrated teams needed to execute the project are identified, defined, structured, and tasked. **SP 4.1** Determine the integrated team structure that will best meet the project objectives and constraints. **SP 4.2** Develop a preliminary distribution of requirements, responsibilities, authorities, tasks, and interfaces to teams in the selected integrated team structure. **SP 4.3** Establish and maintain teams in the integrated team structure.		

Project Planning (PP)

Specific Goals (SG) and Practices (SP)	Opportunity, Situation, or Potential Problem	Benefit
SG 1 Estimates of project planning parameters are established and maintained. **SP 1.1** Establish a top-level work breakdown structure (WBS) to estimate the scope of the project. **SP 1.2** Establish and maintain estimates of the attributes of the work products and tasks. **SP 1.3** Define the project life-cycle phases upon which to scope the planning effort. **SP 1.4** Estimate the project effort and cost for the work products and tasks based on estimation rationale.		
SG 2 A project plan is established and maintained as the basis for managing the project. **SP 2.1** Establish and maintain the project's budget and schedule. **SP 2.2** Identify and analyze project risks. **SP 2.3** Plan for the management of project data. **SP 2.4** Plan for necessary resources to perform the project. **SP 2.5** Plan for knowledge and skills needed to perform the project. **SP 2.6** Plan the involvement of identified stakeholders. **SP 2.7** Establish and maintain the overall project plan content.		
SG 3 Commitments to the project plan are established and maintained. **SP 3.1** Review all plans that affect the project to understand project commitments. **SP 3.2** Reconcile the project plan to reflect available and estimated resources. **SP 3.3** Obtain commitment from relevant stakeholders responsible for performing and supporting plan execution.		

Process Monitoring and Control (PMC)

Specific Goals (SG) and Practices (SP)	Opportunity, Situation, or Potential Problem	Benefit
SG 1 Actual performance and progress of the project are monitored against the project plan. **SP 1.1** Monitor the actual values of the project planning parameters against the project plan. **SP 1.2** Monitor commitments against those identified in the project plan. **SP 1.3** Monitor risks against those identified in the project plan. **SP 1.4** Monitor the management of project data against the project plan. **SP 1.5** Monitor stakeholder involvement against the project plan. **SP 1.6** Periodically review the project's progress, performance, and issues. **SP 1.7** Review the accomplishments and results of the project at selected project milestones.		
SG 2 Corrective actions are managed to closure when the project's performance or results deviate significantly from the plan. **SP 2.1** Collect and analyze the issues and determine the corrective actions necessary to address the issues. **SP 2.2** Take corrective action on identified issues. **SP 2.3** Manage corrective actions to closure.		

The Key Deliverables Review

An extract from the Product Development Incorporated **Engineering Handbook**.

Key Deliverables Review (KDR)

The Key Deliverables Review is held monthly. It is chaired by the Chief Operating Officer (COO) and is attended by the heads of the site Engineering organizations, Operations, and Technical Support and Services. Each project is allocated a half-hour during which the project manager presents the progress of the project against standard, high-level milestones. Dependencies, issues, and risks are reviewed. In addition, each presentation may be attended by the project managers for any projects that are dependent on the project being reviewed. Each project manager provides a presentation for the meeting. Each month's presentations, along with any action items developed in the review meeting are maintained in the Project Tracking Book by the COO Project Administrator.

A template for the presentation is provided on the next page.

Key Deliverables Review Project Presentation Template

Date	
Project	
Project Manager	

PROJECT STATUS — **MARK ONE**: ☐ **GREEN** ☐ **YELLOW** ☐ **RED**

▲	WBS Item	Description	Completion Date			
			Original	Last	Current	Actual
		Project PRD and PP				
		OEM Qualification COMPLETE				
		Major Sub-System 1 DTD				
		Major Sub-System 2 DTD				
		Major Sub-System 3 DTD				
		Hardware Specification				
		PIP				
		Prototype test				
		Software Integration START				
		Validation START				
		Manufacturing Pre-Production Plan				
		Regulatory COMPLETE				
		RTM				
		Beta START				
		RTS – LA				
		RTS – GA				

▲ = Mark if change from last KDR

Move **Current** to **Last** before changing **Current**

Changes

WBS Item	Justification

Issues

Previous Actions

Action	Progress	Target

Acronyms

GA	General Availability	LA	Limited Availability
DTD	Detailed Design	KDR	Key Deliverables Review
PP	Project Plan	PIP	Product Introduction Plan
PRD	Product Requirements Document	RTS	Release to Ship
RTM	Release to Manufacturing	START	Start
WBS	Work Breakdown Structure		

Sample Phase Completion Checklists

The following are selected, sample phase completion or milestone checklists.

Alpha Test Readiness Review Checklist

- ❑ Manufacturing Pre-Production Plan complete
- ❑ Validation Testing has confirmed:
  - ❑ Operation of new features, enhancements, and specified bug fixes
  - ❑ All identified operational defects are documented
  - ❑ Interoperability with previous releases, all identified interoperability exceptions are documented.
  - ❑ All identified performance shortfalls against the performance criteria in the Design Specification are documented

Approval

- ❑ Validation Manager
- ❑ Beta site coordinator(s)
- ❑ Manufacturing Manager

Beta Test Readiness Review Checklist

- ❑ Validation Testing has confirmed:
  - ❑ Features targeted for Beta are implemented and have been tested
  - ❑ No open Class A defects in the portion of the product to be exercised in the Beta Test
  - ❑ Established performance targets have been reached
  - ❑ All identified performance shortfalls against the Design Specification are documented
- ❑ Preliminary user documentation is available
- ❑ Preliminary release description is available
- ❑ Beta test planning complete (i.e., functionality to be exercised specified; agreements on file)
- ❑ Manufacturing Production Plan complete

Approval

- ❑ Product Manager
- ❑ Software Engineering development lead(s)
- ❑ Hardware development lead
- ❑ Validation Manager
- ❑ Beta site coordinator(s)
- ❑ Manufacturing Manager

Release to Ship (RTS) Readiness Review Checklist – for Limited Availability (LA)

- ❑ Validation has confirmed:
  - ❑ 100% of the features for the identified market/customer/etc. are implemented and tested
  - ❑ All performance targets are met
  - ❑ No open Class A defects
  - ❑ Four or less Class B defects
  - ❑ Load testing completed; report available
- ❑ Final user and field service documentation are available and reviewed.
- ❑ Release Description is complete and available
- ❑ Planned Beta Tests successfully completed
- ❑ Order Processing trained; order processing procedures, pricing, and part numbers are complete and available
- ❑ Sales trained; supporting external literature is complete and available
- ❑ Technical Support is trained on the new features
- ❑ Product Introduction and Support Services Plan approved
- ❑ Customer training is available for the new release
- ❑ Any approved waivers are documented with appropriate risk assessment and corrective action plans

Approval

- ❑ Product Manager
- ❑ Marketing (representing Sales)
- ❑ Project Manager
- ❑ Publications
- ❑ Manufacturing
- ❑ Regulatory compliance engineering
- ❑ Software Engineering development lead(s)
- ❑ Hardware development lead
- ❑ Validation Manager
- ❑ Legal
- ❑ Technical Support

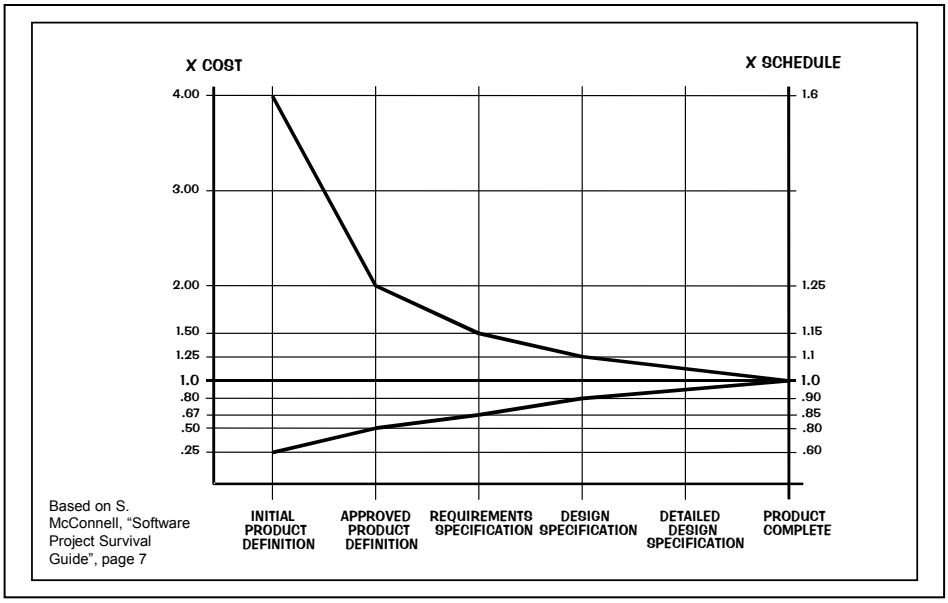
Key Performance Indicators (KPI)

Key Performance Indicators are metrics, attributes or dimensions, of products and processes which, when measured, provide information to support project planning and management. Historical measurement data forms models for predicting performance and for establishing thresholds for taking action. Current measurement data enables management to monitor performance and make appropriate adjustments to ensure that results comply with planned arrangements. As project management skills and resources mature, plans are more accurate and adjustments are less frequent. When adjustments are necessary, they are typically less disruptive, since problems are identified as or before they occur.

The goal of a metrics program is to continuously measure selected product and process attributes and provide a flow of information that is consistent in granularity, volume, and frequency with management's decision making capacity. Too much information, too little information, and information received too late all result in ineffective decision making.

Consider the following metrics, presented in no particular order, as key performance indicators, appropriate for various levels of management.

Metric 1: Estimation Accuracy - The Cone of Variability



The Cone of Variability models the performance of the organization's estimation processes. The X axis represents points in the life cycle at which the balance of the project is replanned. The Y axis is calibrated for cost, schedule, or, as illustrated, for both. The Y axis is the ratio of planned values to actual values, as determined at project completion.

In the example, for Cost, at Initial Project Definition, the historical data from completed projects demonstrates that estimates of total project cost are off by a factor of 4. At Requirements Specification, estimates from replanning are from 1.5 times actuals (50% high) to .50 times actuals (50% low).

In the example, for Schedule, at Initial Project Definition, the historical data from completed projects demonstrates that estimates of the project schedule range from 1.6 times the actual schedule (e.g., estimated 12 months, completed in 7.5 months) to .60 times the actual schedule (e.g., estimated 12 months, completed in 20 months). At Requirements Specification, estimates from replanning are from 1.15 times actuals (e.g., estimated 12 months, completed in 10.4 months) to .85 times actuals (e.g., estimated 12 months, completed in 14.1 months).

It is typically appropriate to maintain models for different technologies or types of projects.

Suggested Application

During planning, the model supports establishing realistic expectations, realistic schedule buffers, and realistic budgetary reserves. As part of lessons learned, it allows the organization to identify opportunities and techniques for improvement. During the execution of the plan, the model provides thresholds that flag activities for management attention.

In the example, activities that take place between Approved Product Definition and Requirements Specification are monitored against a plan that historically ranges from 1.15 times the actual schedule to .85 times the actual schedule. An

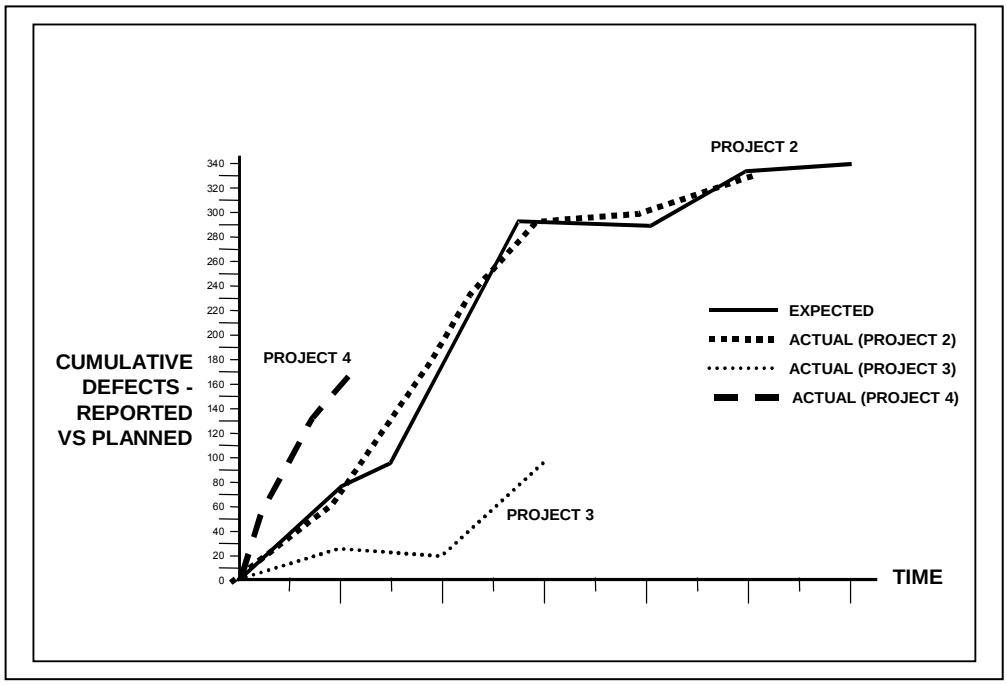
activity planned for completion in 20 days may extend to 24 days before management intervention is appropriate. Or, if it is completed in 17 days, there is no reason for management to be concerned that something is not done - or to reward the team for beating the clock.

Comments

The values in the example represent the results of large systems projects performed under government contracts. Such projects are required to prepare detailed plans as part of the proposal process; they also tend to have significant costs in hardware components. In commercial organizations, while time to market makes maintaining schedules the highest priority, effort is underestimated by a factor of 1.9 and schedules are maintained by removing 25% to 50% of the committed features (see The Standish Group, **Chaos**, 1995, available at www.standishgroup.com).

Metric 2: Defects

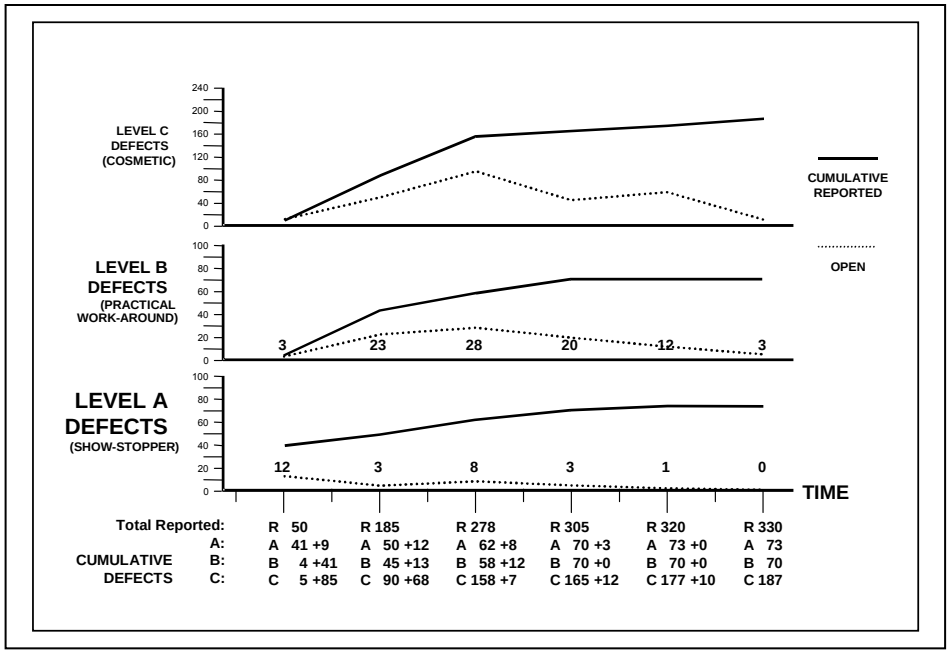
Defects can be measured within design and development (e.g., from first integration to release) or the measurement activity can extend across the product life cycle, to include post-release defects.



In this example, all defects are counted equally. The historical data on defects is used to establish a baseline. Any significant deviation from the baseline signals a need for management attention. In the example, Project 3 and Project 4 both require attention. Is Project 4 in trouble or has it instituted a more rigorous inspection or testing strategy, which should result in much lower numbers in the future? Or is Project 4 addressing a legacy component that is virtually unmaintainable? Is Project 3 an example of exceptional quality? Or has inspection and testing been deferred? Or are the inspection and testing inadequate?

Once again, separate models may be appropriate for projects categorized by size or technology.

Since not all defects are equal, the same approach is taken for modeling and monitoring defects by severity.



In this example, cumulative reported defects and remaining open defects are represented. Labels on the open defect line provide precise counts of the Level A and Level B defects remaining open. Spreadsheet-style captions below the X axis provide complete detail on the number of new defects added to the counts.

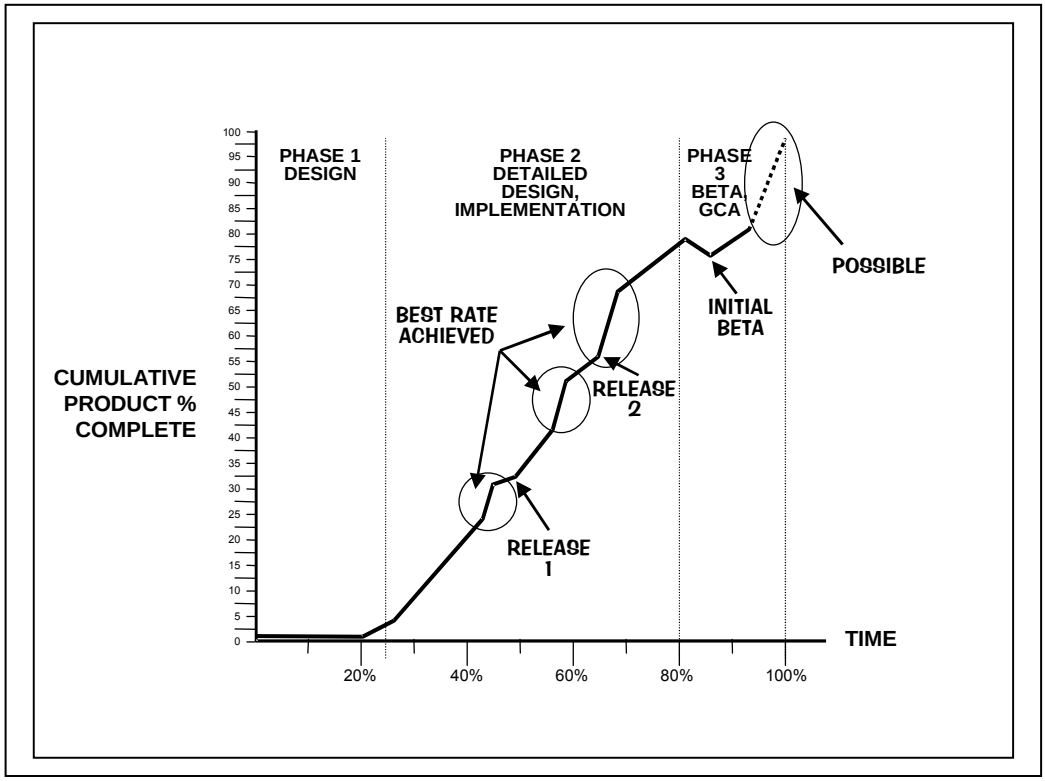
Suggested Application

During planning, an accurate defect model enables management to predict and plan accurately for rework. During the execution of the plan, comparing defect levels to the plan (or model) identifies potential problem areas. As part of lessons learned, comparing defect levels to the plan (or model) identifies product components that are candidates for reengineering. Monitoring defect find and closure rates without a plan or model is common and useful, but without any historical reference, it promotes unnecessary stress.

(The argument about not being able to afford to reengineer is most effectively countered by providing actual data on the cost of not reengineering.)

Metric 3: Project productivity

Since engineering work is rarely completed at a predictable, steady rate, measuring actual productivity enables management to identify potential problems without having to rely on questionable estimates of "per cent complete".



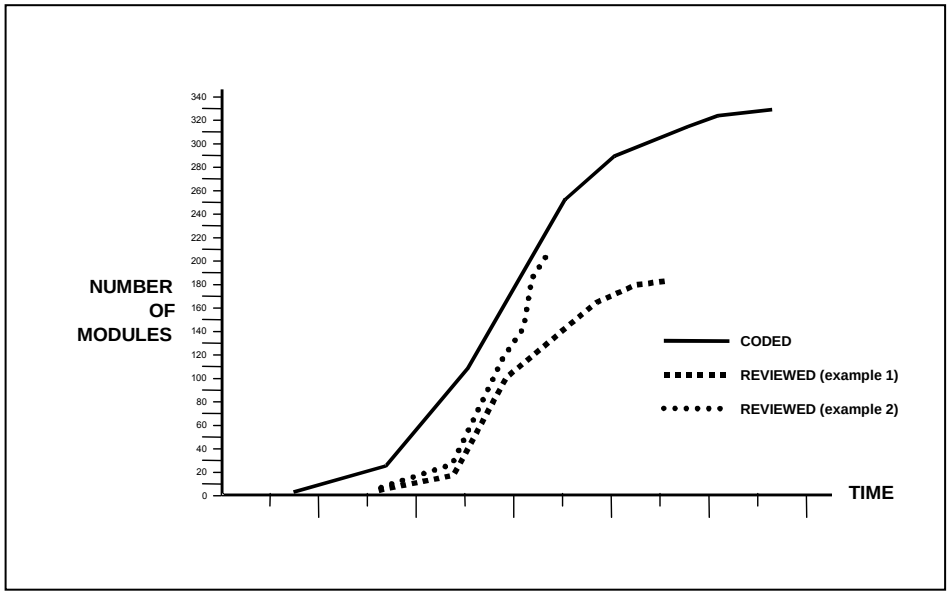
In this example, *time*, on the X axis, is the time remaining in the plan and *product per cent complete*, on the Y axis, is based on modules checked into the configuration management system as *ready to release*. The three segments of solid line that are circled represent the highest rates of productivity achieved by the project team, as they sprinted to the various intermediate release milestones. The circled, dotted line segment represents the rate of productivity that is required to complete the project on time (100% of product complete when 100% of the time is reached). By inspection, based on the productivity rates that have already been achieved, the amount of product to complete and the time available represent a reasonable goal. Unless, of course, the last five percent of the product is the part that no-one knows how to do.

Suggested Application

Because productivity is influenced by a number of variables and is highly dependent on the team make-up, an effective use of project productivity is during execution of the later parts of the plan. Management can monitor progress against time to ensure that expectations of heroic last minute efforts are reasonable.

Metric 4: Verification activities

Comparing the completion of verification activities, like reviews, to the availability of the target work products allows management to ensure that those activities take place and that, when other organizations are involved, plans are being effectively coordinated. Any significant deviation from the plan is a signal to management to investigate.

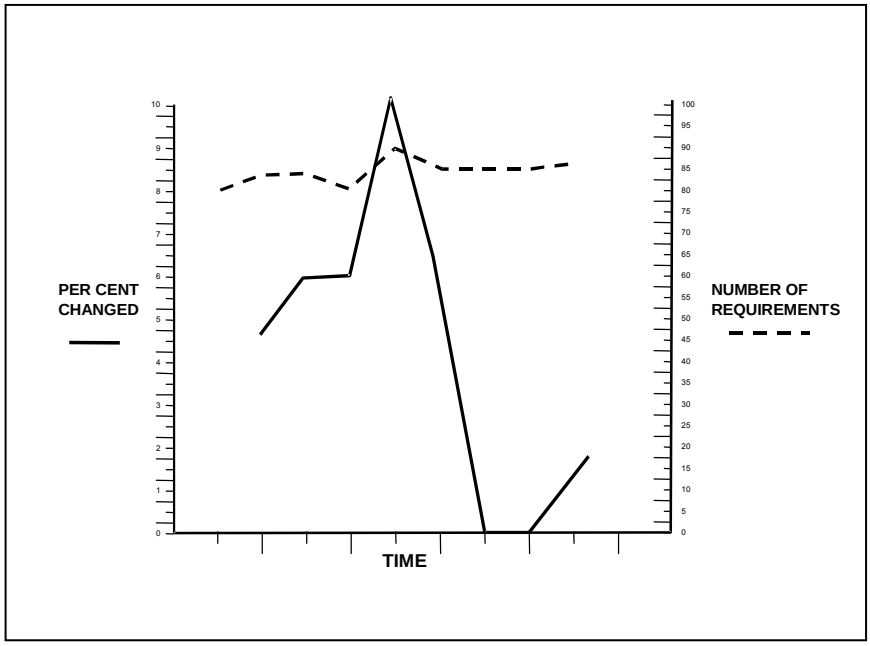


In this example, the number of modules that have completed code review is measured against the number of modules coded (e.g., ready for review). The number of coded modules is represented by the solid line. The assumption is that 100% of these modules undergo code review. In Example 1 (the lower, dotted line), the backlog of modules that are ready for code review is fairly constant for three time periods and then appears to start increasing, as the dotted line moves further from the solid line. Management attention is indicated. Why is the project falling behind?

In Example 2, the backlog decreases dramatically. Management attention is indicated. Is the project doing an exceptional job of completing reviews? Are participants given adequate time to prepare? Or are reviews considered an academic exercise, to be disposed of with minimum effort and attention?

Metric 5: Requirements stability

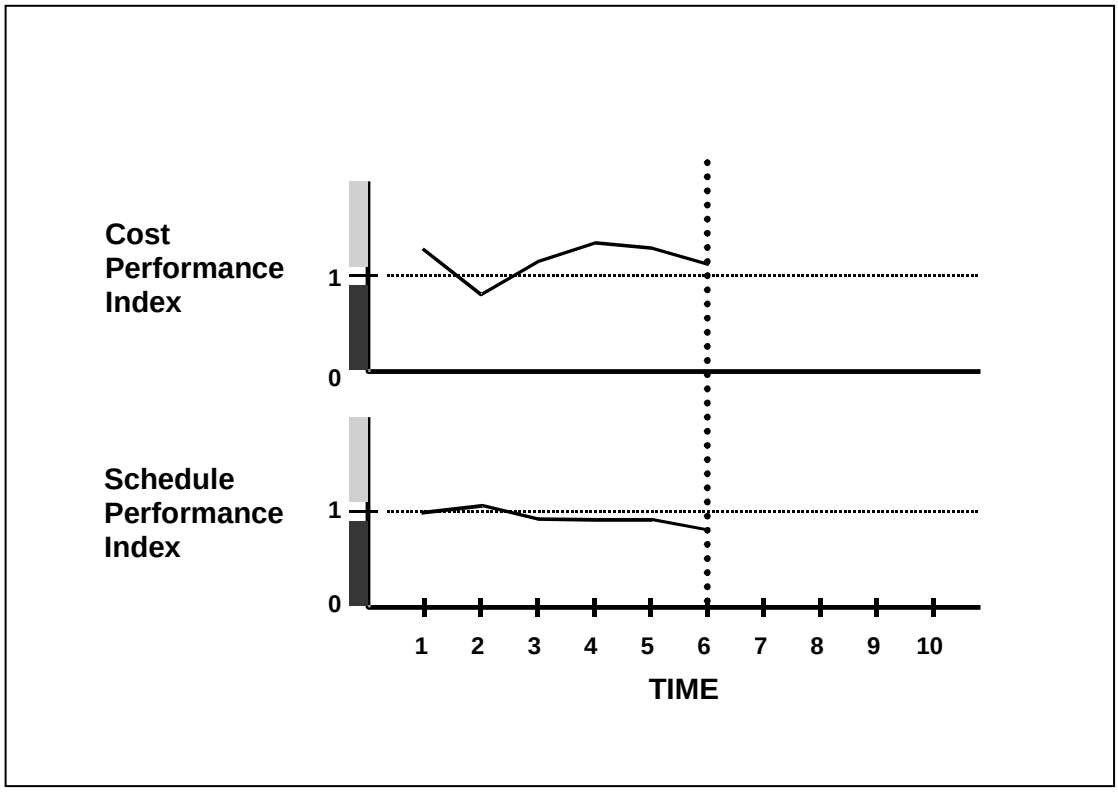
Requirements changes (as recorded by the change approval process) represent a significant risk to the project. Too many can negate even the best engineering and project management processes. Too few indicate that the project may not be hearing about needed changes in a timely manner. This pent up demand inevitably surfaces late in the project (e.g., beta test) when it poses the greatest risk to the project.



In this example, there are approximately 80 requirements, as indicated by the dotted line and the scale on the right. The relatively high rate of change (6% to 10%) appears to have stabilized in the 2 to 3% range.

Metric 6: Earned value

Earned value measures performance against schedule and against budget. The cost performance index compare the actual cost of work completed to the amount budgeted for that work. The schedule performance index compares the actual amount of work completed to the amount of work planned to be completed. Earned Value allows management a view of schedule and budget performance independent of the shifts in order and priority that are managed on a daily basis at the team level. With the tools currently available for data capture and reporting, Earned Value can be considered to supplement Key Deliverables Reviews in smaller organizations.



Each index is constructed so that a value of “1” indicates “on schedule” or “on budget”. Below 1 is “bad”; above 1 is “good”. By monitoring late starts, which can be used to hide problems by shifting activities to the end of the project, management can monitor the overall health of a project. A wealth of additional information is available to support managers who need to look at the causes of potential problems identified by the indexes.

In the example, the Cost Performance Index, consistently above 1, shows that the project is spending less than budgeted; the problem is that the Schedule Performance Index shows that the project is behind schedule.

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HAD1	Hadden, Rita, *Credible Estimation*, **Proceedings of the Software Engineering Process Group (SEPG) Conference, 2001**	Held from March 12 – 15, 2001, New Orleans, co-sponsored by the Software Engineering Institute, Carnegie Mellon University
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	Scheduling & Control : A Hands-On Guide to Bringing Projects in on Time and on Budget (2nd edition), Probus Publishing Company; ISBN: 1557388695 ; 1995	
MAH1	Mah, Michael, *High-Definition Software Metrics*, **Software Development**, May 1999, page S9	Available on-line without the graphics at http://www.sdmagazine.com/articles/1999/0005/0005e/0005e.htm See also CAR1. Key Concepts: Discussion of core metrics (Size, Time, Effort, Defects) at end of article.
MCC1	McConnell, Steve, *Software Quality at Top Speed*, **Software Development**, August 1996, page 38	http://www.sdmagazine.com/articles/1996/0008/0008a/0008a.htm Key Concepts: "[While] Some project managers try to shorten ... schedules by reducing quality assurance practices such as design and code reviews ... [studies show that] projects that achieve the lowest defect rates also achieve the shortest schedules." (page 39) The figures are not included in the online version, but the verbal description of Figure 1 identifies the 95% defect removal level as optimum for reducing development time. (page 40) "Reworking defective requirements, design, and code typically consume 40% to 50% of the total cost of software development." (page 41) "Every hour you spend on defect prevention will reduce repair time from three to ten hours." (page 41) "Reworking a ... requirements problem once the software is in operation typically costs fifty to two hundred times what it would take to rework the problem in the requirements stage." (page 41) "... about 60% of all defects usually exist by design time." (page 41) See the section on "Additional Reading" in the side bar at the end of the article, on page 42.
MCC2	McConnell, Steve, **Software Project Survival Guide: How to Be Sure Your First Important Project Isn't Your Last**. Microsoft Press, 1997, Redmond WA. ISBN: 1-57231-621-7	
NASA1	**NASA Parametric Cost Estimating Handbook**	http://www.jsc.nasa.gov/bu2/PCEHHTML/pceh.htm
OSD1	http://www.acq.osd.mil/pm/	Program Management homepage of the Office of the Secretary of Defense. See http://www.acq.osd.mil/pm/paperpres/paperpres.html for a wealth of information.
PAG1	Page-Jones, Meilir, *Seduced by Reuse*, **Software Development**, September 1998, page 80	Impact of reuse, available at www.sdmagazine.com
PHI1	Phillips, Dwayne, *Proxy-Based Estimation*, **Software Development,** July 1998	**For PROBE**: Available through SD Magazine Online at http://www.sdmagazine.com/breakrm/features/s987f3.htm. [NOTE: While the formulas and method appear to be sound, the actual data reported is suspect.]
PMI1	http://www.pmi.org/	Homepage of the Project Management Institute (PMI)
POT1	Potter, Neil, Sakry, Mary, *Keep Your Project On Track*, **Software Development**, April 2001	Risk management; available at www.sdmagazine.com/articles/2001/0104/0104g/0104g.htm
PRE1	**General Information Resources**	An excellent set of references related to estimation techniques and various models is found at: http://www.premia.com/support/starestimator/weblibrary/resource.html
PRS1	Pressman, Roger, **Software Engineering A Practitioner's Approach, 3rd ed.**, McGraw Hill,	

Ref	Item or Location	Description
	Inc., New York, 1992, ISBN 0-07-050814-3	
PSM1	**Practical Software Measurement, A Foundation for Objective project management**, Office of the Undersecretary of Defense for Acquisition and Technology, 1998	www.psmsc.com Homepage of the Practical Software Measurement Support Center (PSMSC). Download the PSM Guide, Guidebook, and Insight Tool
ROE1	Roetzheim, William H.**,** *Estimating Internet Development*, **Software Development,** August 2000, page 70	http://www.sdmagazine.com/articles/2000/0008/0008d/ 0008d.htm Key Concepts: Parameters for estimation can include function points (for data-driven applications), GUI metrics (menus, dialogs, windows), and object metrics. A project schedule can be compressed or expanded within a range of 75% to 200%.
SDM1	http://www.sdmagazine.com/supplement/ppm/	Software Development Magazine Project Management home page
SEI1	http://www.sei.cmu.edu/psp/psp.html	**For PROBE**: The Personal Software Process (PSP) home page at the Software Engineering Institute
SEP1	http://sepo.spawar.navy.mil/docs.html or http://sepo.nosc.mil/docs.html	A complete set of downloadable documents for all KPAs from the Software Engineering Project Office (SEPO), Space and Naval Warfare Systems Center, San Diego, (SSC SD)
THI1	Thielen, David, *The Commando Returns*, **Software Development**, March 1999, page 80	Not available on line. Key Concepts: "As projects get larger and more complex, projects get larger and more complex, good practices, design, and planning are the best approaches to project management."
WEL1	Wells, J. Donovan, *Planning Feedback Loops*	**For Extreme Programming** http://www.extremeprogramming.org/map/loops.html Key Concepts: Time frames between phases; phase activities
WEL2	http://www.extremeprogramming.org	**For Extreme Programming** J. Donovan Wells Extreme programming home page Key Concepts: Detailed descriptions of activities, tools, references to articles, etc.
WIE1	Wiegers, Karl, *Know Your Enemy*, **Software Development**, October 1998, page 38	http://www.sdmagazine.com/articles/1998/0010/0010a/ 0010a.htm Key Concepts: Structured risk management
WIL1	Williams, Laurie, Kessler, Robert R, Cunningham, Ward, Jeffries, Ron, *Strengthening the Case for Pair Programming*, **IEEE Software**, July August 2001, pp 19 - 25	www.objectmentor.com/s4williams.lo.pdf Key Concepts: pairs spent 60% more time on project; completed tasks 40% faster

Partial List of Tools and Contacts

Provider	Planning	Tracking	Resource Management	Risk Management	Contact
ABT Corporation	Planner™ Workbench™	Publisher™ Team™ Connect™	Repository™ Resource™		ABT Corporation 361 Broadway New York, NY 10013 Tel: (212) 219-8945 www.abtcorp.com
Artemis Management Systems	Views 4				Artemis Management Systems 6260 Lookout Road Boulder, Colorado 80301 Tel: (800)477-6648 www.artemispm.com
Computer Associates	CA SuperProject	SuperProjectNet	CA SuperProject		One Computer Associates Plaza Islandia, NY 11749 631-Dial CAI (342-5224) Fax: 1-631-342-5329 www.cai.com
Microsoft Corporation	Project™	Project Central/ Project Server	Project™		Microsoft Corporation One Microsoft Way Redmond, WA 98052-6399 (800) 426-9400 www.microsoft.com
Nikū	Portfolio Manager Suite				Appears to include Bridge Modeler and Project Manager's Work Bench formerly from Applied Business Technology (ABT), which was acquired by Nikū in August 2000. World Headquarters 305 Main Street Redwood City, CA 94063 Tel: +1 650 298 4600 Fax: +1 650 298 4601
PlanView Inc.	PlanView				PlanView Inc. 7320 North MoPac #300 Austin, TX 78731 Tel: (512) 346-8600 www.planview.com
Primavera Systems, Inc.	TeamPlay™				Primavera Systems, Inc. Three Bala Plaza West Bala Cynwyd, PA 19004 Tel: (800) 423-0245 www.primavera.com
Scitor Corporation	Project Scheduler	Project Communicator			Scitor Corporation 256 Gibraltar Drive Sunnyvale, CA 94089 Tel: (800) 533-9876 www.scitor.com

Provider	Planning	Tracking	Resource Management	Risk Management	Contact
Software Program Managers Network		Project Control Panel		Risk Radar	SPMN 4600 N. Fairfax Drive Arlington, VA 22203 (703) 521.5231 www.spmn.com (both products are available for download at no cost)
Time Line Corporation	Time Line 6.5				Time Line Solutions Corp 1020 Railroad Ave. Suite D Novato, CA 94945 (415) 898-1919 www.tlsolutions.com
	On Target	Project Updater			

Provider	Cost/Size/Metrics	Contact
Galoreth, Inc.	SEER	Galoreth Incorporated 100 North Sepulveda Boulevard Suite 1801 El Segundo, CA 90245 Phone 310-414-3222 Fax 310-414-3220 http://www.gaseer.com
Marotz, Inc., Cost Xpert Group	Cost Xpert	Marotz Inc. Cost Xpert Group 13518 Jamul Drive Jamul, CA 91935-1635 (619) 669-3100 http://www.costxpert.com
Quantitative Software Management	SLIM	QSM 2000 Corporate Ridge Suite 900 McLean, Virginia 22102 TEL: 800-424-6755 FAX: 703-749-3795 http//www.qsm.com
Software Productivity Research (SPR)	KnowledgePLAN®	Software Productivity Research Three Bethesda Metro Center Suite 700 Bethesda, Maryland 20814 Tel. 301.657.6266 Fax 301.942.4361 http://www.spr.com
USC (Dr. Barry Boehm)	COCOMO II	http://sunset.usc.edu/available_tools/index.html USC Center for Software Engineering, free, downloadable tools, including COCOMO II The main address for COCOMO tools is http://sunset.usc.edu/research/cocomosuite/suite_main.html

45th printing

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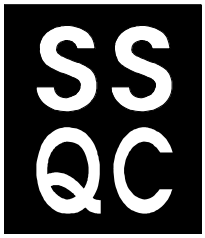
Internet: ssqc@concentric.net ◆ http://www.ssqc.com

Engineering Workshops

Requirements Engineering

A Practical Approach to Modeling and Managing Requirements

Course Guide



Version 20 (Slides Version 20)

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About SSQC

William J. Deibler II has an MSc. in Computer Science and 20 years experience in the computer industry, primarily in the areas of software and systems development, software testing, and software quality assurance. Bill has extensive experience in managing and implementing CMM- and ISO 9001-based process improvement in engineering environments.

Robert Bamford has an MAT in mathematics, and has managed training development, technical publications, professional services, and third-party software development. His over 20 years of experience include the implementation of a Crosby-based Total Quality Management System, facilitating quality courses, managing education teams, and serving on a corporate quality council.

Bob and Bill are the principals of SSQC. Since 1990, SSQC has specialized in supporting organizations in the definition and implementation of Engineering Practices, Software Quality Assurance and Testing, Business Process Reengineering, ISO 9000 Registration and CMM implementation. SSQC offers HM2, a unique, hybrid appraisal method that defines and correlates the position of an organization with respect to both ISO 9001 and the CMM. The results of an HM2 assessment are a plan and framework for improving engineering processes and for implementing the requirements of the two models.

Bob and Bill have developed and published numerous courses, auditing tools, research papers, and articles on interpreting and applying the ISO 9000 standards and guidelines and the SEI Capability Maturity Model for Software. Their articles have appeared in McGraw Hill's Quality Systems Update, IEEE COMPUTER, McGraw Hill's ISO 9000 Handbook, CrossTALK, and Software Marketing Journal.

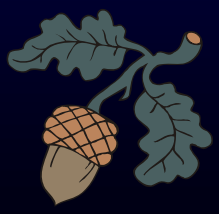
They have presented research papers at numerous national and international conferences, including those sponsored by the American Society for Quality (ASQ), Pacific Northwest Software Quality (PNSQC), the Software Publishers Association (SPA), Software Technology Support Center (STSC), the Software Engineering Institute (SEI) and Software Research Inc. Their courses have been attended by software engineering professionals from many of the country's leading technology companies. Their courses have been sponsored for their members by professional associations, including the ASQC, CSU Long Beach's Software Engineering Forum for Training, Semiconductor Equipment and Materials International (SEMI), Software Engineering Institute (SEI), UC Berkeley and UC Santa Cruz.

They have served as active United States TAG members in the ISO/IEC JTC1 SC7 - Software Engineering Standards subcommittee, which is responsible for the development and maintenance of ISO 12207 and ISO 15504 (SPICE). Their clients have successfully achieved ISO registration and advanced CMM maturity levels.

Engineering
Workshop Series

Requirements Engineering

A Practical Approach to Modeling and Managing Requirements



Objectives

- Prepare you to systematically
  - Mitigate current requirements problems
  - Prevent future requirements problems
  - Maximize efficiency in dealing with requirements and requirements changes
- Individual - immediate application
- Organization
  - Evolve infrastructure/processes
  - Identify obstacles, opportunities

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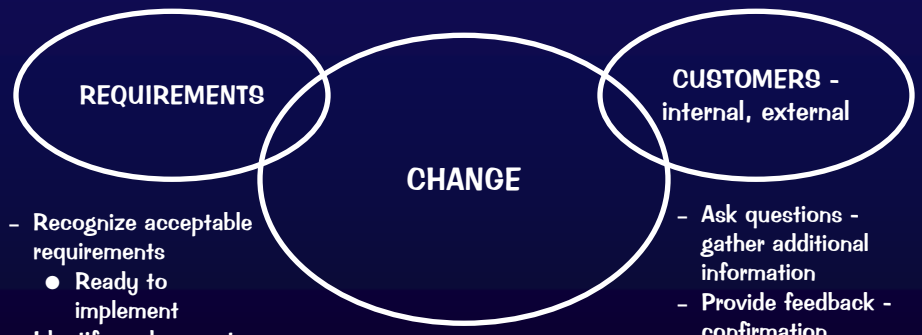
2

Required skills - deal with:



- Recognize acceptable requirements
  - Ready to implement
- Identify and correct specific problems
  - Ask the right questions
  - Appear professional
- Identify and trace

- Requirements will change
- Customers will change
- No unnecessary changes
- Manage change - assess impact, prioritize, plan

- Ask questions - gather additional information
- Provide feedback - confirmation
- Elicit information - joint development of requirements

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Agenda

- Introduction
- The benefits of requirements engineering
- The impact of requirements
- Issues, questions, and priorities
- Requirements engineering
  - Processes
  - Techniques
  - Tools

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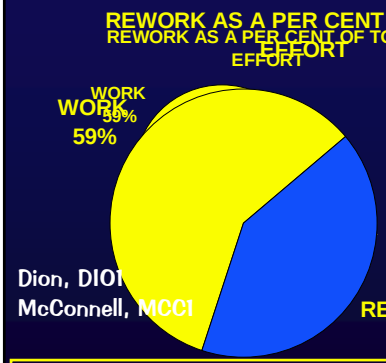
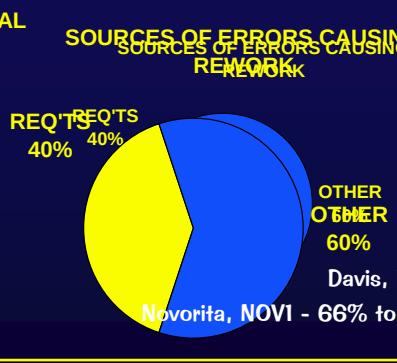
4 SS QC

By the numbers: the impact of requirements



Dion, DIOT
McConnell, MCC1



Davis, DAV1,
Novorita, NOV1 - 66% to 55%

TYPES OF REQ'TS ERRORS

Incorrect fact	49%	
Omission	31%	
Inconsistency	13%	
Ambiguity	5%	
Misplaced	2%	Hooks, H003

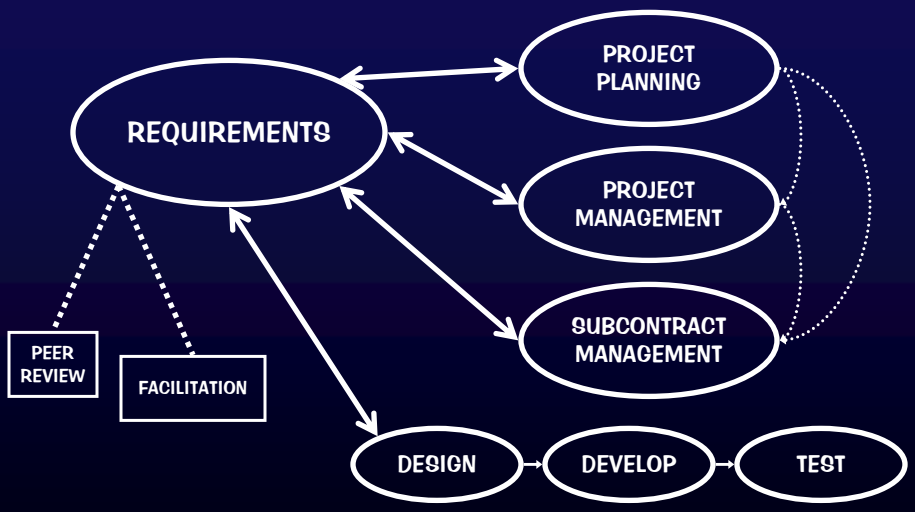
To fix requirements errors after deployment:
50x to 200x cost factor McConnell, MCC1

55% or more of the ... failures discovered by end users and system testers are caused by problems with requirements. The most probable causes are:

- Ambiguous words and phrases
- Incomplete statements
- Inconsistent functions
- Untestable functions
- Untraceable functions
- Undesirable design impositions

Robert M. Poston, **Generating Test Cases from Use Cases Automatically**

The impact of requirements



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Team Exercise:

Issues, questions, and priorities

- Related to requirements - wherever they come from
  - Customers
  - Systems Engineering
  - Marketing
- Top five issues and questions - in priority order. Base priority on:
  - What issues offer the greatest opportunity for improvement?
  - Recurrent issues

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- Confusion about what a requirement is
- Inadequate customer involvement
- Vague and ambiguous requirements
- Unprioritized requirements
- Building functionality no one uses
- Analysis paralysis
- Scope creep
- Inadequate requirements change process
- Insufficient change impact analysis
- Inadequate requirements version control

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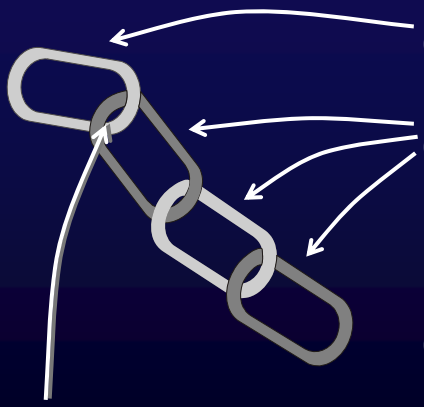
Defining “requirement”



Confirmation, agreement and commitment

(1) A condition or capability needed by a user to solve a problem or achieve an objective

(2) A condition or capability that must be possessed by a system or system component to satisfy a contract, standard, specification, or other formally imposed document

(3) A documented representation of a condition or capability as in (1) or (2)

IEEE 610.12-1990 **Standard Glossary**

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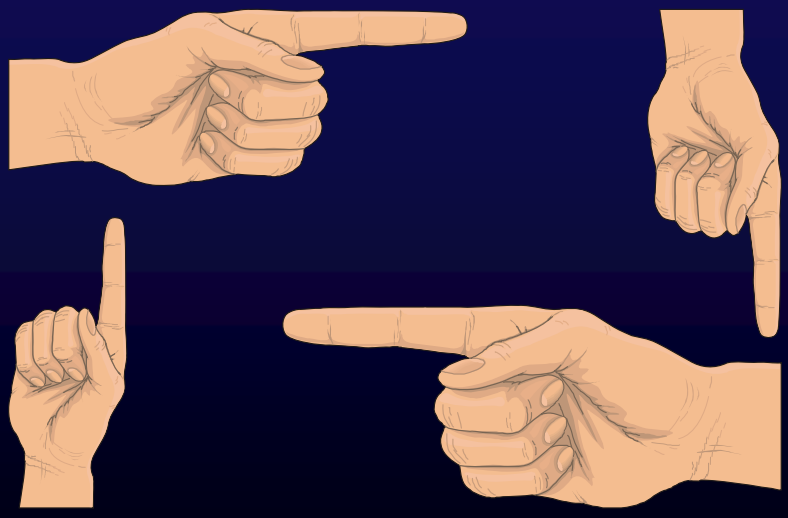
THE HISTORY OF REQUIREMENTS MANAGEMENT

Common themes - responsibility



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THE HISTORY OF REQUIREMENTS MANAGEMENT

Uncommon theme

TO SOLVE THIS PROBLEM

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Strategy and philosophy

2. Educate our customers as to what we need and why we need it
   - Benefits to them
   - Provide tools and training
1. Get our own house in order so that
   - There is a benefit to our customers and to us
     - If we don't listen, why should they bother telling us what they want
   - We know what we need

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Team Exercise
Test Drive: User-originated input

SHR INCORPORATED

Formal Input Tracking System **FITS**

		FITS Identifier **FID**	1204-006-030422.183-0454Z
	UNIVERSAL PERSONNEL CODE **UPC**	**NAME**	**LOCATION**
ORIGINATOR	015477408	Skilling, P. W.	SM2-06 DEPT cc

	PRODUCT IDENTIFIER PID	**VERSION**
SYSTEM INFORMATION	Operating Budget Target Tracking Application - OBTTA	5.01.0004

PROBLEM OR REQUEST X Problem Request	The Extended Money Values for approved Inter-Depot Transfer Transactions are not permanently reflected in the on the Depot Working Budget Report. I reported this problem t/r #552950 which was cancelled w/o explanation. This is critical since depot managers use the budget report when making approval decisions.
IMPACT	Depot managers may approve requests when budget not there.

	CRITICAL	**IMPORTANT**	**ROUTINE**
ORIGINATOR PRIORITY		X	

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Team Exercise
Background: FITS

SHR INCORPORATED

Formal Input Tracking System **FITS**

		FITS Identifier **FID**	1204-006-030422.183-0454Z
	UNIVERSAL PERSONNEL CODE **UPC**	**NAME**	**LOCATION**
ORIGINATOR	015477408	Skilling, P. W.	SM2-06 DEPT cc

	PID	**VERSION**
SYSTEM INFORMATION	Op… king Application -	5.01.0004

PROBLEM OR REQUEST X Problem Request	Th… r approved Inter-Depot Transfer Transa… ns are not permanently reflected in the on the Depot W… king Bu… s problem t/r #552950 which was cance… s critical since depot managers … king approval decisions.
IMPACT	Depot mana… en budget not there.

	CRITICAL	**IMPORTANT**	**ROUTINE**
ORIGINATOR PRIORITY		X	

PROBLEM OR REQUEST
Select one
- Problem = System not working correctly
- Request = New capability needed; improvement

IMPACT
How does this problem affect your (unit's) performance?
How will this change affect your (unit's) performance?

PRIORITY
- Critical = Impacts current mission readiness, compliance with regulation
- Important = Improves efficiency, reduces error rates
- Routine = Request consideration

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Team Exercise

Background - OPERATING BUDGET TARGET TRACKING APPLICATION (OBBTA)

You download his data and determine that Skilling has the correct, current, version.

You check FITS and determine that:

- TR 552950 was cancelled; the reason was “system operating as designed”. The SHR contact is not available.
- You can’t find another problem report related to the problem described.

You walk down the passageway to the Standard Systems Simulation Lab (S^3L), load version 5.01.004 of OBBTA and Skilling’s data, and determine that:

- Inter-depot transfers show up correctly in the Depot Working Budget Report (DWBR-0021).

Finally, because you are thorough, you accelerate time by a factor of 1,000 to simulate running the system for a month and determine that:

- Inter-depot transfers still show up correctly in DWBR-0021.
- Inter-depot transfers show up correctly in the Regional Monthly Roll-up Report (REG-0033)

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YOU HAVE (AT LEAST) 2 CHOICES

OR ... DO YOU FEEL LUCKY TODAY?

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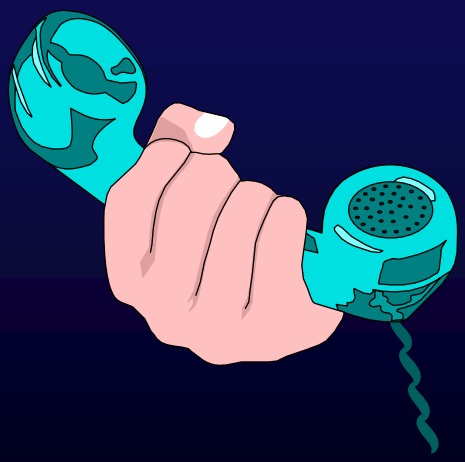

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Defining a requirements engineering process

- Requirements engineering
- Requirements identification

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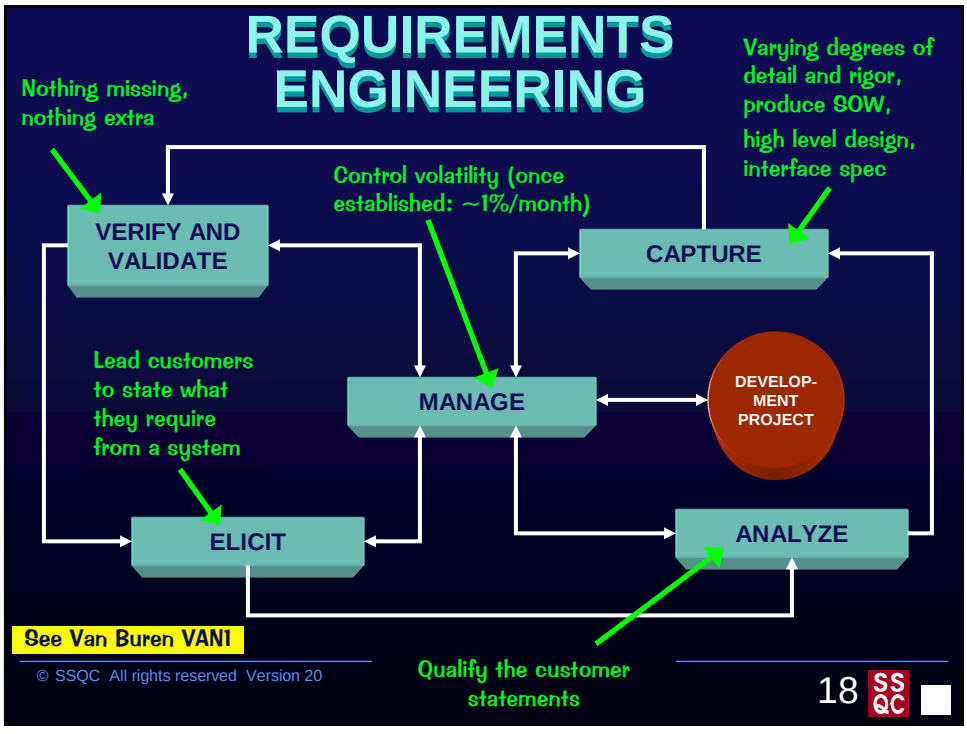

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ELICIT

- RFP
- Interviews
- Focus groups
- Questionnaires, surveys
- Brainstorming
- Role play
- Review incident reports, enhancement requests
- Joint authorship
- Benchmark - similar or competing systems
- Prototype
  - Throw-away: when critical features or architecture not well understood
  - Evolutionary: to refine, to understand non-critical features

Davis DAV1, SEI1

CAPTURE, VERIFY, VALIDATE

- **Text**
  - Incident reports
  - Enhancement requests
  - Documents (SRS, RFP, SOW, Test Plan, Test Cases, etc.) - electronic or paper
- **Prototype**
- **Graphical representations**
  - Process maps
  - Test cases
- **Database**
- **Provide**
  - Verification and validation
    - Review - upstream (confirmation) and downstream (sufficiency)
    - Test - at various stages; prior to deployment
  - Consistent communication - across time and location
  - Baseline - for plans and for content

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Identify requirements: attributes and data

- Enumeration
- Type
- Necessity
- Stability
- Allocation
- Parent (requirement)
- Source (document, paragraph)
- Rationale
- Verification (method, documents)
- Changes
- Current status
- Planned release

- Program (process, legal, schedule)
- Technical
  - Functional (user, mode)
  - Exception handling (user, mode)
  - Performance (quantitative)
  - Design constraint (environment)
  - Interface (interact with user, external components and other internal components)
  - Communications (connectivity, access)
  - Computer security and access
  - Backup and recovery
  - Implementation (conversion, installation, hardware acquisition)
  - Information (examples, other)

Essential, Desirable, Optional

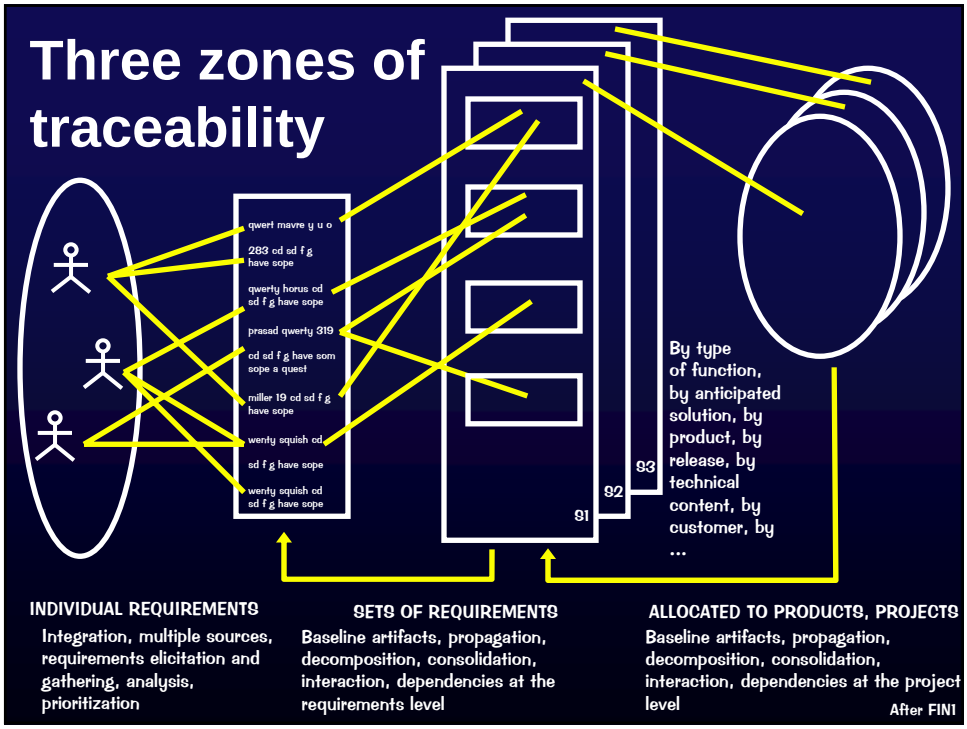
High, Medium, Low (Risk of change)

To be defined
To be reviewed
Defined

Approved
Planned
Verified

Deleted
Deferred

Kar KAR1, DOE1, IEEE 830



Robust identification

- Decompose, merge requirements
- Trace allocation through
  - Projects
  - Components
  - Products

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The allocation conundrum

BSC offers three products: a word processor, a spreadsheet, and a presentation tool. Two of the products are from separate companies that were acquired by BSC; the third was developed by BSC. The three products all run under Windows QT and are written in C and C++, but otherwise, they have virtually nothing in common. They are sold as a single suite. The products are maintained by three separate development teams, which compete for budget based on revenues from the sales of the suite (for which they all try to take full credit).

Market research has proven that customers for the word processor and the presentation tool urgently need the ability to draw flow charts with live connectors (e.g., they are "attached" to shapes so that they move when the shape is moved). The competition has such a capability.

1. Given just the above information, brainstorm at least four theoretically-feasible strategies (good, bad, or otherwise) for allocating the requirement to the engineering teams.
2. For the two most likely strategies, state the potential risks and benefits to BSC.

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Defining sets of requirements

- The Requirements Specification
  - Establish the basis for agreement between the "customer" and the development organization on what the delivered product is to do
  - Reduce the development effort
  - Provide a basis for estimating costs and schedules
  - Provide a baseline for validation and verification
  - Facilitate transfer
  - Serve as a basis for enhancement and change
- Engineering establishes control of "customer" input
  - Elicit (additional) information and clarification
  - Lead the customer - collaborate
  - Confirm understanding and agreement - active listening

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Defining sets of requirements (cont.)

- Amount of work depends on
  - Source
    - Technically sophisticated “customer”
    - Someone with an idea in search of support
  - Received content
    - Back of a napkin (create, collaborate)
    - Detailed Statement of Work - SOW (verify)

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Guidance on processes and documents

Systems

- IEEE Std. 1233-1998 **IEEE Guide for Developing System Requirements Specifications** [IEE3]
- ISO/IEC 15288 **System Engineering - System Life Cycle Processes** (final draft) [ISO1]
- EIA/IS 731 **Systems Engineering Capability Model** [INC2]
- CMU/SEI-2002-TR002 **Capability Maturity Model Integrated (CMMI) for Systems Engineering/ Software Engineering, Version 1.1** [SEI3]

Software

- ISO/IEC 12207 **Software Life Cycle Processes** (parts 1, 2, and 3 in IEEE/EIA 12207) [IEE4]
- IEEE 830-1998 **IEEE Recommended Practice for Software Requirements Specifications** [IEE1]

GENERAL SOURCES

- Cooperative Systems Engineering Group (CSEG), Lancaster University [LAN1]
- International Council on Systems Engineering (INCOSE) [INC1]

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- Trigger a controlled explosion of creativity
  - No unnecessary constraints
  - Not a data dump
  - Clearly organized and presented
    - TBDs
    - Assumptions
    - Redundancy and repetition
    - Focus
    - Technical (and non-technical?) requirements

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Outline of a generic SRS

1 Introduction
- 1.1 System purpose
- 1.2 System scope
- 1.3 Definitions, acronyms, and abbreviations
- 1.4 References
- 1.5 System overview

2 General System Description
- 2.1 System context
- 2.2 System modes and states
- 2.3 Major system capabilities
- 2.4 Major system conditions
- 2.5 Major system constraints
- 2.6 User characteristics
- 2.7 Assumptions and dependencies
- 2.8 Operational scenarios

3 System capabilities, conditions, and constraints

4 System interfaces

System Requirements Specification

IEEE 1233-1998

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Outline of a generic SRS

1. Introduction
   - 1.1 Purpose
   - 1.2 Scope
   - 1.3 Definitions, acronyms, and abbreviations
   - 1.4 References
   - 1.5 Overview
2. Overall description
   - 2.1 Product perspective
   - 2.2 Product functions
   - 2.3 User characteristics
   - 2.4 Constraints
   - 2.5 Assumptions and dependencies
3. Specific requirements

Appendixes

Index

Software Requirements Specification

IEEE 830, 1990/IEC 12207

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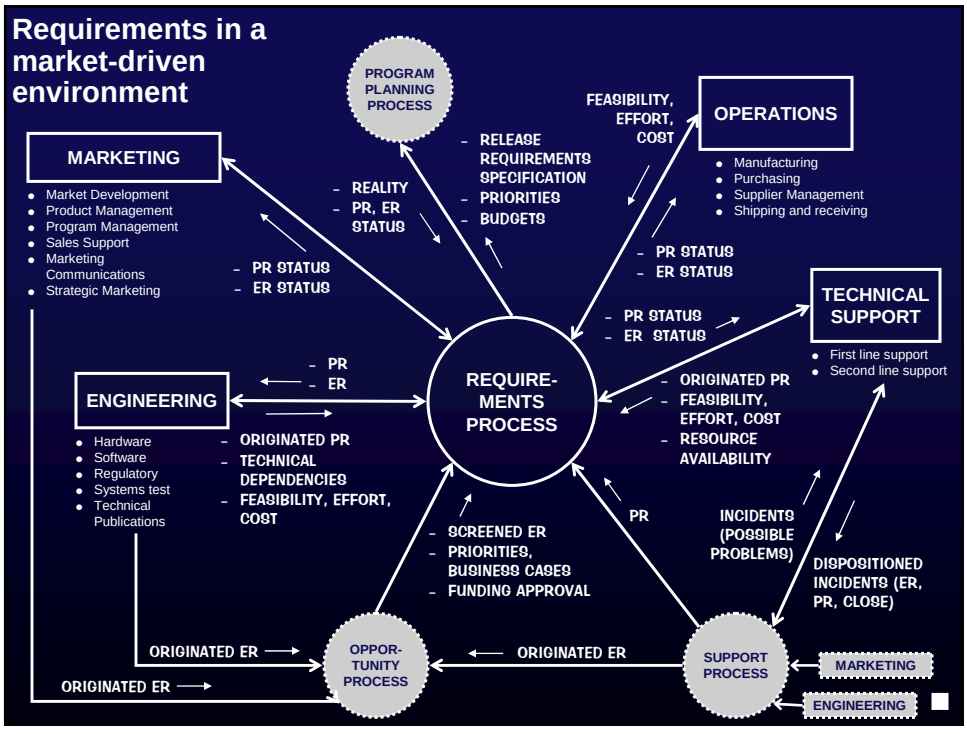

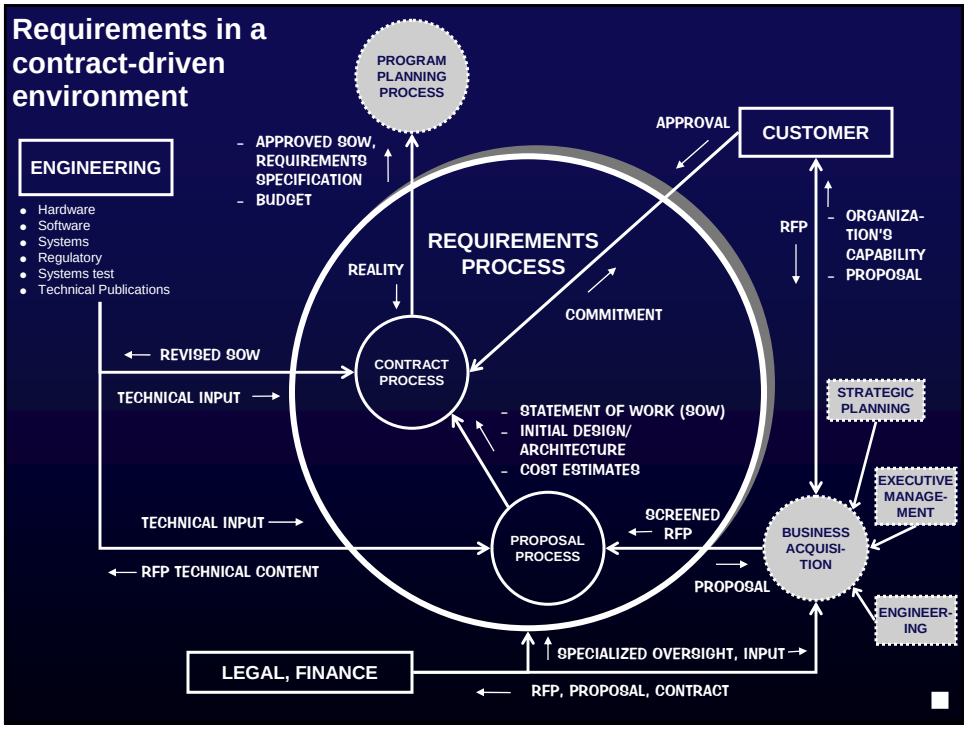

Elements of a requirements process

- Baseline - set
- Version - individual and set
- Identification
- Capture
- Visible
- Responsibility and authority - approval and change
- Internal peer review; external review
- Address all types of requirements
- Requirements specification - package of requirements, interactions, dependencies, etc.

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TEAM EXERCISE
How's YOUR process?

- Describe how your current requirements process(es) address the process attributes
  - 5 minute presentation
  - Consider key activities - inside and outside engineering
  - Evaluate anything that's missing (e.g., unnecessary because …)

PROCESS ELEMENTS

- ✔ Baseline
- ✔ Version
- ✔ Identification
- ✔ Capture
- ✔ Visible
- ✔ Responsibility and authority
- ✔ Review - internal, external
- ✔ All types
- ✔ Requirements specification

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What are the qualities of a requirement?

	Individual	Set
✔ Clear	X	X
✔ Correct	X	
✔ Consistent		X
✔ Singular	X	
✔ Testable, verifiable	X	
✔ Feasible		X
✔ Design independent	X	
✔ Traceable	X	

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Clear: unambiguous and complete

- Unambiguous: representatives of all affected parties should be able to read the statement and come to a single, consistent interpretation
- Completely describes performance, functionality to be delivered - not just the undesirable behavior to be eliminated or replaced.
  - All related types considered - including exceptions
  - Internal references resolved
  - Contains the information needed for all affected parties to agree to begin work on the next stage in the life cycle

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- ***Beware:*** "include, but not limited to", "support", “and/or”, “appropriate”, “consider”, “any”, complex grammatical construction

BEFORE
The report isn’t coming up quickly enough and it isn’t available where we need it.

DURING
- ✔ What is quickly enough? Where is it needed?
- ✔ Is it coming up where it shouldn’t?
- ✔ Are there security concerns?
- ✔ What form is it needed in?
- ✔ What if a printed form is requested, but no printer is available?

AFTER
The report shall be generated for viewing, printing, or both, when requested by an authorized user at any networked workstation. The report shall be available for on-screen viewing and search within 10 seconds; a complete printout shall be available within 45 seconds of request.

BEFORE
When the record is not completely updated, the data may be incorrect.

DURING
- ✔ When is a record “not completely updated”?
- ✔ What does incorrect mean?

AFTER
If the operator exits the system with F8 prior to completing a transaction, the data in the system may not match the data entered.

FURTHER AFTER
- ✔ Why exit?
- ✔ Do we need to keep partial records?

BEFORE
Sound an alarm for two minutes.

DURING
- ✔ And then?

AFTER
?

Correct

- Accurate (and complete) as determined by the customer and user or their representative(s)
  - Is it the right thing to do (priority and content)
  - Does it have value for the customer
- Examples of customer responses indicating incorrect requirements derived from customer input
  - Well, *technically* that is what we asked for, but … .
  - That's what we need right now.
  - Where did you see that?
  - That's a nice idea.
  - That is not open to discussion.
- Advise, facilitate, escalate

Correct?

- Modify CTRL+V to jump to the verify screen
- Change all screen colors to black
- This release will focus on both pediatric and adult imaging
- Lock out inter-depot transfers
- Don't waste time testing everything. We need it now.

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Consistent

- Not in conflict with other requirements (technical or non-technical, policies, regulations, etc.).
  - Do not duplicate or overlap
- Examples
  - *Lock out inter-depot transfers.*

  and
  - *Cut turn-around time on inter-depot transfers.*
- Conflict is natural and inevitable
  - Advise
  - Broker
  - Facilitate
  - Escalate

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Singular

- Does not contain multiple requirements. A non-complex requirement. Sufficient granularity to specify a single requirement.
  - "and", "or", commas, semicolons, "module", "system", "capability"
- Examples:
  - The training is wrong and the system gives us the wrong report.
  - We need to be able to enter the transactions and see the audit report at any terminal.
  - Web-enable
- Analyze, decompose, factor

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Testable, verifiable

- Description is sufficient that it is possible to determine whether the statement is properly implemented in the product.
- *Ambiguous requirements may be untestable*
  - *Depending on the range of ambiguity.*
- *Incomplete requirements are untestable.*
- *It may be infeasible or impossible to test an unambiguous, complete requirement.*

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- ***Beware:*** minimize, maximize, fast, user-friendly, easy, sufficient, relevant, acceptable, adequate, quick, industry standard, normal

BEFORE
The number of calls that cannot be initially completed should exceed the competition.

DURING
What are the current rates competitors achieve?
Wait a minute ...

BEFORE
Under Windows, the new system shall provide all of the functionality of the DOS-based system, with a user-friendly GUI and easy-to-use screen architecture.

DURING
User friendly?
Easy to use?
Conforms to Microsoft Corporation, **Microsoft Windows User Experience**, 09/08/1999, ISBN 0-7356-0566-1.
Prerequisites for users? Training?

BEFORE
Mode 2 imaging must be competitive with or superior to the IQ 55C and the HUFFY HighFive system.

DURING
Specific functions? Performance criteria or targets? Tradeoffs? What are competitive futures?

Feasible

- It is possible to implement the requirement set within the known capabilities and limitations of the system and its environment
  - Technically, and
  - Within costs and schedule constraints
- Feasible is based on what we know about the requirements as stated, not on whether we have all the information we need to move to the next phase in the life cycle
- The first phase of a program may be to gather additional detailed information

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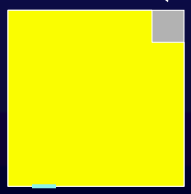
Design independent

- Describes “what”, not “how”
  - User need or problem - not a solution
  - Function not operation
- Ask *WHY?*
- Accepted exceptions are constraints
- Exploring the constraint frequently exposes additional requirements
  - *What I really need is …*
  - *Read my mind*
  - Incompletely considered implications
  - You gave me what I asked for, not what I need

You are here



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- Use Windows NT
- Do in 64MB of RAM
- Add a field for standard industry classification (SIC) to the employee’s competency record
- Provide a common data base for Customer Relationship Management applications
- Control work stations with access cards.
- Web-enable the application
- Direct printer support will be available for all calculation packages with reporting features
- The system shall verify that the machine status is “OFF LINE” before allowing repair parts to be ordered

WHY?

Apply common sense in enforcing design independence

- Consider the source of the proposed requirement
- Consider the nature of the project - maintenance versus new development

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A Dialogue (of sorts)

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Traceable

- Able to link the requirement to a specific origin
- Beware
  - Adding this feature was recommended by Direct Digital Systems, Inc.
  - As required by Federal EEO regulations
  - This requirement is from the Direct Digital Systems Request for a Proposal (RFP) received last month.
  - Everybody thinks this is a problem.
  - The competition …
  - The market ...

You don't trust me?
I.M. Hurt

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Complete - the whole story

- All appropriate attributes of identification provided
- Internal references are all resolved
  - No referenced or implied elements or activities are missing
  - Exceptions

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BEFORE	DURING	AFTER
■ Sound an audible alarm for two minutes.	■ And then?	■ ?
■ Allow the operator to correct the date.	■ The operator? What entry device? Security and integrity implications? Logging? Why? What if the correction is wrong?	■ ?
■ The goal of this feature is to limit access to utilities so that a customer can purchase distinct service levels. Possible layers would be: “self service”, “basic service”, “full service”, and “premium service”.	■ What are “layers” versus “levels”? What should go in each layer? Layers are cumulative, aren’t they? Who decides what goes in a layer - or a level?	■ ?

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Evaluate a requirement to determine ...

- What improvement it may need
- What strategies to employ to improve it
- A realistic level of confidence in estimates based on the requirement
- When it is sufficient to proceed

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Evaluate a requirement to establish ...

- A common language to discuss requirements
- Realistic customer expectations of what we need

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Making it better

If It's Not	Then we have to …
Clear, Test-able, Design Independ-ent	Search for the "real" requirement through interviews with the originator(s) or subject matter expert(s) (SME). If appropriate, assist the SMEs through research, models, demos, use cases, or prototypes. Validate the requirement with the originator or SME.
Consistent	Resolve the conflict by determining relative priority or through negotiation with affected stakeholders. Change or eliminate conflicting or overlapping requirements.
Complete	Track down the missing information; query the originator.
Correct	Determine the "right" requirement. Validate the requirement with the originator/user or their representative(s). Escalate/expose for a decision/solution.
Traceable	Pinpoint the source. If appropriate, compare it to its source to determine if the stated requirement meets the intent of the source (originator, policy, regulation, law, etc.)
Feasible	Refer, defer, identify trade-offs (schedule, performance - What can we do?), decline, play chicken.

Techniques

- Evaluate textual statements to identify adequacy and opportunities for improvement
- Elicit, capture, and confirm complex requirements through graphical representation

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A few suggested "do"s and "don't"s

DON'T

- Guess
- Impose or assume
- Rely on prior knowledge
- Live with it
- Jump to a solution
- Make a mountain out of a molehill

DO

- Discuss
- Propose and verify
- Draw on prior knowledge
- Present the risk of poor requirements and the benefits of clear requirements
- "Read" what's there – the facts
- Respond to customer priorities and needs
- Ensure you communicate clearly with your customer(s)
  - Internal and external
  - Not too much; not too little
  - Anticipate misunderstanding
  - Peer review before release

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Test Drives - three parts

EVALUATE INITIAL INPUT,
IDENTIFY PROBLEMS,
PREPARE QUESTIONS

REVISE QUESTIONS,
PREPARE FOR AND
CONDUCT AN INTERVIEW

WRITE
REQUIREMENT(S)

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Test drive 1

From a request submitted for Flak-Trak, an automated hot-line system. Flak-Trak is installed in 7x24 help-desk centers that handle customer telephone calls.

After 12 minutes we need FlakTrak to automatically escalate any incoming call that has not been answered to the hot-shift line lead.

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Test drive 2

From a bug report for an inventory management system your group maintains. The report is listed as originated by M. Wagner at the Denver Depot.

When the Flash utility is used to add and item to the Depot Parts List (DPL), the item doesn't show up in a DPL Query. But when DPL Add is run, it says the item is already there. If an item is added with DPL Add everything works fine. Except Flash overwrites an item with the same part number.

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Test drive 3

From an enhancement request for a data warehouse query application your group maintains. The enhancement request comes from the Southern Region Field Sales Support organization.

The system shall allow users at IBM-compatible PCs with 32 MB of memory to construct report templates without being connected to the network and the system shall work the same.

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Test drive 4

From a problem report for a data warehouse query application your group maintains. The problem report comes from the Southern Region Field Sales Support organization.

On the On-Hand Inventory screen, OHI-24, PARTS AVAILABLE BY PART NUMBER, the field for “Total Units Available at all Sites” is not updated so information is not available to personnel checking inventory at one location.

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Test drive 5

From the statement of work for a warehouse fire detection system.

The system shall poll up to 128 sensors divided in up to 4 zones, with a maximum of 28 sensors per zone, at a rate of once every 30 seconds, except under high-load conditions, in which case the polling may by zone may take up to 60 seconds, or 90 seconds, if necessary, but an exception record will be logged on a journal printer (at the operator console) if the length of the polling cycle exceeds the above stated rate for more than 3 minutes and 10 seconds. After more than 4 minutes of extended polling, an audible alarm sounds.

Test drive 6

From a proposal approved as a top priority by Product Marketing, to consolidate two systems your group maintains.

Develop SuperSystem, a single, integrated system for managing inventories at all repair depots and regional warehouses. Start with and use most of the Regional Warehouse Distribution Center System (DCS) on-hand inventory valuation and distribution capability. Incorporate repair-kit management functionality from the Depot Stock Management System (SMS). Develop real-time update and data replication functionality to replace current batch reporting under DCS and SMS. Develop interfaces to use bar code technology wherever applicable.

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Test drive 7

From an e-mail from the CIO at a major customer, which has installed your comprehensive manufacturing plant management system at 14 sites world-wide.

All applications need guidance for Application Administrators to perform verification of database restore and procedures for recovery upon catastrophic system failure. Guidance should be in the form of a Manual that be referred to from the System Administrators Manual and contain proper restart, restore, and validation procedures to be used by Administrators after recovery of system prior to letting all users back on system.

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Test drive 8

From the statement of work for which you are preparing a response.

Starting with and using the functionality of the San Corolla City System for tracking citations, develop a system which will consolidate all citations issued in Costanoa County by any City police department (in the County), or by the County sheriff. The citation should be automatically referred to the correct Municipal or County Court, which will be responsible for recording the disposition of the citation. Currently, data on unpaid fines is manually reported monthly by each Court Clerk to the State Department of Motor Vehicles so that drivers license renewals and vehicle registrations can be withheld until any outstanding items are resolved to the satisfaction of the Court with jurisdiction. The new system should automate this reporting.

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Test drive 9

From a problem report submitted by the day-shift supervisor at a customer site.

When I use the Web3M v6 to record a MACHINE DOWN problem with a piece of mountable equipment (e.g., sorter, stapler) which can be moved from one copying machine to another, the problem stays against the machine as well as the piece of mountable equipment. So I can't put the machine back on READY status so I can schedule work for it. Right now when I move the broken mountable equipment, I delete the original DOWN problem as a "misdiagnosis" and open a new problem against a fake machine I added to Web3M and which everyone knows to show as always DOWN. This really messus up our equipoment inventory and our maintenance numbers.

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Test drive 10 - Evaluate

From a change proposal received from P. Blanchard at the TAS Travel Office for TAS, a Travel Accounting System your group maintains:

When a travel request is processed from the “pending transactions” screen, then saved and closed, the next travel request is not highlighted.

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A few suggestions for authors and reviewers of text-based requirements

- The correct choice of words and phrasing is important, but
  - Supply examples, discussion, pictures - identified as supplementary, goals
- Focus on the audience
  - What is necessary? Useful?
- Focus on **cause and effect**
  - Results - What?
  - Means - Who?
  - Methods - How? (function not operation)

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Communication, not great literature

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Be aware of ...

- Four words
  - It
  - This
  - That
  - Which

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For example

- A component of MARKER provides the necessary communications protocol to communicate with the 15504 Data Sensor on-board self-diagnostic unit. It is written in a combination of Assembly Language and C to run in DOS or in full-screen DOS mode.
- It was recommended by the Sales Order Admin Supervisor at Martin Mariposa Company to add the feature on Customer Order Entry Screen to show the last two transactions.

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- Automated routing shall allow the maintenance technician to submit the requisition for approval to the shift supervisor and for this person to forward the approved request to the central stock room to be filled.
- A copy of the release form is attached to the distribution media, which is retained by the project software development manager or lead.

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Be aware of ...

- Four words
  - It
  - This
  - That
  - Which
- Passive voice

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- User accounts are created by generating a user list from Microsoft Outlook prior to 8 o'clock between 7:53 and 7:58 Mondays through Fridays

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Choice of words

- Standardize terminology
  - Within a set of requirements - across sets of requirements
    - Acronyms
    - Examples

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- Make clear what is required and what is optional
- Avoid weasel words - ambiguous, no agreed-upon usage
  - May, should, recommend, request, can, try
  - Consider
  - Guideline
  - And/or, either, or
- Focus on what you want, not what you don't want
  - Do not treat incoming inventory records processed through Inventory Count Transfer as final count transactions (unless count quantities match recorded quantities).
- Grammar, spelling, and constriction
  - Maintain confidence
  - Avoid distraction

Recommended Usage

Requirements: shall
Facts: is, are, will
Goals: should

- **Read it before you send it.**
- **Have someone else read it.**
  - **Apply Peer Review tools and techniques**

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Communicating with customers

- Gaining support for requirements elicitation
  - Establishing expectation and ground rules
- Eliciting requirements

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The data around the increased quality and reduced costs of using JAD-like workshops are impressive.

According to Capers Jones, … 60% of defects originate in the requirements and design phases, early facilitated workshops reduce those defects by 20% to 60% … reduce the risk of scope creep from 80% to 10% … provide 5% to 15% overall time savings.

Ellen Gottesdiener, *Decoding Business Needs*, **Software Development**, Vol. 7, No.12, December 1999, page 28; quoting
Capers Jones, **Assessment and Control of Software Risk** (Prentice Hall, 1994)

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The impact of requirements (.25)

16 Critical Software Practices for Performance-Based Management

Project Integrity

1. Adopt continuous risk management.
2. Estimate cost and schedule empirically.
3. Use metrics to manage.
4. Track earned value.
5. Track defects against quality targets.
6. Treat people as the most important resource.

Product stability and integrity

7. Inspect requirements and design.
8. Manage testing as a continuous process.
9. Compile and smoke test frequently.

Construction Integrity

10. Adopt life cycle configuration management.
11. Manage and trace requirements.
12. Use system-based software design.
13. Ensure data and database interoperability.
14. Define and control interfaces.
15. Design twice, code once.
16. Assess reuse risks and costs.

17 Delay of value to the customer

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[EVA1] Michael Evans

The impact of requirements (.600)

	RISK ITEM	RISK MITIGATION TECHNIQUES
1	PERSONNEL SHORTFALLS	STAFFING WITH TOP TALENT, JOB MATCHING; TEAMBUILDING; CROSS-TRAINING; PRE-SCHEDULING KEY PEOPLE; MORALE BUILDING
2	UNREALISTIC SCHEDULES AND BUDGETS	DETAILED, MULTISOURCE COST AND SCHEDULE ESTIMATION; DESIGN TO COST; INCREMENTAL DEVELOPMENT; REUSE; REQUIREMENTS SCRUBBING
3	DEVELOPING THE WRONG FUNCTIONS	ORGANIZATION ANALYSIS; MISSION ANALYSIS; OPS-CONCEPT FORMULATION; USER SURVEYS; PROTOTYPING; EARLY USERS' MANUALS
4	DEVELOPING THE WRONG USER INTERFACE	TASK ANALYSIS; PROTOTYPING; SCENARIOS; USER CHARACTERIZATION (FUNCTIONALITY, STYLE, WORKLOAD)
5	GOLD PLATING	REQUIREMENTS SCRUBBING; PROTOTYPING; COST-BENEFIT ANALYSIS; DESIGN TO COST
6	CONTINUING STREAM OF REQUIREMENT CHANGES	HIGH CHANGE THRESHOLD; INFORMATION HIDING; INCREMENTAL DEVELOPMENT (DEFER CHANGES TO LATER INCREMENTS)
7	SHORTFALLS IN EXTERNALLY FURNISHED COMPONENTS	BENCHMARKING; INSPECTIONS; REFERENCE CHECKING; COMPATIBILITY ANALYSIS
8	SHORTFALLS IN EXTERNALLY PERFORMED TASKS	REFERENCE CHECKING; PRE-AWARD AUDITS; AWARD-FEE CONTRACTS; COMPETITIVE DESIGN OR PROTOTYPING; TEAMBUILDING
9	REAL-TIME PERFORMANCE SHORTFALLS	SIMULATION; BENCHMARKING; MODELING; PROTOTYPING; INSTRUMENTATION; TUNING
10	STRAINING SCIENCE CAPABILITIES	TECHNICAL ANALYSIS; COST-BENEFIT ANALYSIS; PROTOTYPING; REFERENCE CHECKING

Risk mitigation, prevention, Barry Boehm, USC

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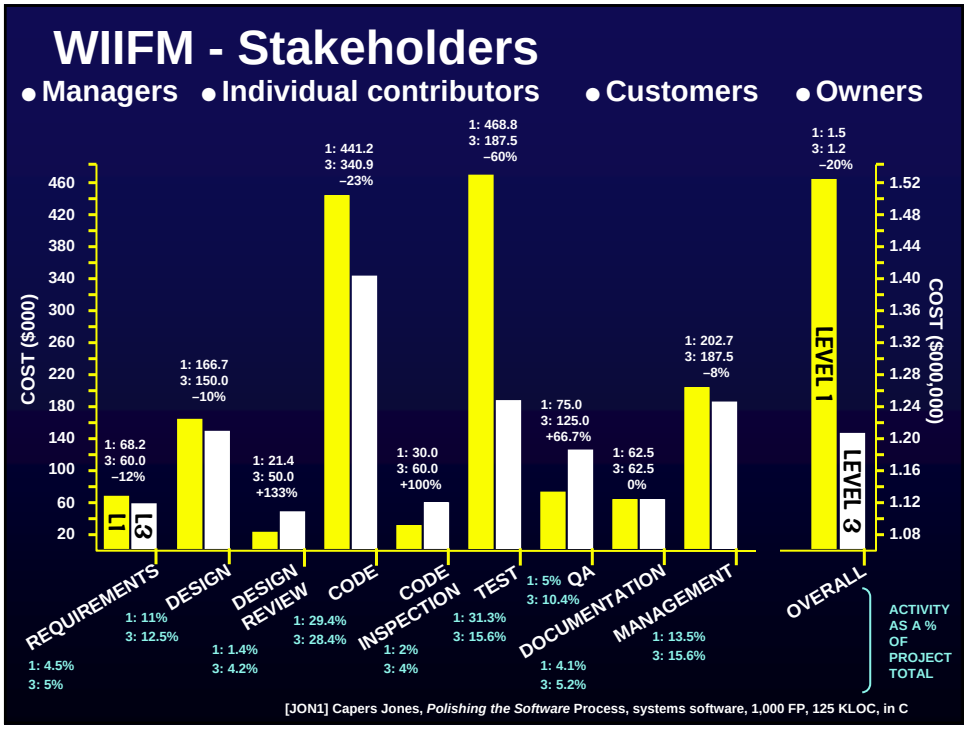
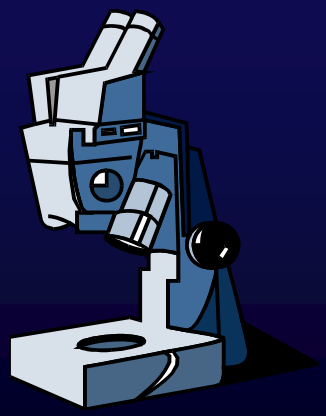


Gaining support - 1



WHAT CAN YOU DO?

Donald E. Over

- Notorious micromanager.
- Wants to discuss requirements endlessly to ensure they are understood.
- Gets into design issues. Constantly asking how things are going to be done. Has some computer background.
- Wants daily reports on progress for a six month project.

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Gaining support - 2

WHAT CAN YOU DO?

Ian DeLegate

- "What do you think?" is his favorite expression.
- He says that he gives people the freedom to succeed or fail on their own merits. He really means "read my mind".
- In the last meeting with he said, "I expect you and your staff to know what I mean, you're the experts in this field. That's why we came to you."

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Gaining support - 3

WHAT CAN YOU DO?

Everett Bristle

- "How should I know." is a frequent statement (not a question).
- He really doesn't know.
- In fact, he couldn't know. He is breaking new ground with his request.
- He's defensive because he thinks he should know.
- In his division, he is the resident expert and is expected to (and does) have the answers.

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Modeling “system” requirements

- Develop understanding
  - Simplify
  - Elaborate, refine
  - Eliminate ambiguity
  - Present, review
- Gain agreement with impacted parties
- Confirm with customer
- Joint development of requirements

Apply existing Engineering tools and techniques

A picture is worth a thousand words
Fred R. Bernard, 1927

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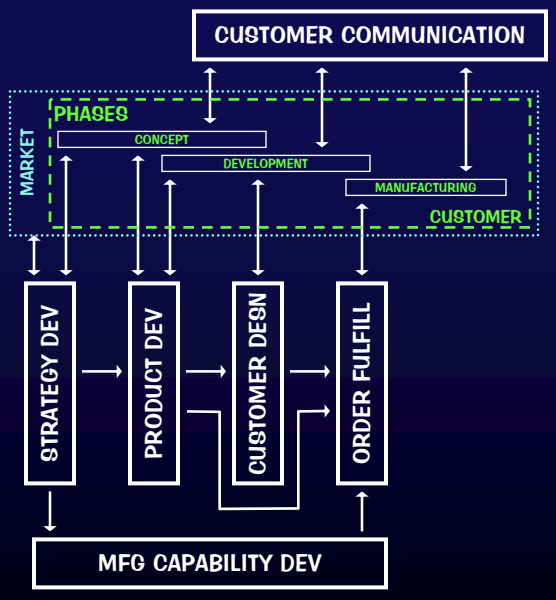
The benefits of graphical representation

The process map shows six processes for a $4 billion business. 'You know,' commented a TI executive, 'until we drew this picture ***we thought we were a lot more complicated than we really are***.'

Reengineering the Corporation, Hammer and Champy, p. 118



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Techniques and Representations

Evolving systematically from (at least) 1979 (Demarco) to the unified modeling language (UML)

	FOCUS	METHOD
WHAT -	activities & deliverables real-world context	Data Flow Diagram (DFD) UML: Use Case Diagram
WHO -	organization & responsibility	Entity Relationship Diagram (ERD) UML: Collaboration Diagram
WHY -	cause & effect	State Transition Diagram (STD) UML: Statechart Diagram
HOW -	procedure & logic	Flow Chart (FC) UML: Activity Diagram, Sequence Diagram

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Tools

- General purpose presentation
  - Integrated (e.g., MS PowerPoint with live connectors)
- Diagramming
  - VISIO, allClear, Argo/UML, ...
- Process modeling and simulation
  - Process98, Optima, Argo/UML, etc.
- Flip chart, whiteboard, markers, ...

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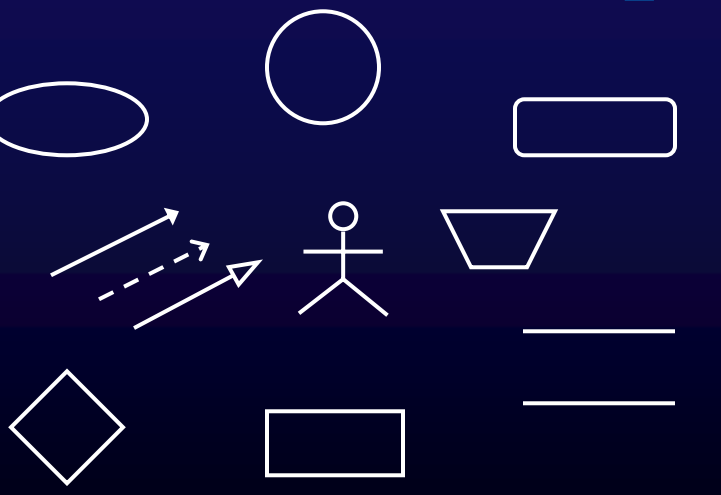
Notation



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PREPARE

GATHER RESOURCES, PLAN, PREPARE USE CASES

WHAT

ACTIVITIES, DELIVERABLES [DFD, Use Case Diagrams]

WHO

RESPONSIBILITY, AUTHORITY [ERD, Collaboration Diagram]

WHY

CAUSE, EFFECT [STD, Statechart]

HOW

PROCEDURE, LOGIC [Flow chart, Activity Diagram, Sequence Diagram]

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Prepare

(A) Identify representatives from affected groups
- Subject matter experts (SMEs)
- Knowledgeable - who do the work
  - From internal and external sources
- Interviewed or participate
- Buy-in, commitment, accuracy

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Prepare (Cont.)

(B) Plan
- Estimate effort
- Schedule - committed resources
- Sponsor/customer and development management agreement

(C) Execute
- No observers
- Report progress - against a WBS
- Revise plan as required

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Prepare (Cont.)

(D) Analyze or jointly develop customer input

ELEMENT	DESCRIPTION
WHY	Goal, purpose, impact, value
WHO	Participants, customers, suppliers, other systems
WHAT	Normal flow of work, outputs
WHAT ELSE	Exceptions, outputs and work flow
WHEN	Preceding events, triggers, inputs
WHERE	Operational context, environment, tools
HOW WELL	Performance criteria

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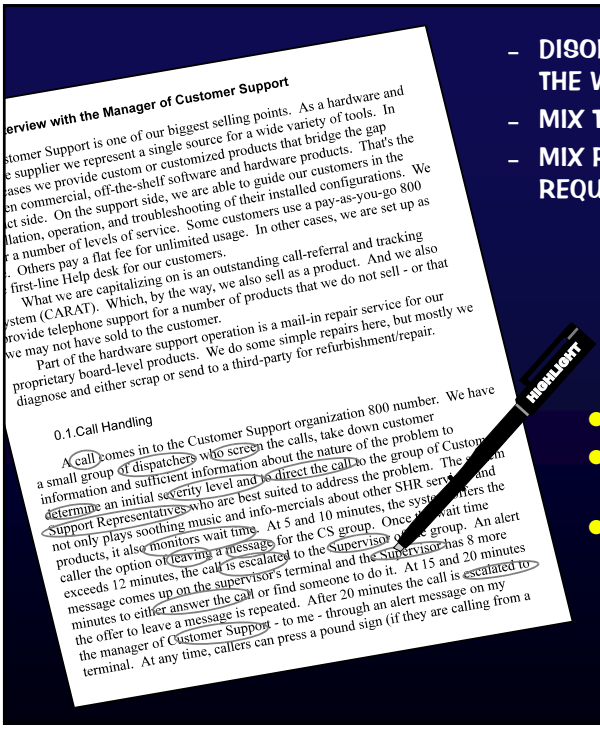

Engineering techniques

- Data flow diagram (DFD)
- Use case diagram
  - Include, extend
- Entity relationship diagram (ERD)
- Collaboration diagram
  - Parent, child
- STD
- Statechart diagram
- Flow chart
  - Deployment flow chart
- Sequence diagram
- Activity diagram
  - Fork, join

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WHAT - Activities & Deliverables

- Customer- and supplier-centric view of process and activities
- Partition the process into activities
- Define relationships between activities and real world
- Identify
  - The services to be provided - outputs
  - The service required - inputs

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WHAT - Activities & Deliverables (Cont.)

(A) Create a top-level DFD - single activity
(B) Decompose each activity in the DFD
(C) Repeat (B) as required

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DFD Notation

EXTERNAL ENTITY - "SUPPLIER" OR "CUSTOMER"

FLOW OF WORK PRODUCTS AND INFORMATION

ACTIVITY, DOMAIN, CORE COMPETENCY

DATA STORE

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WHAT - Activities & Deliverables (Cont.)

(A) create the top-level DFD
- Architecture
- The external
  - Deliverable(s)
  - Input(s)
  - Customers
  - Suppliers
- View process as a single activity - set the scope

Top-level DFD aliases
✓ Context diagram
• Level 0 DFD
DFD aliases
• Bubble chart
• Bubble diagram
• Process model
• Work flow diagram
• Function model
• Activity model

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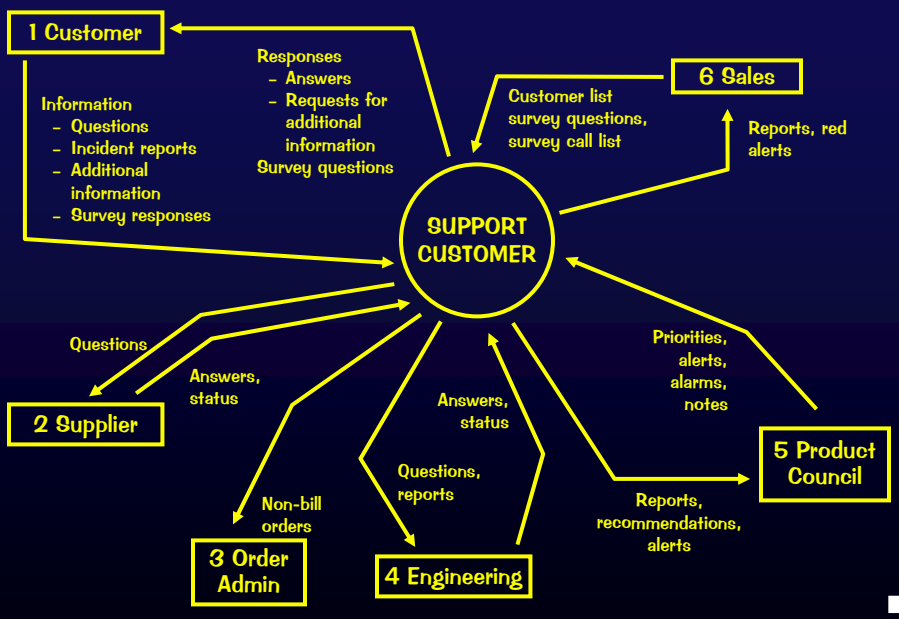
A Level 0 DFD - SHR Customer Support



WHAT - Activities & Deliverables (Cont.)

(B) decompose each activity (bubble) in the DFD

(C) repeat (B) for each activity in the previous level DFD. Continue until sequential steps are reached.

The DFD is not a flow chart.

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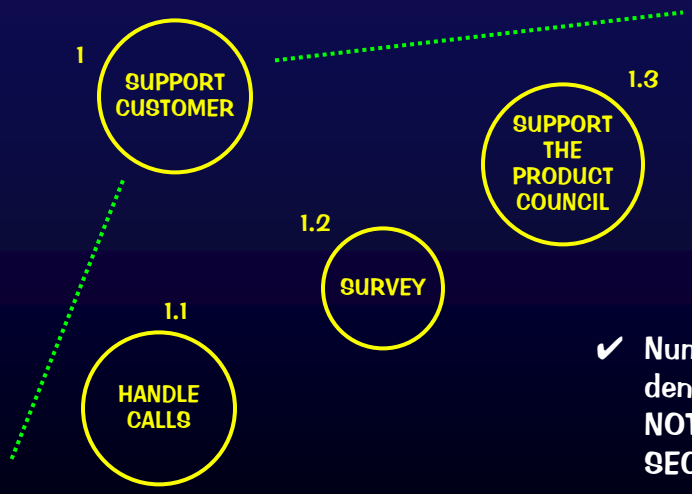
Creating a Level 1 DFD for SHR Customer Support



✔ Numbers denote level - NOT SEQUENCE

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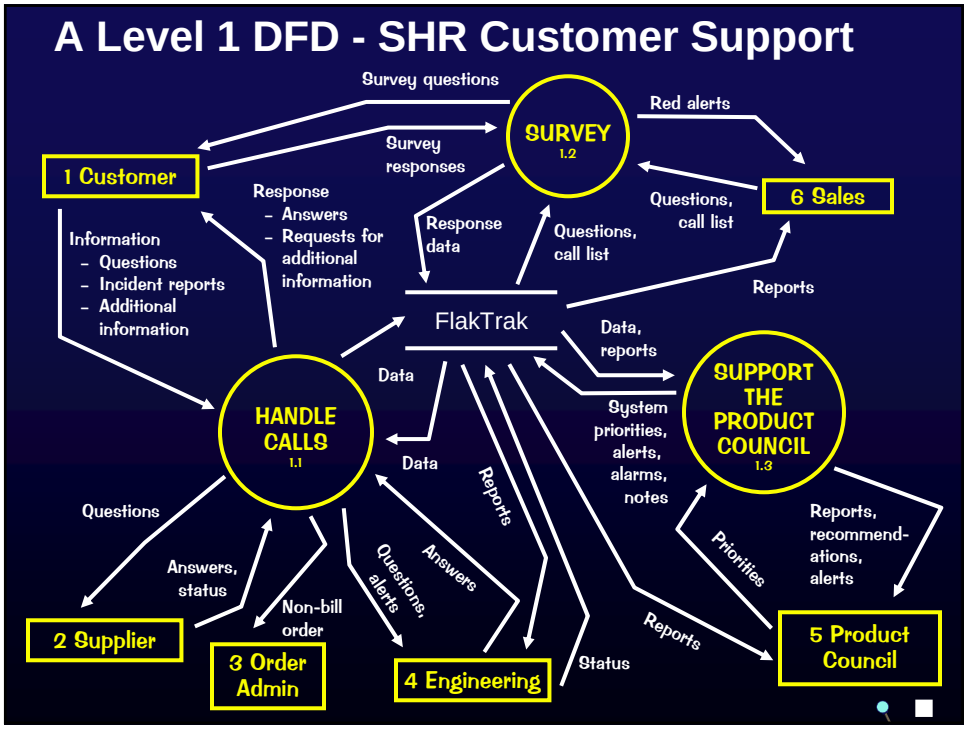

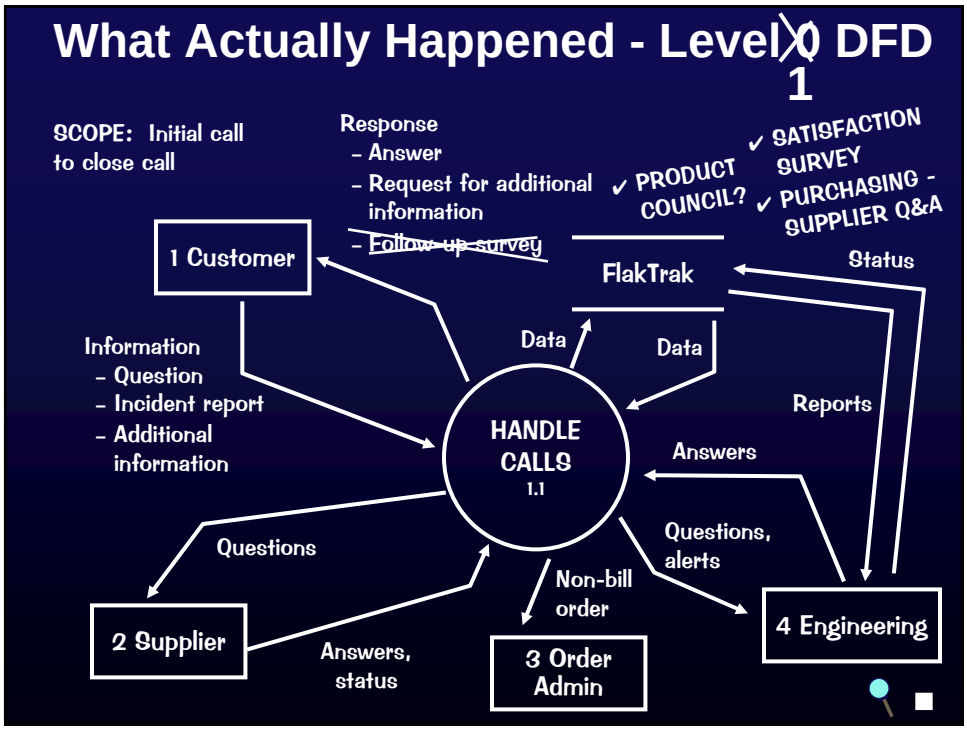

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WHAT - Activities & Deliverables (Cont.)

RULE 1
Preserve inputs

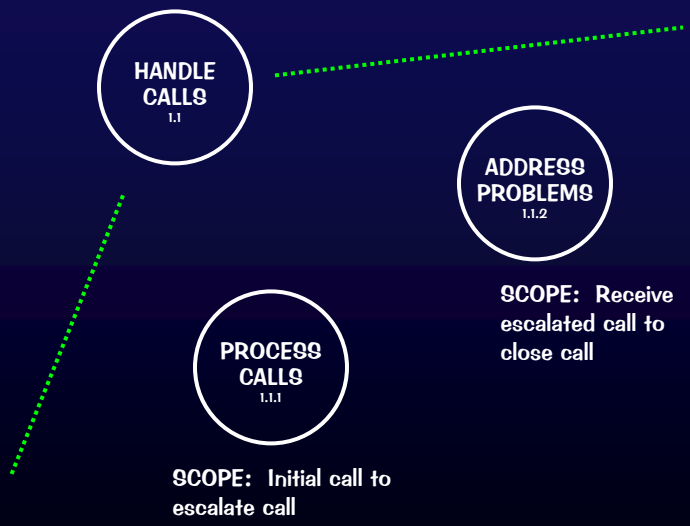
RULE 2
Preserve outputs

RULE 3
Continue until sequential steps are reached. The DFD is not a flow chart.

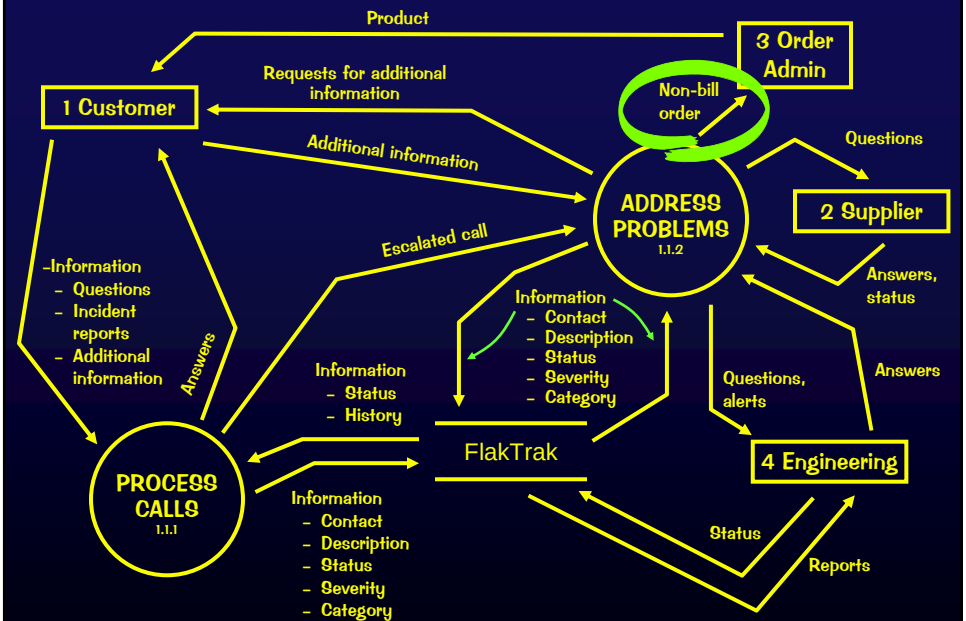
RULE 4
Derive a maximum of 9 bubbles from each higher level bubble

COROLLARIES
- ✔ You will have to back track
- ✔ Use subteams based on the scope of the activity

Creating a Level 2 DFD - SHR Customer Support



A Level 2 DFD - SHR Customer Support



A DFD Captures

- Activities
- Customers
- Suppliers
- The flow of deliverables between activities - inputs and outputs

A DFD does NOT capture

- Time
- Responsibility
- Logic

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Health Monitoring System (HMS)

The vital signs of high-risk patients at Pinafore Regional Hospital (PRH) are closely monitored. Pulse, temperature, and blood pressure sensors on the patient are read by HMS every 30 seconds. HMS records actual readings in the patient's record and compares them to ranges specified for the particular patient by the assigned doctor.

If a value falls outside the range, HMS records the exception in the patient's record and sends an alert to the terminal at the appropriate nursing station so an appropriate response can be initiated.

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The UML: Use Case Diagrams

Notation

USE CASE - A COHERENT UNIT OF FUNCTIONALITY PROVIDED BY A SYSTEM INVOLVING ONE OR MORE ACTORS

ACTOR - A ROLE PERFORMED BY AN OBJECT IN INTERACTING WITH THE SYSTEM - CUSTOMER [RECEIVES VALUE], SUPPLIER [PROVIDES INPUT], PARTICIPANT, DATA STORE

JOIN USE CASES

JOINS AN ACTOR AND A USE CASE

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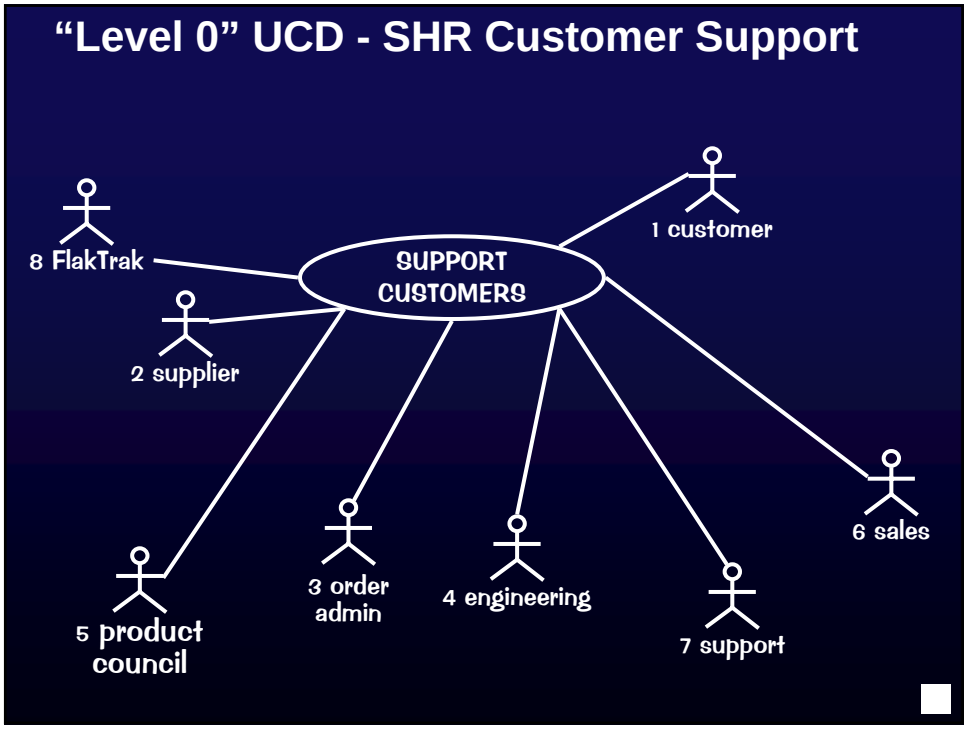

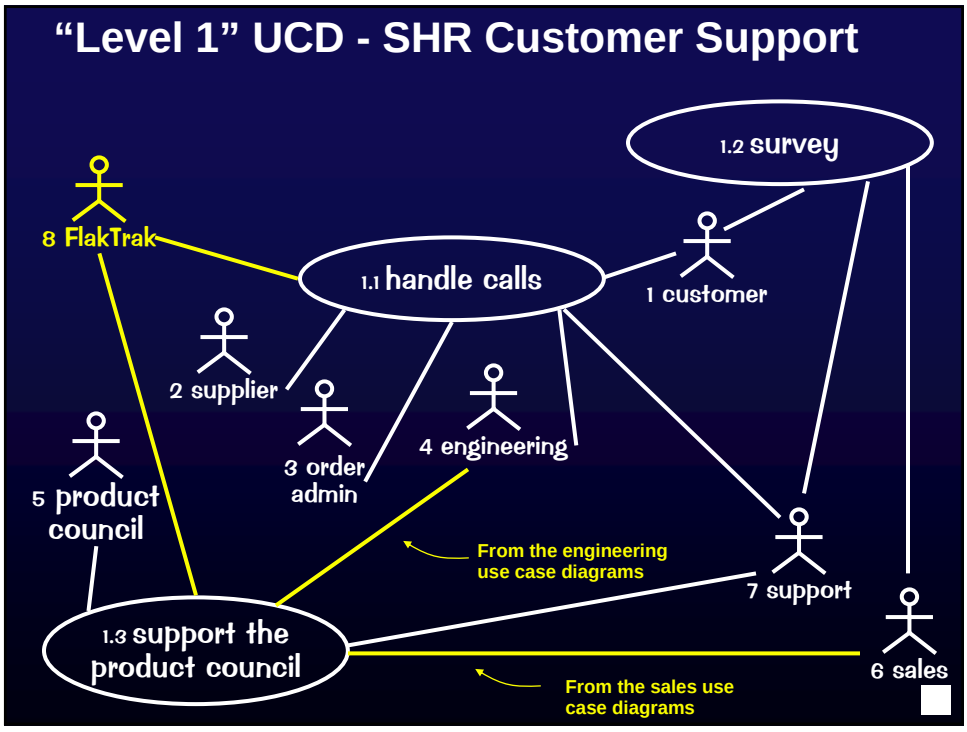

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Optimizing the Set of Activities

- Identify relationships among activities
  - Maximize standardization
    - Aggregate related activities
    - «extends»
  - Minimize duplication
    - Isolate common activities
    - «includes»

Expediting a rush order and rejecting an order are variations on processing a standard order.

Processing an inventory transfer and a requisition both require that the approver verify the budget balance.

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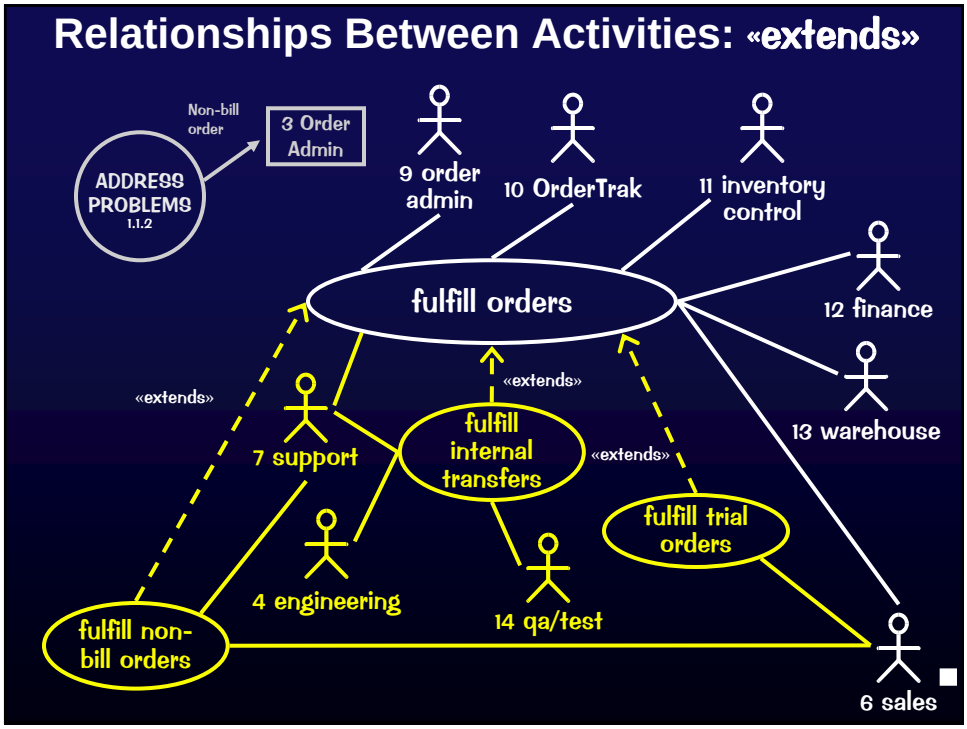
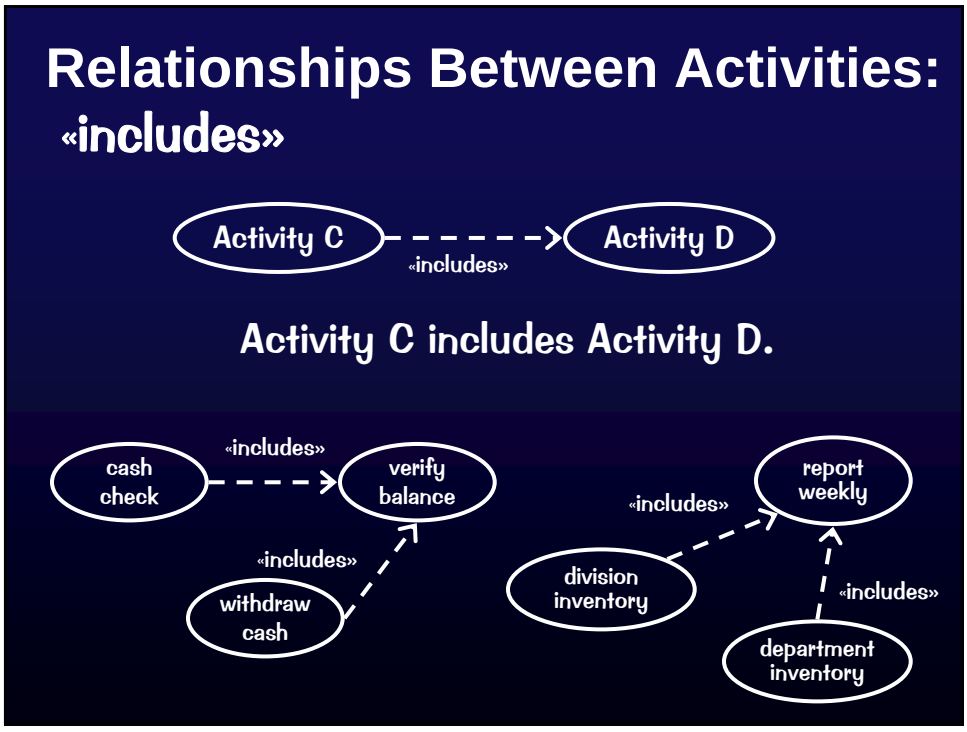
Relationships Between Activities: «extends»

- Under certain conditions, Activity B includes the behavior in Activity A (e.g., exception handling)
- Activity A is an optional part of Activity B
- Activity A is a variant of Activity B


Relationships Between Activities: «extends»
Non-bill order
3 Order Admin
ADDRESS PROBLEMS
1.1.2
9 order admin
10 OrderTrak
11 inventory control
12 finance
13 warehouse
fulfill orders
«extends»
«extends»
«extends»
7 support
fulfill internal transfers
fulfill trial orders
4 engineering
14 qa/test
fulfill non-bill orders
6 sales


Relationships Between Activities: «includes»
Activity C
«includes»
Activity D
Activity C includes Activity D.
cash check
«includes»
verify balance
«includes»
withdraw cash
«includes»
report weekly
division inventory
«includes»
department inventory

WHAT - Activities & Deliverables - Summary

- Identify and optimize

DFD
- Activities
- External customers
- External suppliers
- Data store
- The flow of deliverables between activities

The UML Use Case
- Participants
- Family relationships among activities

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WHO - Responsibility & Authority

- Entity = organizations, people, deliverables, etc.
- Identify and define the relationships and interactions among the entities associated with the process
- Entities: from the nouns in the narrative
- Relationships: from the verbs

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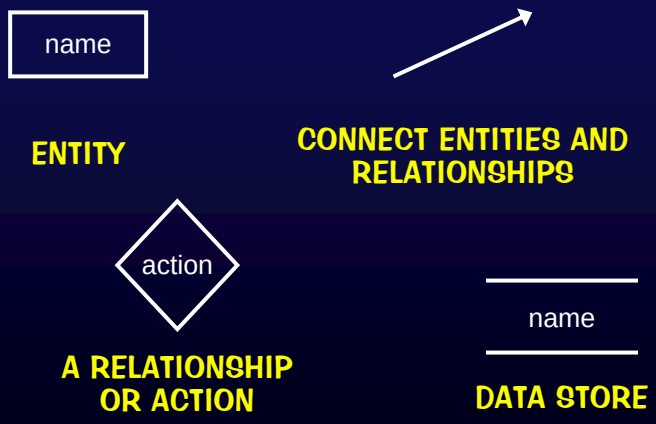
Entity Relationship Diagram (ERD) Notation



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For Example

Relationships may be:

- One to one
- Many to one
- One to many
- Many to many
- None to one

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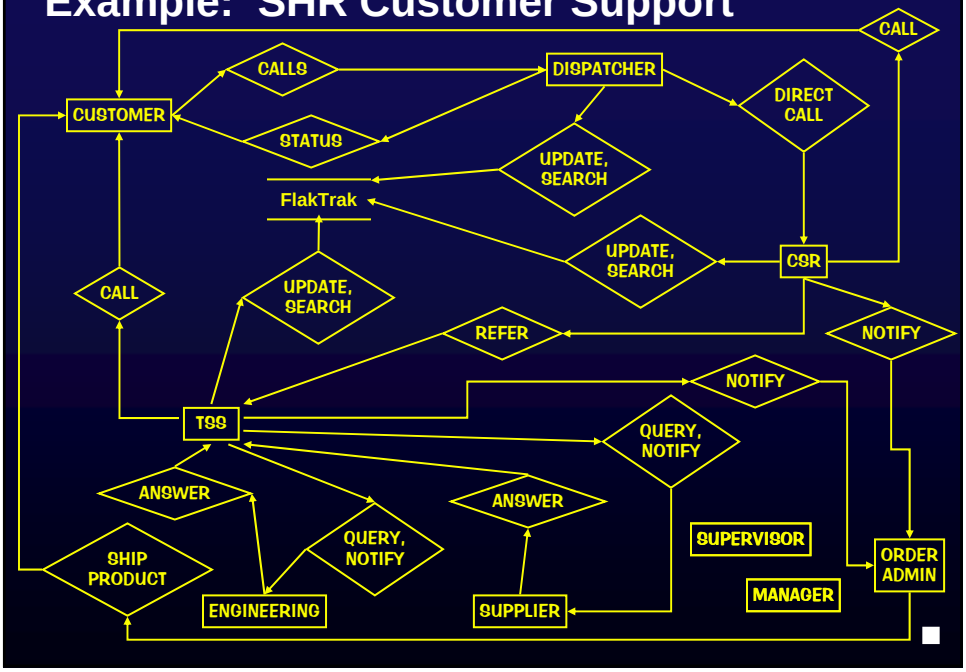
Rules for Appearing in an ERD

1 Represent “things” in the real world
- People, products, reports, strategies, standards, ...

2 When the entity is a set of objects, there is some way to distinguish individual objects
- For example: customers, items

3 Each entity is necessary to the process
- For example: supervisor monitoring
- Consistent with DFD

Example: SHR Customer Support



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An ERD captures

- Actions, interactions
- Responsibility, relationship

An ERD does NOT capture

- Time
- Logic

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Health Monitoring System (HMS)

The vital signs of high-risk patients at Pinafore Regional Hospital (PRH) are closely monitored. Pulse, temperature, and blood pressure sensors on the patient are read by HMS every 30 seconds. HMS records actual readings in the patient's record and compares them to ranges specified for the particular patient by the assigned doctor.

If a value falls outside the range, HMS records the exception in the patient's record and sends an alert to the terminal at the appropriate nursing station so an appropriate response can be initiated.

In some cases, the doctors specify the ranges in written orders which are entered into the system by the nurses.

The nurses also check patients periodically - both in person and by inspecting the values recorded in HMS.

If a sensor reading goes to zero, the nurses' station is notified.

The UML: collaboration diagrams

Notation - fewer lines, structured notation, sequence

name

AN OBJECT THAT INTERACTS WITH THE SYSTEM - CUSTOMER, SUPPLIER, PARTICIPANT, DATA STORE

PATH BETWEEN OBJECTS

FLOW

label message

A DESCRIPTION OF AN INTERACTION BETWEEN OBJECTS ALONG A PATH

JOIN OBJECTS AS PARENT AND CHILD

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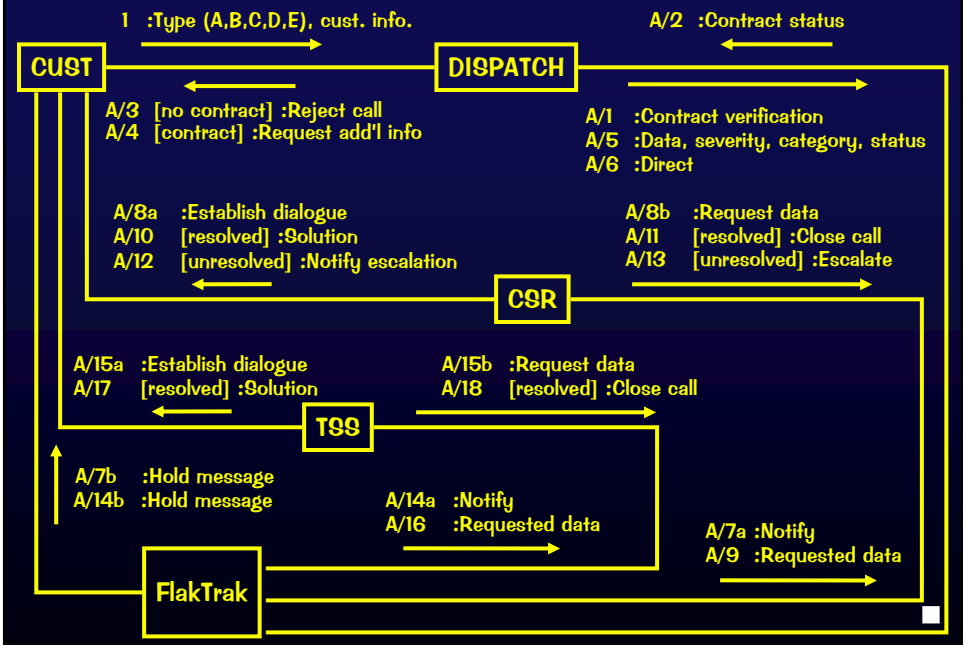
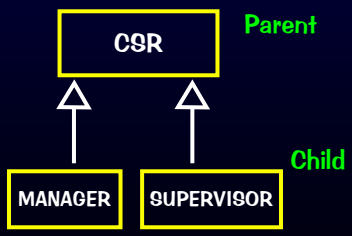
Example: SHR Customer Support



Optimizing interactions

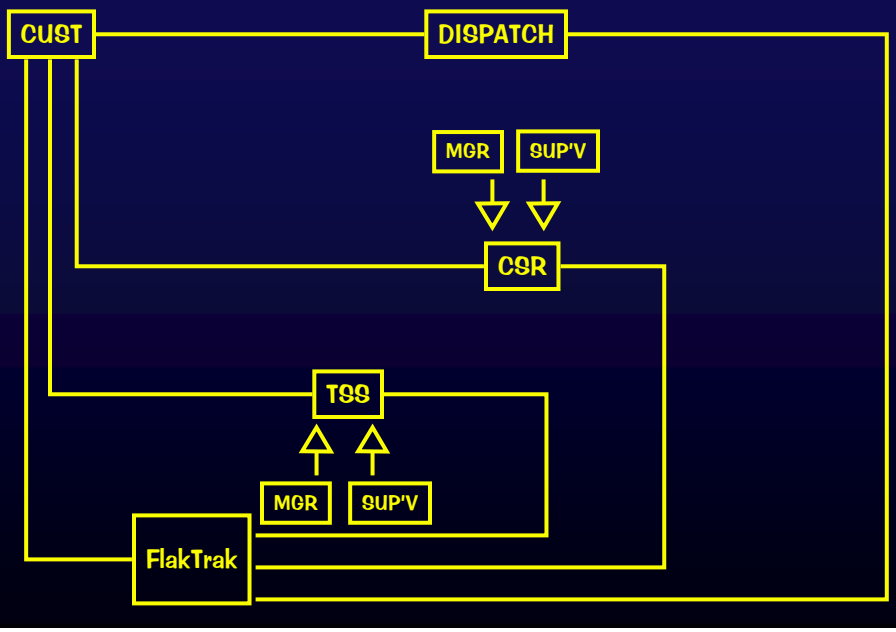
- Identify relationships among objects
  - Maximize standardization
  - Minimize duplication
  - Generalization - *parent* and *child*

- The child inherits all of the responsibilities of the parent.
- The child may be substituted for the parent.
- The child may add to or modify responsibilities inherited from the parent.



A Supervisor or Manager may be called on to act as a CSR.

Example: SHR Customer Support



WHY - cause & effect

- Identify the different states the PROCESS may be in
  - Event-driven activities
  - Not work product states
  - *ON HOLD* versus *INVESTIGATING*
- List the triggering event and the resulting action as annotation

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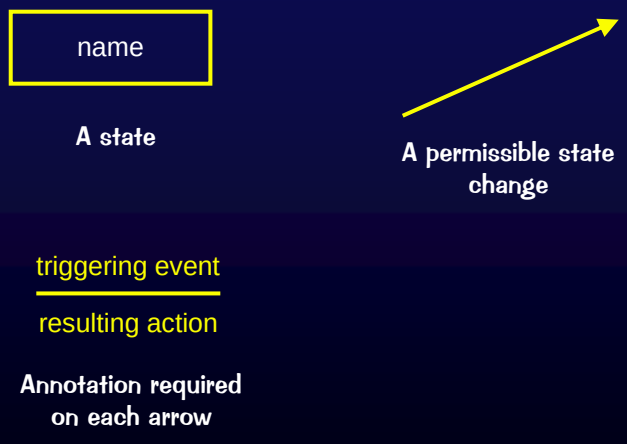
State Transition Diagram (STD) notation



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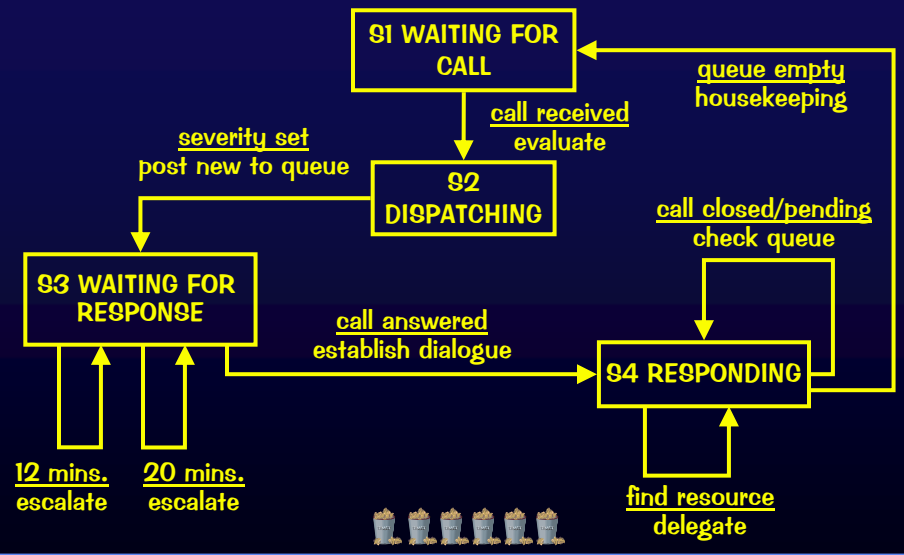
Example: SHR Customer Support



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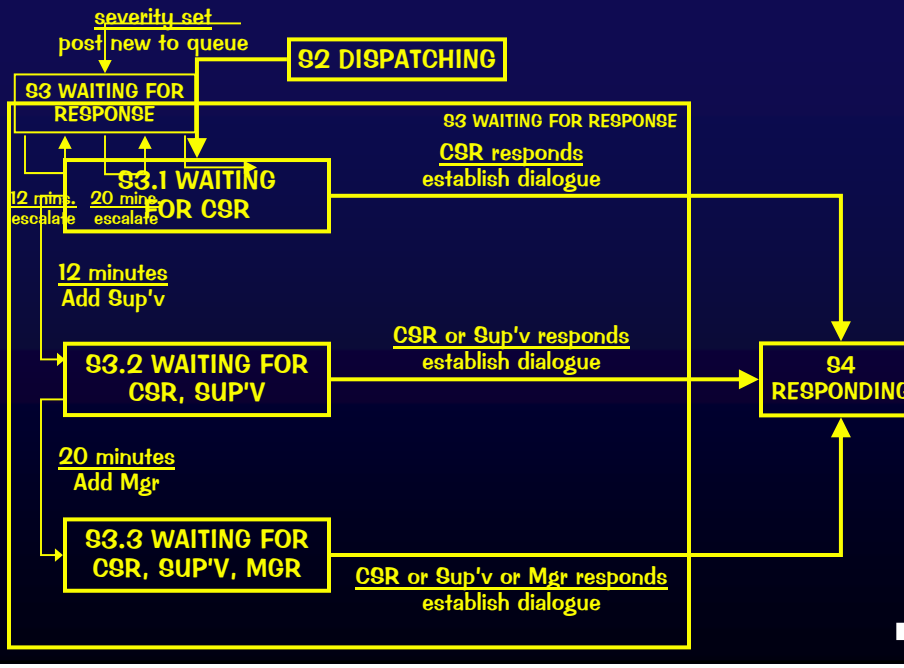
Example: SHR Customer Support (cont.)



Rules for an STD

RULE 1

Every state except the initial state must have a predecessor state

RULE 2

Every state except the final must have a successor state

RULE 3

Every state change must have a triggering event and resulting action

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If a value falls outside the range, HMS records the exception in the patient's record and sends an alert to the terminal at the appropriate nursing station so an appropriate response can be initiated.

In some cases, the doctors specify the ranges in written orders which are entered into the system by the nurses.

The nurses also check patients periodically - both in person and by inspecting the values recorded in HMS.

If a sensor reading goes to zero, the nursing station is notified.

If an alert is not acknowledged from the nursing station within 30 seconds, the nursing supervisor is paged with an appropriate action code, which indicates the source of the alert.

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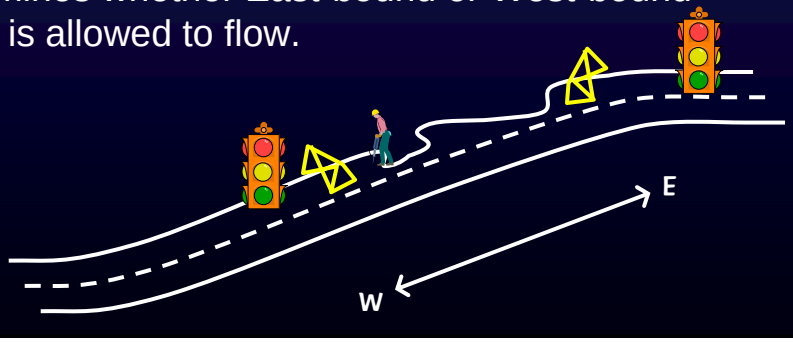
Under repair

A section of a two-lane, two-way highway is under repair. As a result only one lane is open. Traffic lights and sensors are set up at either end of the one-lane section. The sensors and lights are connected to a controller, which determines whether East-bound or West-bound traffic is allowed to flow.



An STD captures

- Relative time, sequence
- Triggering events and initial actions
- Control, alternatives

An STD does NOT capture

- Logic
- Flow of deliverables
- Responsibility, relationship

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The UML Statechart notation

A state

A permissible state change

'[' triggering event ']' '/' action-expression

Annotation on each arrow

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HOW - procedure & logic

- Model processes in which transitions between steps are triggered by the completion of other activities
- Start with a single box
- Define first and last steps

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Flow chart notation

More than two-alternative decision (case statement)

Process flow-sequence of steps

Two-alternative (binary) decision

Label for case statement alternatives

Last action or connector to another flow chart

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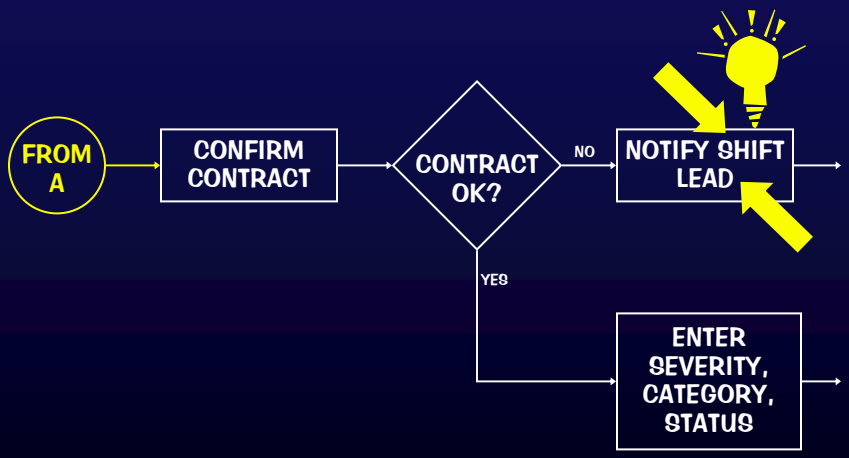
Surprise!



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How detailed? Depends on ...

- Where you start
  - Stability
  - Complexity
  - Knowledge, experience, education
- How they will be used
  - Throw away
  - Part of the contract
  - Requirements documentation

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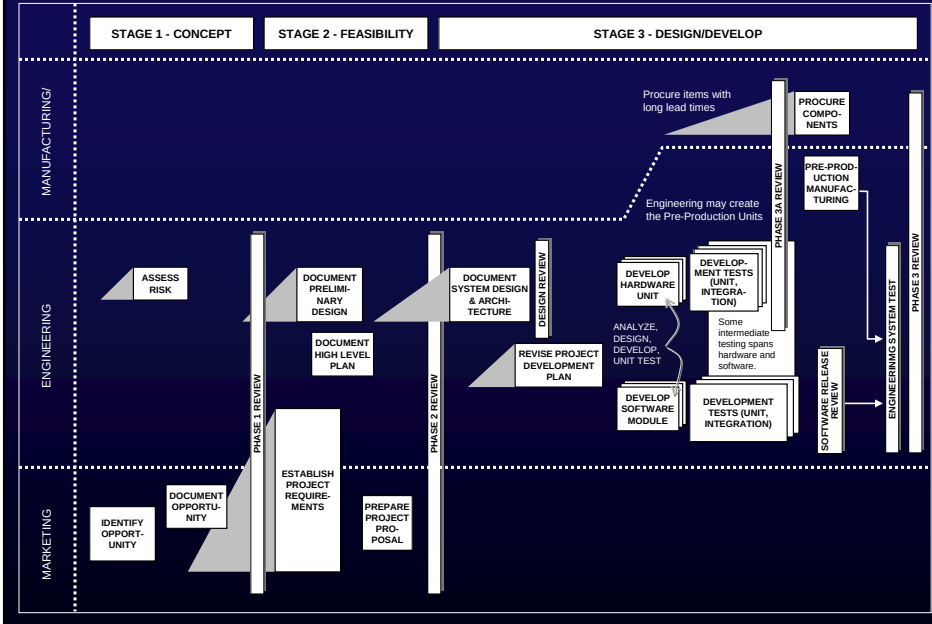

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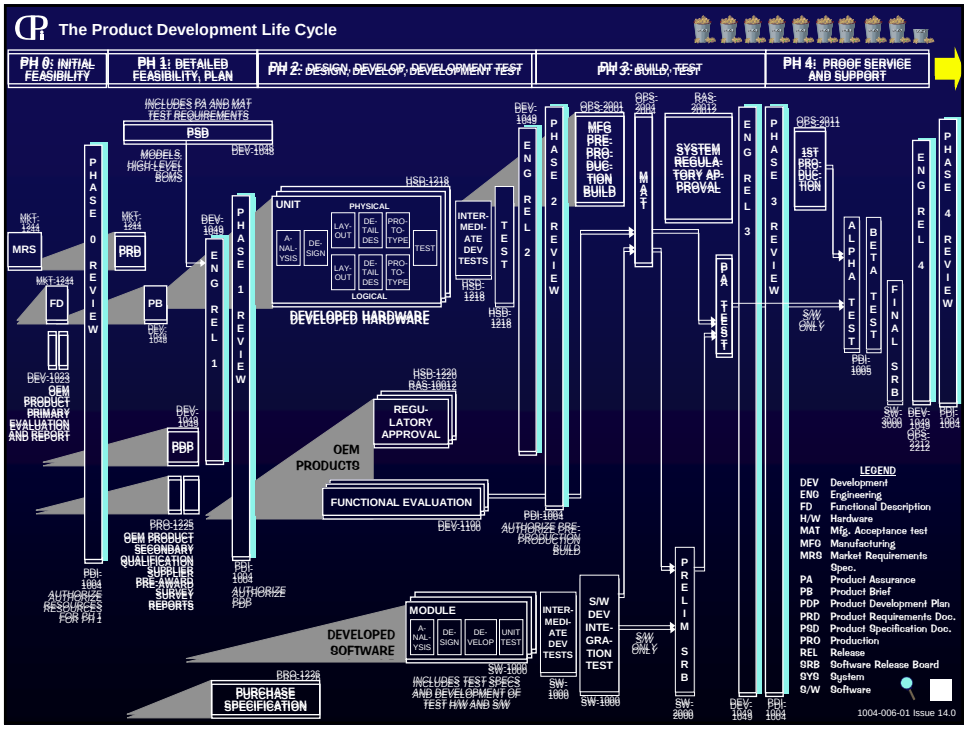

“more complicated than we really are"

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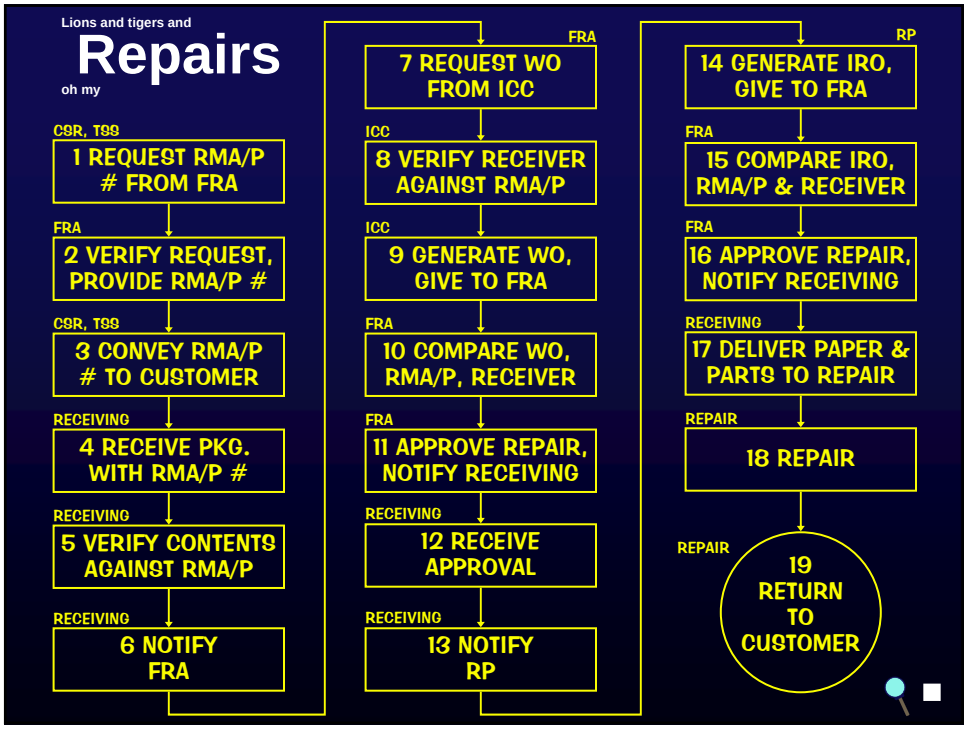
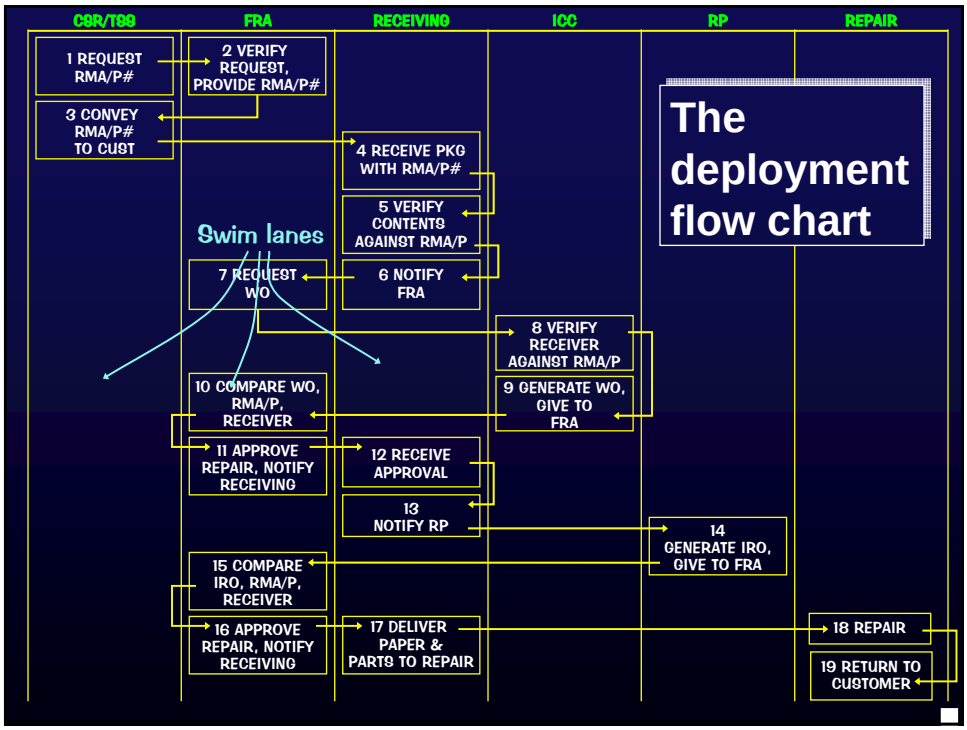

Lions and tigers and
Repairs
oh my
C9R, T99
1 REQUEST RMA/P # FROM FRA
FRA
2 VERIFY REQUEST, PROVIDE RMA/P #
C9R, T99
3 CONVEY RMA/P # TO CUSTOMER
RECEIVING
4 RECEIVE PKG. WITH RMA/P #
RECEIVING
5 VERIFY CONTENTS AGAINST RMA/P
RECEIVING
6 NOTIFY FRA
FRA
7 REQUEST WO FROM ICC
ICC
8 VERIFY RECEIVER AGAINST RMA/P
ICC
9 GENERATE WO, GIVE TO FRA
FRA
10 COMPARE WO, RMA/P, RECEIVER
FRA
11 APPROVE REPAIR, NOTIFY RECEIVING
RECEIVING
12 RECEIVE APPROVAL
RECEIVING
13 NOTIFY RP
RP
14 GENERATE IRO, GIVE TO FRA
FRA
15 COMPARE IRO, RMA/P & RECEIVER
FRA
16 APPROVE REPAIR, NOTIFY RECEIVING
RECEIVING
17 DELIVER PAPER & PARTS TO REPAIR
REPAIR
18 REPAIR
REPAIR
19 RETURN TO CUSTOMER


C9R/T99
FRA
RECEIVING
ICC
RP
REPAIR
1 REQUEST RMA/P#
2 VERIFY REQUEST, PROVIDE RMA/P#
3 CONVEY RMA/P# TO CUST
4 RECEIVE PKG WITH RMA/P#
5 VERIFY CONTENTS AGAINST RMA/P
6 NOTIFY FRA
7 REQUEST WO
8 VERIFY RECEIVER AGAINST RMA/P
9 GENERATE WO, GIVE TO FRA
10 COMPARE WO, RMA/P, RECEIVER
11 APPROVE REPAIR, NOTIFY RECEIVING
12 RECEIVE APPROVAL
13 NOTIFY RP
14 GENERATE IRO, GIVE TO FRA
15 COMPARE IRO, RMA/P, RECEIVER
16 APPROVE REPAIR, NOTIFY RECEIVING
17 DELIVER PAPER & PARTS TO REPAIR
18 REPAIR
19 RETURN TO CUSTOMER
Swim lanes
The deployment flow chart

A flow chart captures

- Actions
- Responsibility
- Logic and rules/control
- Time - cause and effect

A flow chart does not easily capture

- Parallel flows
- Complex flows, numerous alternative routes and decision criteria, numerous entry points

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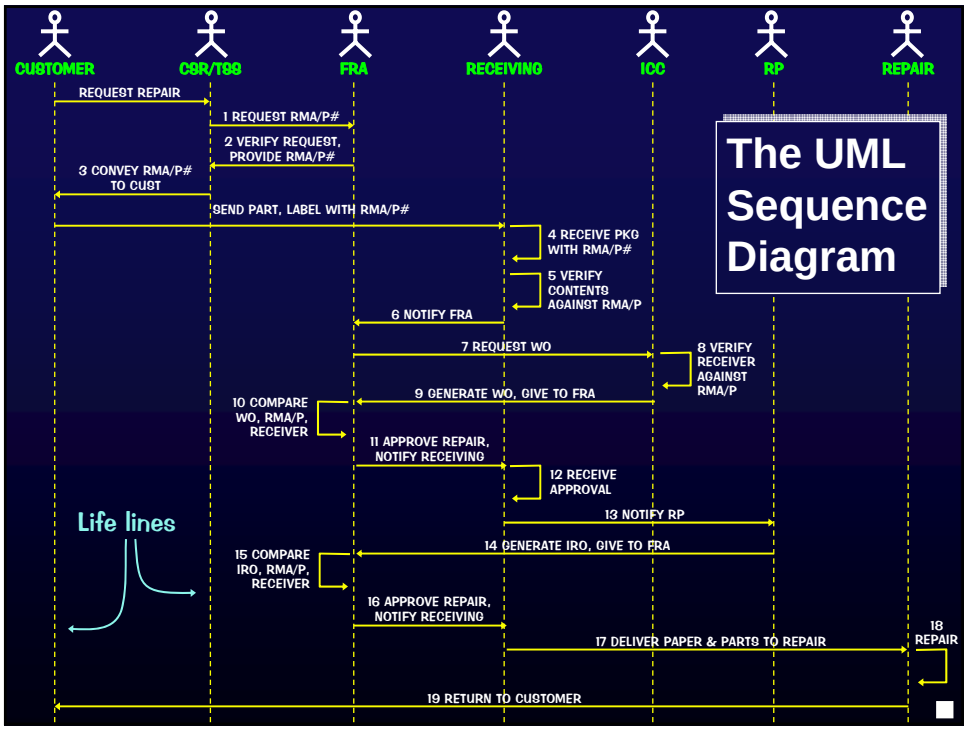

The UML Activity Diagram

Notation

activity

Process flow - sequence of activities

Fork - beginning of parallel activities

Decision point (any number of alternatives)

Join - completion of parallel activities

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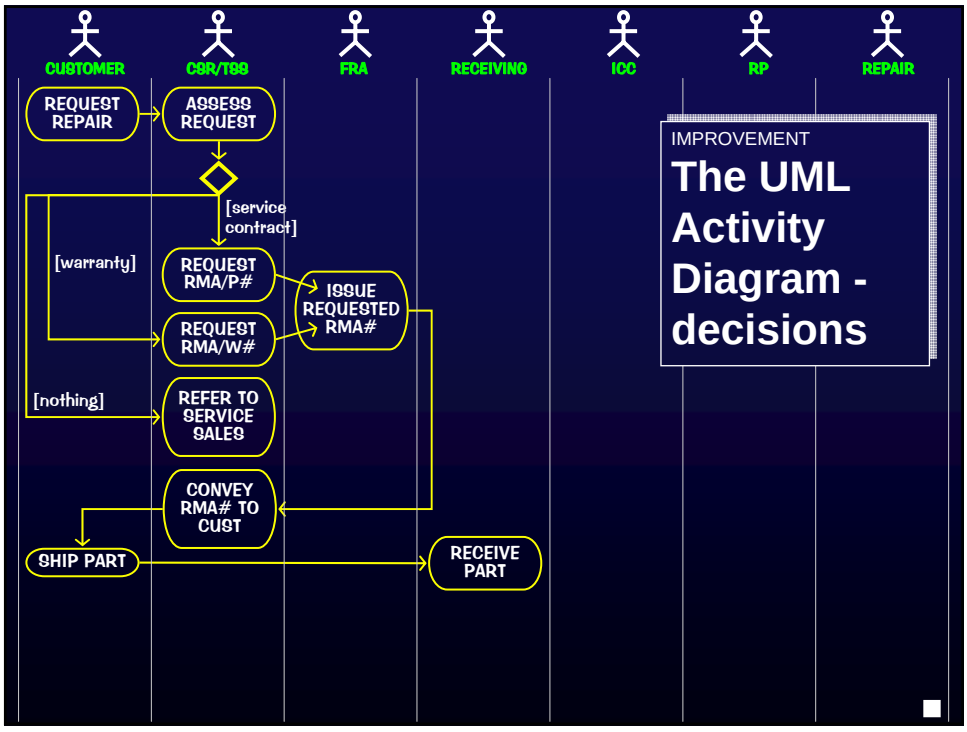

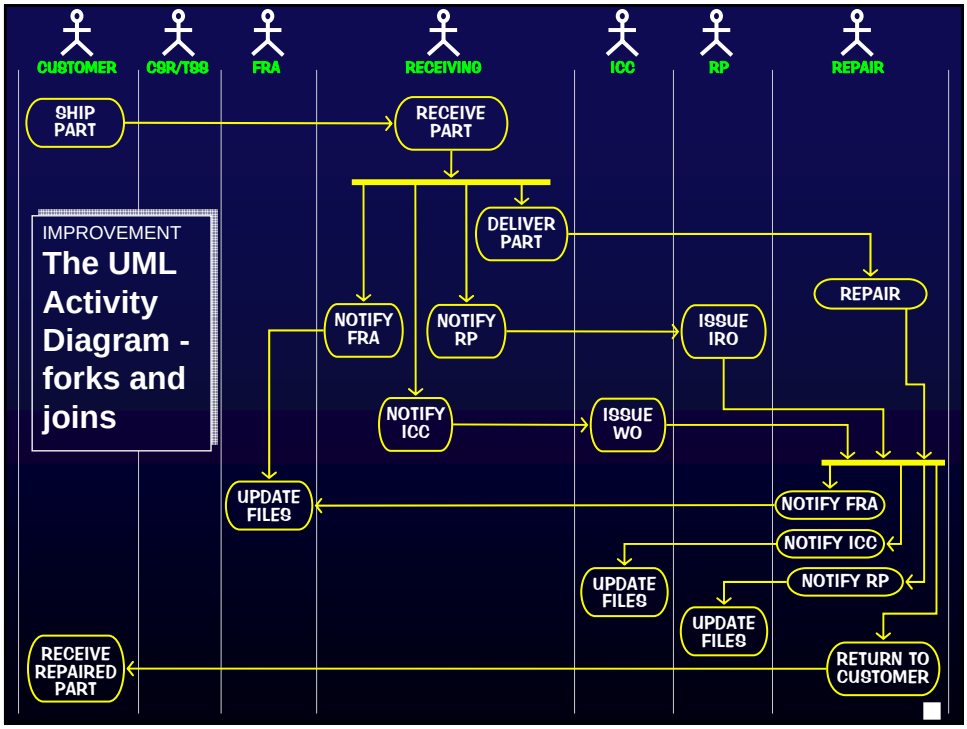

Confirm

For flow charts, Activity Diagrams, Sequence Diagrams

- Observe (show me vs. tell me)
- Walk through
- Review - present to others
- Ensure process capability is consistent with customer requirements

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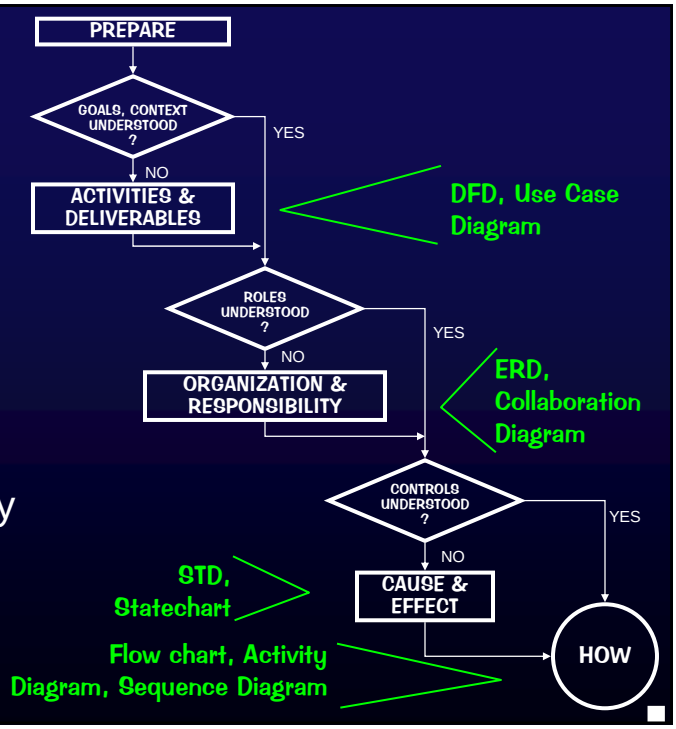
A suggested hierarchy



- Iterative - reenter at any point
- Optional steps

Juran's six sources of error

- Misinterpretation
- Inadvertent errors
- Lack of technique
- Conscious errors
- Bias
- Futility

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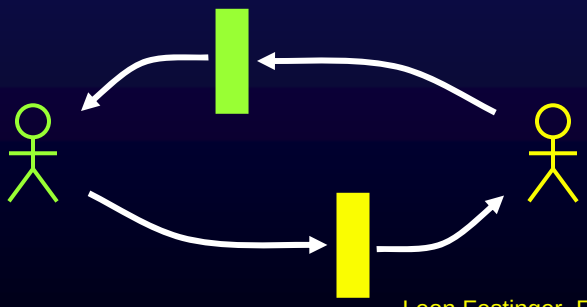
Selective listening, blind spots, and other self-inflicted limits

- Cognitive dissonance
- Rational versus rationalizing



Leon Festinger, Elliot Aronson

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FINAL TEAM EXERCISE

SAV

Assignment

Prepare and deliver a 10 minute presentation to H. Strasser and B. Arnold. Your goal is to **KICK OFF** the requirements-gathering phase of a possible project so focus on requirements and questions from the memorandum.

Suggested Topics

- Introductions
- Summarize input (confirm understanding)
- Identify basic requirements
- List issues and questions for follow-up

A Test Drive

SHR INCORPORATED

Formal Input Tracking System **FITS**

		FITS Identifier **FID**	1204-006-030422.183-0454Z
	UNIVERSAL PERSONNEL CODE **UPC**	**NAME**	**LOCATION**
SHR CONTACT	199046134	Delane, E.	CODE xx DEPT yy

DISPOSITION	**REQUIREMENT STATEMENT**
X Defect Change Close-SOAD Investigate	When an inter-depot transfer is approved, it is charged against the depot budget and is correctly reported in the Depot Working Budget Report (DWBR-0021). When a partial shipment is received for an approved inter-depot transfer, the line item disappears from the Depot Working Budget Report and is not reflected in the totals. When the transfer is complete, the line item reappears and the totals are correct. (SEE ATTACHED SAMPLE REPORTS, DB DUMP) DWBR-0021 shall correctly reflect approved inter-depot transfers for which partial shipments are received.

IMPACT	This problem can affect month-end reconciliation since 1) an inter-depot transfer for which partials have been received may never be completed or it may extend over a month-end balance 2)approved inter-depot transfers for which partial shipments have been received are in the Regional Monthly Roll-up Report (REG-0033)

	CRITICAL	**IMPORTANT**	**ROUTINE**
WORKING PRIORITY	X	X	

What Can Engineers and Project Managers Do about Requirements?

Gaining Support

Customer	Strategy
(1) Donald E. Over	
(2) Ian DeLegate	
(3) Everett Bristle	

NOTES

Test Drive

From the Formal Input Tracking System (FITS), you have the following information.

		FITS Identifier **FID**	1204-006-030422.183-0454Z
	UNIVERSAL PERSONNEL CODE (UPC)	**NAME**	**LOCATION**
ORIGINATOR	015477408	Skilling, P. W.	SM2-06 DEPT cc
	PRODUCT IDENTIFIER PID		**VERSION**
SYSTEM INFORMATION	Operating Budget Target Tracking Application - OBTTA		5.01.0004
PROBLEM OR REQUEST X Problem Request	The Extended Money Values for approved Inter-Depot Transfer Transactions are not permanently reflected in the on the Depot Working Budget Report. I reported this problem t/r #552950 which was cancelled w/o explanation. This is critical since depot managers use the budget report when making approval decisions.		
IMPACT	Depot managers may approve requests when budget not there.		
	CRITICAL	**IMPORTANT**	**ROUTINE**
ORIGINATOR PRIORITY		X	

Background

You download his data and confirm that Skilling has the correct versions of OBTTA and all the associated hardware and software..

You check FITS and determine that:

- TR 552950 was cancelled; the reason was "system operating as designed". The person who closed it is not available.
- You can't find another problem report related to the problem described.

You walk down the passageway to the Standard Systems Simulation Lab (S3L), load version 5.01.004 of OBBTA and Skilling's data, and determine that:

- A few sample inter-depot transfers you enter show up correctly in the Depot Working Budget Report (DWBR-0021).

Finally, because you are thorough, you accelerate time by a factor of 1,000 to simulate running the system for a month and determine that:

- The sample inter-depot transfers still show up correctly in DWBR-0021.
- The sample inter-depot transfers show up correctly in the Regional Monthly Roll-up Report (REG-0033)

Attributes	Types	(C1) Notes/Issues
❑ Clear ❑ Correct ❑ Consistent ❑ Singular ❑ Testable, verifiable ❑ Feasible ❑ Design independent ❑ Traceable ❑ Clear	❑ Functional (user, mode) ❑ Exception handling (user, mode) ❑ Performance (quantitative) ❑ Design constraint (environment) ❑ Interface (interact with user, external components and other internal components) ❑ Communications (connectivity, access) ❑ Computer security and access ❑ Backup and recovery ❑ Implementation (conversion, installation, hardware acquisition) ❑ Information (examples, other)	

(C2) Question/Topic		(C3) Notes/Answer
	STOP here until directed to continue to the next part.	

Test Drive - Capture the Requirements

(C4) Restated problem(s) or request(s)	(C5)
Restated impact(s)	

NOTES

Test Drive 1

From a request submitted for Flak-Trak, an automated hot-line system. Flak-Trak is installed in 7x24 help-desk centers that handle customer telephone calls.

> **After 12 minutes we need FlakTrak to automatically escalate any incoming call that has not been answered to the hot-shift line lead.**

Background

FlakTrak incorporates a standard HoldAll Call Director, which automatically places incoming calls on hold and plays soothing music until they are answered by a support person. FlakTrak includes software that polls the HoldAll twice every second and which displays a constant on-screen message at all active support work stations regarding how many calls are waiting in the queue. For each call, FlakTrak also records the date, time, sequential identification number, and the amount of time between first ring and when the call is answered. The information is recorded in a file that can be read in Microsoft Excel.

Attributes	Types	(C1) Notes/Issues
❑ Clear ❑ Correct ❑ Consistent ❑ Singular ❑ Testable, verifiable ❑ Feasible ❑ Design independent ❑ Traceable ❑ Clear	❑ Functional (user, mode) ❑ Exception handling (user, mode) ❑ Performance (quantitative) ❑ Design constraint (environment) ❑ Interface (interact with user, external components and other internal components) ❑ Communications (connectivity, access) ❑ Computer security and access ❑ Backup and recovery ❑ Implementation (conversion, installation, hardware acquisition) ❑ Information (examples, other)	

(C2) Question/Topic		(C3) Notes/Answer
	STOP here until directed to continue to the next part.	

Test Drive - Capture the Requirements

(C4) Restated problem(s) or request(s)	(C5)
Restated impact(s)	

NOTES

Test Drive 2

From a bug report for an inventory management system your group maintains. The report is listed as originated by M. Wagner at the Denver Depot.

> **When the Flash utility is used to add and item to the Depot Parts List (DPL), the item doesn't show up in a DPL Query. But when DPL Add is run, it says the item is already there. If an item is added with DPL Add everything works fine. Except Flash overwrites an item with the same part number.**

Background

DPL is an application that incorporates a commercial data base. DPL Add and DPL Query are tools provided in the DPL application suite (along with DPL Delete, DPL Edit, DPL Report, and DPL Analyze). Flash is a $29.00 commercial utility program that provides direct access to the database for users to delete, edit, and add records. Flash was distributed two years ago when the DPL application suite was discovered to be incompatible with the latest version of Windows, a problem that has since been corrected. You can duplicate the facts in the Problem Report.

Attributes	Types	(C1) Notes/Issues
❑ Clear ❑ Correct ❑ Consistent ❑ Singular ❑ Testable, verifiable ❑ Feasible ❑ Design independent ❑ Traceable ❑ Clear	❑ Functional (user, mode) ❑ Exception handling (user, mode) ❑ Performance (quantitative) ❑ Design constraint (environment) ❑ Interface (interact with user, external components and other internal components) ❑ Communications (connectivity, access) ❑ Computer security and access ❑ Backup and recovery ❑ Implementation (conversion, installation, hardware acquisition) ❑ Information (examples, other)	

(C2) Question/Topic		(C3) Notes/Answer
	STOP here until directed to continue to the next part.	

Test Drive - Capture the Requirements

(C4) Restated problem(s) or request(s)	(C5)
Restated impact(s)	

NOTES

Test Drive 3

From an enhancement request for a data warehouse query application your group maintains. The enhancement request comes from the Southern Region Field Sales Support organization.

> **The system shall allow users at IBM-compatible PCs with 32 MB of memory to construct report templates without being connected to the network and the system shall work the same.**

Background

The system has two utilities for creating report templates: one is for on-line use (e.g., connected to the server); the other for off-line use (e.g., when a network connection is not available). Off-line operation is supposed to require a PC with at least 32 MB of memory. In reality, it requires a minimum of 64MB.

Attributes	Types	(C1) Notes/Issues
❑ Clear ❑ Correct ❑ Consistent ❑ Singular ❑ Testable, verifiable ❑ Feasible ❑ Design independent ❑ Traceable ❑ Clear	❑ Functional (user, mode) ❑ Exception handling (user, mode) ❑ Performance (quantitative) ❑ Design constraint (environment) ❑ Interface (interact with user, external components and other internal components) ❑ Communications (connectivity, access) ❑ Computer security and access ❑ Backup and recovery ❑ Implementation (conversion, installation, hardware acquisition) ❑ Information (examples, other)	

(C2) Question/Topic		(C3) Notes/Answer
	STOP here until directed to continue to the next part.	

Test Drive - Capture the Requirements

(C4) Restated problem(s) or request(s)	(C5)
Restated impact(s)	

NOTES

Test Drive 4

From a problem report for a data warehouse query application your group maintains. The problem report comes from the Southern Region Field Sales Support organization.

> **On the On-Hand Inventory screen, OHI-24, PARTS AVAILABLE BY PART NUMBER, the field for "Total Units Available at all Sites" is not updated so information is not available to personnel checking inventory at one location.**

Background

The field is supposed to be updated according to the latest design documentation. You do some further investigation with the software developers and confirm that it is updated following each monthly physical inventory.

Attributes	Types	(C1) Notes/Issues
❑ Clear ❑ Correct ❑ Consistent ❑ Singular ❑ Testable, verifiable ❑ Feasible ❑ Design independent ❑ Traceable ❑ Clear	❑ Functional (user, mode) ❑ Exception handling (user, mode) ❑ Performance (quantitative) ❑ Design constraint (environment) ❑ Interface (interact with user, external components and other internal components) ❑ Communications (connectivity, access) ❑ Computer security and access ❑ Backup and recovery ❑ Implementation (conversion, installation, hardware acquisition) ❑ Information (examples, other)	

(C2) Question/Topic		(C3) Notes/Answer
	STOP here until directed to continue to the next part.	

Test Drive - Capture the Requirements

(C4) Restated problem(s) or request(s)	(C5)
Restated impact(s)	

NOTES

Test Drive 5

From the statement of work for a warehouse fire detection system.

> **The system shall poll up to 128 sensors divided in up to 4 zones, with a maximum of 28 sensors per zone, at a rate of once every 30 seconds, except under high-load conditions, in which case the polling may by zone may take up to 60 seconds, or 90 seconds, if necessary, but an exception record will be logged on a journal printer (at the operator console) if the length of the polling cycle exceeds the above stated rate for more than 3 minutes and 10 seconds. After more than 4 minutes of extended polling, an audible alarm sounds.**

Attributes	Types	(C1) Notes/Issues
❑ Clear ❑ Correct ❑ Consistent ❑ Singular ❑ Testable, verifiable ❑ Feasible ❑ Design independent ❑ Traceable ❑ Clear	❑ Functional (user, mode) ❑ Exception handling (user, mode) ❑ Performance (quantitative) ❑ Design constraint (environment) ❑ Interface (interact with user, external components and other internal components) ❑ Communications (connectivity, access) ❑ Computer security and access ❑ Backup and recovery ❑ Implementation (conversion, installation, hardware acquisition) ❑ Information (examples, other)	

(C2) Question/Topic		(C3) Notes/Answer
	STOP here until directed to continue to the next part.	

Test Drive - Capture the Requirements

(C4) Restated problem(s) or request(s)	(C5)
Restated impact(s)	

NOTES

Test Drive 6

From a proposal approved as a top priority by Product Marketing (see note), to consolidate two systems your group maintains.

> **Develop SuperSystem, a single, integrated system for managing inventories at all repair depots and regional warehouses. Start with and use most of the Regional Warehouse Distribution Center System (DCS) on-hand inventory valuation and distribution capability. Incorporate repair-kit management functionality from the Depot Stock Management System (SMS). Develop real-time update and data replication functionality to replace current batch reporting under DCS and SMS. Develop interfaces to use bar code technology wherever applicable.**

We have to be able to offer this. Everyone is asking for it, the competition has it, and it should be easy to do through reuse and through standard data base tools.

The Boss.

Attributes	Types	(C1) Notes/Issues
❑ Clear ❑ Correct ❑ Consistent ❑ Singular ❑ Testable, verifiable ❑ Feasible ❑ Design independent ❑ Traceable ❑ Clear	❑ Functional (user, mode) ❑ Exception handling (user, mode) ❑ Performance (quantitative) ❑ Design constraint (environment) ❑ Interface (interact with user, external components and other internal components) ❑ Communications (connectivity, access) ❑ Computer security and access ❑ Backup and recovery ❑ Implementation (conversion, installation, hardware acquisition) ❑ Information (examples, other)	

(C2) Question/Topic		(C3) Notes/Answer
	STOP here until directed to continue to the next part.	

Test Drive - Capture the Requirements

(C4) Restated problem(s) or request(s)	(C5)
Restated impact(s)	

NOTES

Test Drive 7

From an e-mail from the CIO at a major customer, which has installed your comprehensive manufacturing plant management system at 14 sites world-wide.

> **All applications need guidance for Application Administrators to perform verification of database restore and procedures for recovery upon catastrophic system failure. Guidance should be in the form of a Manual that be referred to from the System Administrators Manual and contain proper restart, restore, and validation procedures to be used by Administrators after recovery of system prior to letting all users back on system.**

Attributes	Types	(C1) Notes/Issues
❑ Clear ❑ Correct ❑ Consistent ❑ Singular ❑ Testable, verifiable ❑ Feasible ❑ Design independent ❑ Traceable ❑ Clear	❑ Functional (user, mode) ❑ Exception handling (user, mode) ❑ Performance (quantitative) ❑ Design constraint (environment) ❑ Interface (interact with user, external components and other internal components) ❑ Communications (connectivity, access) ❑ Computer security and access ❑ Backup and recovery ❑ Implementation (conversion, installation, hardware acquisition) ❑ Information (examples, other)	

(C2) Question/Topic		(C3) Notes/Answer
	STOP here until directed to continue to the next part.	

Test Drive - Capture the Requirements

(C4) Restated problem(s) or request(s)	(C5)
Restated impact(s)	

NOTES

Test Drive 8

From the statement of work for which you are preparing a response.

> **Starting with and using the functionality of the San Corolla City System for tracking citations, develop a system which will consolidate all citations issued in Costanoa County by any City police department (in the County), or by the County sheriff. The citation should be automatically referred to the correct Municipal or County Court, which will be responsible for recording the disposition of the citation. Currently, data on unpaid fines is manually reported monthly by each Court Clerk to the State Department of Motor Vehicles so that drivers license renewals and vehicle registrations can be withheld until any outstanding items are resolved to the satisfaction of the Court with jurisdiction. The new system should automate this reporting.**

Background

You got a speeding ticket 7 months ago and you know what a nightmare it is waiting for the ticket to make its way through the different departments and courts so you could schedule traffic school. Your ticket was initially sent to the wrong Court, which delayed processing past the last date on which you were supposed to appear in Court of pay the fine. Everyone was very helpful and the dates were adjusted.

Attributes	Types	(C1) Notes/Issues
❑ Clear ❑ Correct ❑ Consistent ❑ Singular ❑ Testable, verifiable ❑ Feasible ❑ Design independent ❑ Traceable ❑ Clear	❑ Functional (user, mode) ❑ Exception handling (user, mode) ❑ Performance (quantitative) ❑ Design constraint (environment) ❑ Interface (interact with user, external components and other internal components) ❑ Communications (connectivity, access) ❑ Computer security and access ❑ Backup and recovery ❑ Implementation (conversion, installation, hardware acquisition) ❑ Information (examples, other)	

(C2) Question/Topic		(C3) Notes/Answer
	STOP here until directed to continue to the next part.	

Test Drive - Capture the Requirements

(C4) Restated problem(s) or request(s)	(C5)
Restated impact(s)	

NOTES

Test Drive 9

From a problem report submitted by the day-shift supervisor at a customer site.

> When I use the Web3M v6 to record a MACHINE DOWN problem with a piece of mountable equipment (e.g., sorter, stapler) which can be moved from one copying machine to another, the problem stays against the machine as well as the piece of mountable equipment. So I can't put the machine back on READY status so I can schedule work for it. Right now when I move the broken mountable equipment, I delete the original DOWN problem as a "misdiagnosis" and open a new problem against a fake machine I added to Web3M and which everyone knows to show as always DOWN. This really messus up our equipoment inventory and our maintenance numbers.

Background

Attributes	Types	(C1) Notes/Issues
❑ Clear ❑ Correct ❑ Consistent ❑ Singular ❑ Testable, verifiable ❑ Feasible ❑ Design independent ❑ Traceable ❑ Clear	❑ Functional (user, mode) ❑ Exception handling (user, mode) ❑ Performance (quantitative) ❑ Design constraint (environment) ❑ Interface (interact with user, external components and other internal components) ❑ Communications (connectivity, access) ❑ Computer security and access ❑ Backup and recovery ❑ Implementation (conversion, installation, hardware acquisition) ❑ Information (examples, other)	v6 is the latest version. This really happens. The system is working the way it is supposed to work. I heard from the sales support people that the work-around is driving the customer's internal financial auditors crazy because they keep looking for capital equipment and are told it doesn't exist. And the customer's Purchasing people are upset because they are supposed to complain to the contract Equipment Maintenance company if equipment stays down for more than 48 hours. And then when they beat the vendor up, they find out the equipment doesn't exist!

(C2) Question/Topic		(C3) Notes/Answer
	STOP here until directed to continue to the next part.	

Test Drive - Capture the Requirements

(C4) Restated problem(s) or request(s)	(C5)
Restated impact(s)	

NOTES

Test Drive 10

From a change proposal received from P. Blanchard at the BoardCom Travel Office for TAS, a Travel Accounting System your group maintains:

> **When a travel request is processed from the "pending transactions" screen, then saved and closed, the next travel request is not highlighted.**

Background

As the duty TAS expert, you quickly review the documentation to refresh your memory. The "pending transactions" screen lists outstanding travel-related transactions, including travel requests, expense reports, trip reports, and trip request approvals. The transactions can only be listed in order by origination date and time, so when any transaction is completed and closed, the transaction is removed from the list of "pending transactions", and TAS returns to the "pending transactions" screen, showing the first 24 outstanding, pending transactions, with the first transaction highlighted.

TAS Quick Reference

PgDn or PgDn	Move highlight up or down through the list of transactions 24 at a time	Alt + ↓	Highlight next transaction of the same type as the one that is currently highlighted
↓ or ↑	Highlight next or previous transaction in relation to the currently highlighted transaction	Ctrl + End	Highlight last (most recent) transaction of the same type as the one that is currently highlighted
Home or End	Highlight the first or last transaction in the set of 24 currently displayed	Ctrl + Home	Highlight first (the oldest) transaction of the same type as the one that is currently highlighted
Shift + Home	Display the first 24 transactions; highlight first transaction (the oldest)	Enter	Begin processing currently highlighted transaction
Shift + End	Display the last 24 transactions; highlight last (most recent) transaction	Ctrl + V	Begin Verification (requires supervisor privileges)
Alt + ↑	Highlight previous transaction of the same type as the one that is currently highlighted	Alt + *nnn*	Jump to transaction *nnn*

Attributes	Types	(C1) Notes/Issues
❑ Clear ❑ Correct ❑ Consistent ❑ Singular ❑ Testable, verifiable ❑ Feasible ❑ Design independent ❑ Traceable ❑ Clear	❑ Functional (user, mode) ❑ Exception handling (user, mode) ❑ Performance (quantitative) ❑ Design constraint (environment) ❑ Interface (interact with user, external components and other internal components) ❑ Communications (connectivity, access) ❑ Computer security and access ❑ Backup and recovery ❑ Implementation (conversion, installation, hardware acquisition) ❑ Information (examples, other)	

(C2) Question/Topic		(C3) Notes/Answer
	STOP here until directed to continue to the next part.	

Test Drive - Capture the Requirements

(C4) Restated problem(s) or request(s)	(C5)
Restated impact(s)	

Review Checklist

Attribute	Apply to Individual	Apply to Set	Definition	Problem Indicators	Examples	Corrective Action
Clear	X		Representatives of all affected parties should be able to read the requirement and come to a SINGLE, CONSISTENT INTERPRETATION	Imprecise, open-ended terms	"include, but not limited to", "support", “and/or”, “appropriate”, “maximize”, “minimize”, “consider”, “any”	Search for the "real" requirement and the additional information through interviews with the originator(s) or subject matter expert(s) (SME).
			Contains the information needed for all affected parties to begin work on THE NEXT STAGE IN THE LIFE CYCLE	Incorrect, complex, or overly precise sentence structure, bad grammar	“The operator chooses between A or B and C.”, “and”, “or”, “but”, “unless”, “above”, “below””, commas, semicolons	If appropriate, assist the SME through research, models, demos, use cases, or prototypes.
				Ambiguous, multiple meanings possible	“it”, “this”, “that”, “which”, “above”, “below”, “previous”, “following”, “next”	Validate the requirement with the originator or SME.
Testable, verifiable	X		Description is sufficient that testers can see where they could devise the means to determine whether the requirement was properly implemented in the product	Open-ended, imprecise, ambiguous terms		
Design independent	X		Describes “what”, not “how”	Operation (not function)	Press the F8 key Add a database field, so ...	
Correct	X		Accurate (and complete) as determined by the customer and user or their representative(s)	Something missed or misinterpreted		Determine if this is the "right" requirement. Validate the restated requirement with the originator/user or their representative(s). Surface for a decision/solution.
Traceable	X		Able to link the requirement to a specific origin	Cannot determine where or who	Federal Regulations, lots of customers, the competition	Pinpoint the source. If appropriate, compare it to its source to determine if the stated requirement meets the intent of the source
Complete	(x)	X	Internal references are all resolved. No referenced or implied elements or activities are missing All attributes of *identification* that can be determined at this time are supplied.	Something missing		Track down the missing information; query the originator.
Consistent	(x)	X	Not in conflict with other requirements (both technical or non-technical, policies, regulations, laws). Do not duplicate or overlap			Resolve the conflict by determining relative priority or through negotiation with affected stakeholders. Change or eliminate conflicting or overlapping requirements.
Feasible	(x)	X	It is possible to implement the requirement set within the known capabilities and limitations of the system and its environment: technically, and within costs and schedule constraints			Refer, defer, identify trade-offs (schedule, performance - What can we do?), decline, play chicken.

Attributes of a Requirements Process

Baselined - set	Requirements are **baselined**. Once a set of requirements have been reviewed and approved, changes are made only through change control procedures.
Versioned - individual and set	Requirements and requirements sets are **versioned**. At any point in the process, the current version of a requirement or set of requirements can be determined.
Identification	Requirements templates and review checklists ensure that all available information is provided.
Captured	Requirements and requirements sets are **captured**. They are recorded in a form which can be baselined, versioned, distributed to all impacted parties, stored, retrieved, and maintained. There is no restriction on medium (e.g., paper, web) or notation (e.g., text, diagrams).
Visible	Requirements, requirements sets, and changes to requirements and requirements sets are **visible** to all impacted parties.
Responsibility and authority - approval and change	**Responsibility and authority** for requirements, requirements sets, and changes to requirements and requirements sets are clearly defined for all phases of the life cycle (e.g., from initial receipt as an incident to the release of a product that satisfies the requirements). Individuals have the skills, knowledge, and time they require to perform their requirements-related tasks. There may be a change control board (**CCB**) which is responsible for the initial approval of requirements and requirements sets and for the on-going approval of changes to requirements and requirements sets. There may be multiple boards with complementary responsibilities. Different boards and/or board members may be active at different points in the life cycle.
Internal peer review; external review	Requirements and requirements sets and changes to requirements and requirements sets are **peer reviewed** by all impacted parties within the organization (e.g., hardware, software, system test, publications, operations, support) before they are reviewed by external parties (e.g., customers).
All types of requirements addressed	The process addresses **all** requirements – including supplied and derived requirements, functional and technical requirements, and non-technical requirements (e.g., schedule, budget).
Requirements specification - package of requirements, interactions, dependencies, etc.	Requirements are considered both as individual items (e.g., as a Change Request or Problem Report) and as they interact in a set of requirements intended for a release (e.g., in a **requirements specification** for a software release or project).

XtremelyAgile Scenario

Customer (C): We're looking at a low-impact, user-friendly way we can standardize company-wide administrative functions and improve day-to-day communication between the various departments.

Engineer (E): So, it sounds like you want a Windows application?

C: Well, yes. We have some of those already and people are comfortable with them. When they have the training.

E: Tell me more about how you envision this standardization working.

C: Well, we have a large number of functions, e-mail, inventory record keeping, performance evaluation, contingency planning, facilities maintenance, and preventive maintenance, that we want to tie together – and we will have more coming on as the organization diversifies – including configuration management, document control, and a link to Corporate Central IS Services. Our functions are all over the map geographically – including those that are used by employees traveling anywhere in the world. Which reminds me, we'll also need Voice over IP for telephone communication over the Internet at the lowest possible rates from anywhere in the world.

E: It sounds like we'll need to take an object-oriented approach hanging discrete application modules off a central data base which can be instantiated in multiple, synchronized servers for maximum availability of mission critical functions. We'll also need to invoke CORBA and SOAP for access to other data bases and existing applications. And we'll need to develop or integrate wireless peripherals.

C: That sounds reasonable, I suppose. Have you done something like this before?

E: Of course. Many times. Tell me what type of budgets and time frames we're looking at.

C: Well, we have $200,000 in the current fiscal year budget that we have to burn and we need to be operational with the first components in less than 6 months.

E: Can't be done.

VIGNETTES

Indicate any CMM, management, or operational issues relevant to each brief scenario.

V1 Each accepted requirement is assigned a tracking number, which is included in the change section of every derived document and in affected code modules as a comment. A requirement remains open until the version of the product in which it is implemented is released for general customer availability. Weekly metrics on status and on-time completion are maintained.
V2 The Engineering Change System (ECS) is used for managing requirements changes, engineering-generated technical changes, and incident reports that have been verified in our support laboratory as real problems.

V3	BSC's software applications are licensed to customers for installation and operation in their own data processing centers. Our applications are also used by a division of BSC that outsources data processing for customers who do not have sufficient data processing capacity. Because of the real-time nature of our applications, the BSC outsourcing center has a small production support software engineering group that handles installation of software upgrades and that makes emergency patches to the software.
V4	As part of BSC's continuous improvement and problem prevention initiative, if there is no impact on development schedules, software engineers are encouraged to improve code that they encounter as part of implementing their assigned, approved change requests. This ranges from cleaning up formatting inconsistencies to improving functionality and capacity to prevent problems that have not yet been reported.

V5	BSC's core product components serve as the foundation for customer-specific customization projects. These projects are run by customer project managers who act as business unit managers with profit and loss responsibility for their projects. As a result, these project managers work with their customer to identify ways to grow their projects.
V6	All projects will adapt or adopt Requirements Engineering Complete (ReCo), the requirements management tool developed by the director of software engineering at his last company.

The Requirements Specification (SRS)

The following is divided into several sections and subsections:

Section	Title	Summary
A	An outline for a generic SRS	The headings for a template for a generic SRS
B	About the Content of an SRS	Suggested conventions and standards to follow in writing and reviewing SRSs.
B.1	Assessing the quality of a requirement	
B.2	The attributes of identification	
C	Typical content by section	Suggestions, and examples for each section in the outline.
C.1	Example 1: By function	An example of requirements organized by function
C.2	Example 2: By mode	An example of requirements organized by mode
C.3	Example 3: By user	An example of requirements organized by user

A. Outline for a Generic SRS

The following is a basic outline for a generic SRS. As a model, it is not usable "as is" for anyone. It omits sections that are critical for some organizations; it contains other sections that are irrelevant for some organizations. It is intended to provide useful ideas, suggestions, and starting point for individuals defining SRSs for their organizations, technologies, and applications.

The template is structured so that, if the size of a project warrants it, it can be written and reviewed in two increments: Sections 1 and 2, to establish a verified framework, and then Section 3, detailed requirements.

In all cases, if a section or block of content is found in all SRSs produced by the organization (e.g., a Human Computer Interface (HCI) standard), provide that information in a separate document and – if worthwhile - refer to it in the SRS. Include only a brief reference to the standard in each SRS, to record, at least, the version current at the time the SRS is being written. Such a reference is particularly useful when there is a possibility that the work may be outsourced.

1. Introduction
    - 1.1 Purpose
    - 1.2 Scope
    - 1.3 Definitions, acronyms, and abbreviations
    - 1.4 References
2. Product description
    - 2.1 Product roadmap
    - 2.2 Target environment
        - 2.2.1 Interfaces
        - 2.2.1.1 Users
        - 2.2.1.2 Hardware
        - 2.2.1.3 Software
        - 2.2.1.2 Communications
        - 2.2.2 Operating modes
        - 2.2.3 Delivery and setup
    - 2.3 Functions
    - 2.4 Users
    - 2.5 Constraints
    - 2.6 Assumptions and dependencies
3. Requirements

Appendixes

B. About the content of an SRS

While there is a section titled *Requirements* in the SRS, it contains detailed descriptions of requirements that complement requirements statements that appear in other sections of the SRS. All of the statements (requirements and others) contained in the SRS follow the same stylistic conventions. Recommended conventions are:

- *Shall* denotes a requirement for the product. For example, *The system shall produce reports that comply with Version 2 of the Federal Standards for Cost Accounting.*
- *Should* denotes an objective for the product. For example, *The system should perform multi-location inventory searches at least 10% faster than any competitive product – from starting the search (after the search criteria are entered) to the presentation of the list of locations*. The objective allows the SRS to capture "customer" objectives that cannot be realistically quantified or expressed as requirements without running the risk of over- or under-specification. Success in meeting objectives is monitored (but not necessarily managed) and is the subject of on-going discussion with the customer as the design and implementation progress. An objective typically supplements or stretches a "shall" statement that establishes a lower bound for the objective. For example, an SRS could include both the objective *10% faster* and the general requirement that *System response times for identical queries shall not exceed those of the current system by more than 2%.*
- *Is*, *are*, *will*, and *present tense of verbs* are statements of fact or intention. For example, the following are statements of fact:
  - *The user is able to read and understand English.*
  - *The user reads and understands English.*

B.1 Assessing the quality of a requirement

All of the statements contained in the SRS are systematically reviewed by all relevant stakeholders to ensure that each individual statement and the complete set of statements in the final, approved SRS are:

- Clear and unambiguous
  Representatives of all affected parties read the statement and come to a single, consistent interpretation. There is consistent, agreed-upon use of stylistic conventions
- Testable, verifiable
  The statement is specific enough that developers and testers agree that they could devise the means to determine or measure whether the statement is properly implemented in the product.
- Design independent
  The statement describes "what", not "how". It describes a need or a problem - not a solution. It describes function, not operation. The following example is based on an enhancement request for an existing system. In the current version of the system, when a stock check at one depot shows zero on hand, the clerk has to waste time changing screens, entering depot codes one by one, and reentering part numbers to find out if any other depot has on-hand inventory of the part. Then the clerk has to go to the screen to request an inter-depot transfer and enter all of the information about the two depots and renter all of the data about the part.

This	Not this
The system shall allow the inventory clerk to go directly from the Stock-on-Hand screen to identifying which depots have inventory available (without requiring that the operator enter a specific depot number and search depot by depot), to requesting an inter-depot transfer (without having to reenter any data about the part.).	Fields on the Stock-on-Hand screen shall show the on-hand inventory of the part at all locations. A field below the list of depots and on-hand inventory amounts shall allow the clerk to enter a depot number. A button on the screen beside the field in which the clerk enters the depot number shall allow the stock clerk to jump directly to the "Request Inter-Depot Transfer" screen.
Other than requiring that the operator supply the number of the depot from which he or she is requesting the transfer, the system shall automatically capture all of the static location, cost code, etc. information for the transfer request.	The system shall fill in all of the static data and carry forward the part information automatically on the "Request Inter-Depot Transfer" screen.

It should be noted that the background information that preceded the "This/Not This" table is also valuable for inclusion in the SRS as a statement of fact, identified as information.

- Correct
  The statement is accurate (and complete) as determined by the customer and user or their representative(s) (e.g., Marketing)
- Traceable
  The statement is linked to a specific origin – a predecessor document included in *1.3 References.*
- Complete
  All appropriate attributes of identification (see *the attributes of identification,* below) are provided for each requirement. All internal references or implications are resolved (e.g., Does requirement x have any security implications that might lead to an additional requirement).
- Consistent
  The statement is not in conflict with other requirements.
- Feasible
  It is possible to implement the requirement set within the known capabilities and limitations of the system and its environment – both technically, and within and established cost and schedule constraints.

B.2 The attributes of identification

Each individual statement in the SRS has a unique identifier which is used to track the status of the requirement statements through each phase of the development process. In addition, the organization uses the SRS or an associated database to capture and maintain, as the project progresses, the following information for each statement in the SRS:

	Requirement (shall)	Objective (should)	Fact (is, …)
- Type	X	X	X
- Necessity	X	X	
- Stability	X	X	X
- Allocation	X		
- Parent (requirement)	X		
- Source (document, paragraph)	X	X	X
- Rationale	X	(X)	
- Verification (method, documents)	X		
- Changes	X	X	
- Current status	X	X	
- Planned or applicable release	X		

For requirements statements, the *shalls*, the following types typically apply:

- Program (process, legal, schedule)

Technical

- Functional (user, mode)
- Exception handling (user, mode)
- Performance (quantitative)
- Design constraint (environment)
- Interface (interact with user, external components and other internal components)
- Communications (connectivity, access)
- Computer security and access
- Backup and recovery
- Implementation (conversion, installation, hardware acquisition)
- Information (examples, other)

C Typical content by section

		Section	Contents, Description, Examples, and Comments
1		**Introduction**	The *Introduction* provides the background for the product or project to which it applies. The content of the *Introduction* is all in the sub-sections.
	1.1	**Scope**	Start with "This document applies to:" and then identify the product(s) and project(s) to which the document applies. For example, *This document applies to:* - *Release 5.2 of OPTI-2000* Or, - *To the Web-link Embedding Project* Or, - *To the Speech Recognition Input and Output Engine Project developed under Contract 02-0004-05 for United Terrestrial LLC"* NOTE: This section contain only statements of fact.
	1.2	**Definitions, acronyms, and abbreviations**	Define any specialized or potentially ambiguous terms used in the SRS, and any acronyms or abbreviations used in the SRS. Consider, at least: - Reviewers, e.g., Marketing, the customer, Systems Engineering, - Designers and architects, who use the SRS as input for their activities, and - Other SRS authors who will use the SRS as a baseline for their follow-on work or who are using the SRS to coordinate the development of their SRSs. NOTE: This section contain only statements of fact.
	1.3	**References**	List all of the documents referred to in the SRS. For each document, provide the title, control number, author, source or location, and current version. Based on the structure of the source document, consider whether to include a section number in the reference. Sub-section 1.3 of the SRS becomes the basis for determining the impact of changes. The information in this sub-section is frequently placed at the end of the SRS. NOTE: This section contain only statements of fact.
2		**Product description**	This section provides a framework for the detailed requirements in Section 3. The content of the *Product Description* is all in the sub-sections.
	2.1	**Product roadmap**	Describe, as appropriate, how this product fits into the organization's product mix. For example, *OPTI-LT* [the product being specified] *is a low-end, entry-level system for users who cannot afford or justify the purchase of an OPTI-2000 system and the associated hardware*. Alternatively, describe how this version of the product fits into the overall strategy for the product. For example, *Release 5 currency conversion functionality for North American banks, which is planned to be enhanced in Release 7, to address the needs of multi-national banks.* If this is an independent product (e.g., developed under a contract for a specific customer), state this. NOTE: This section contain only statements of fact.
	2.2	**Target environment**	Characterize all aspects of the environment in which the product will be used. Describe, as appropriate, the rules governing the interaction between this product and external entities. Block diagram(s) are particularly appropriate to support this description. This sub-section is frequently divided into categories (e.g., *Interfaces* and *Operational Modes*), which are further decomposed into related topics (e.g., *Interfaces* is decomposed into *Users*, *Hardware*, *Software*, and *Communications).* The content of the *Target Environment* is all in the sub-sections.
	2.2.1	**Interfaces**	This section lists external entities with which the product interacts directly. The nature of the interaction is defined in *2.3 Functions.* The content of the *Interfaces* is all in the sub-sections.

	Section	Contents, Description, Examples, and Comments
2.2.1.1	Users	Define or reference any applicable Human Computer Interface standards or related rules that must be supported by the product being developed. For example: - Established use of a particular function key for a common task - Windows Developers Tool Kit Standard Human Computer Interface Specification v 21.6
2.2.1.2	Hardware	List any hardware components (other than communications) with which the product must interact directly; define or reference any applicable protocols that must be supported by the product. For example: - A 12-port DigiDog board supporting bi-directional S-BUS message protocols from 155X-series SmartSensors - Use Windows QT printer and file management services
2.2.1.3	Software	List any software products (other than communications) with which the product must interact; define or reference any applicable formats, etc. that must be supported by the product. For example: - Use standard Windows file management and print services - Access the Corporate Customer Data Base using SQL - Be fully compatible with the Norden Disaster Recovery (NDR) utilities and routines implemented by MIS (at client, server, and mainframe level)
2.2.1.4	Communica-tions	List any communications interfaces (e.g., LAN, WAN, etc.); define or reference any applicable protocols, etc. that must be supported by the product.

	Section	Contents, Description, Examples, and Comments

2.2.2	**Operating modes**	Characterize the distinct modes in which the target user organization operates – as they relate to the product being developed. Depending on the scope of the product being specified, modes may be associated with organizational units or locations. The functions that occur in each mode are described in *2.3 Functions*.
		
		For example, describing an organization for which a bug-tracking application is being specified:
		
		- *Customer Service and Support (CS&S)* is divided into two distinct organizations:
		  - *Support Center*. Customer calls are accepted by two tiers of technicians from 05:00 to 08:00 Monday through Saturday PST.
		  - *Advanced Engineering*. Escalated (e.g., severe or high priority) customer calls are addressed on a 7x24 basis. They currently plan for the system to be unavailable from 01:00 to 02:30 PST Monday through Friday for minor maintenance (e.g., incremental database backup, hardware replacement) and 01:00 to 06:00 PST Saturday for major maintenance (e.g., full backup, software upgrade, server maintenance)
		
		A more effective alternative to the *Customer Service and Support (CS&S)* example immediately above would be:
		
		- *Customer Service and Support (CS&S)* is divided into two distinct organizations: *Support Centre (SC)*, which handles customer calls and *Advanced Engineering (AE)*, which handles escalated, high priority customer calls and which creates patches. These two organizations operate in three overlapping modes:
		  - *Mode Active-Full:* Customer calls are accepted by two tiers of SC technicians from 05:00 to 08:00 Monday through Saturday PST.
		  - *Mode Active-Advanced:* Escalated (e.g., severe or high priority) customer calls are addressed by AE personnel on a 7x24 basis.
		  - *Mode Active-Advanced-Offline:* The current system is unavailable from 01:00 to 02:30 PST Monday through Friday for minor maintenance (e.g., incremental database backup, hardware replacement) and 01:00 to 06:00 PST Saturday for major maintenance (e.g., full backup, software upgrade, server maintenance)
		
		For example, describing the modes of operation for an organization for which a credit-checking application is being specified:
		
		- *Finance* operates four regional centres. The centres are in NCSA (North, Central, South America; Dallas USA), EMEA (Europe, Middle East, Africa; Bonn GER), AP (Asia Pacific; Adelaide AUS) and China (Jinan CH)
		- Mode OPEN: Each centre is fully staffed and operates from 07:00 to 17:00 local time Monday through Friday.
		- Mode LOCKED: Mandatory database backup is performed by the MIS department from 18:00 to 19:30 local time Monday through Thursday and from 18:00 to 21:00 on Friday. During these times *systems are not available – i.e., the centre cannot function during these periods, and other centres cannot access data from the centre.*
		- Mode CLOSED: At all other times each center is nominally closed (e.g., individuals may be working).

2.2.3	**Delivery and setup**	Describe how the product will be distributed, delivered, and setup. For example, they product being specified may be intended for delivery on CD-ROM or by download: - For automated installation over existing versions (e.g., upgrade) or on a clean system. - For installation over a competing system, requiring data conversion. - For customization by a trained value-added reseller

	Section	Contents, Description, Examples, and Comments
2.3	**Functions**	Summarize the major functions that the product being specified is expected to provide. Once again, a graphical representation can be particularly useful in constructing this summary. This section contains initial, high-level decompositions of the functions. This section categorizes *functions* – it is not a design. To avoid creating a huge document, consider the various audiences for the SRS. Describe additional, detailed decomposition, which is of interest to narrower, more specialized audiences, in separate documents, which are referenced in this section of the "master" SRS. It is also particularly useful to identify the modes (from *2.2.2 Operating modes*) with which each function is associated. For example, in specifying a financial application, *2.3 Functions* states that: The application shall provide functionality in the following areas: customer account maintenance, billing, and processing payments. [Note that In *2.2.1.3 Software interfaces*, the interfaces to the Order Processing, Shipping, and Credit Checking systems were defined.] *2.3 Functions* is then broken down into subsections in which each of the major functions is further decomposed (e.g., subsections for *Customer account maintenance*, *Billing*, and *Processing payments*. The subsection for *Customer account maintenance (CAM)* specifies that CAM addresses: - Credit verification - Customer data maintenance (address, contact, etc.) - Customer status maintenance (ok, hold temporary, hold permanent) - Order summary reports (3 months, 6 months, 12 months) - Aging (monitoring, notification, reporting) - Payment history report (3 months, 6 months, 12 months) Corresponding subsections describe *Billing* and *Processing payments*.
2.4	**Users**	Characterize the individuals involved in performing the various functions listed in *2.3 Functions*. This section of the SRS is typically divided into sub-sections for each class of user. Useful attributes of these individuals include: - Functions performed (as listed in *2.3 Functions*) - Level of education - Level of training on the application being specified - Professional certification - Level of experience on computers, on similar applications, in the application domain - Cultural issues (e.g., with respect to Collections) - Language limitations

	Section	Contents, Description, Examples, and Comments
2.5	**Constraints**	From one perspective, an SRS contains nothing but constraints. The SRS focuses developers on solutions that address specific needs. The constraints described in *2.5 Constraints* are those that are related to technical decisions, decisions that are normally left to the engineering team (e.g., choice of a development platform, a data base vendor, a configuration management tool). As part of the documentation and review processes, each of these constraints is questioned to ensure that it has a basis in the customer needs. For example, - The product shall run on a WINTEL platform with a maximum of 64MB of memory. *[Questioning reveals that the customer has thousands of these systems deployed and has no intention of upgrading them.]* - The development group shall use CodeKeeper for all a configuration management. *[Questioning reveals that the customer uses CodeKeeper for internally developed software and drawings and requires that all development subcontractors use the same system to facilitate the exchange of source code and other project artifacts.]* - The software shall run under Windows 98. *[Questioning reveals that 80% of the customers in the target market have Windows 98 installed and cannot justify the expense of upgrading to Windows 2000. The other 20% have a combination of Windows 95, ME, 2000, and XP. It is highly uncertain as to when or if the Windows 98 users will upgrade; and, if they do, it is not clear whether they will move to 2000 or XP. Many users are so determined not to upgrade, they are buying systems with XP installed and replacing it with Windows 98.]* In each case, the elaboration obtained through questioning is added to the description of the constraint (1) to reinforce the validity of the constraint and (2) to minimize the number of times the reason for the constraint has to be independently rediscovered. The relationship between *2.5 Constraints* and 2.*2. Target environment* is potentially confusing. The confusion typically results in repetition within an SRS (e.g., "I'm not sure where it goes, so I'll put it in both places") and inconsistency between SRSs (e.g., one author defines hardware constraints as part of the interface, in *2.2.1.2 Hardware [interfaces]*; another author defines them in *2.5 Constraints*). There is a logical distinction that can be conveyed through training and perfected through exercises and writing specification. *2.2 Target environment* focuses on the interactions between the product and other entities. Specific limitations and the associated justifications imposed by the technical entities – hardware and software – are documented in *2.5 Constraints*.

	Section	Contents, Description, Examples, and Comments
2.6	**Assumptions and depend-encies**	In some cases, the most effective and efficient way to verify detailed assumptions associated with statements made in any of the other sections of the SRS is to document the assumption (flagged for reviewers as "ASSUMPTION") in line with those statements. For example, if no user input has been received regarding language support and localization, the SRS could include the following in *2.2.1.1 Users* : *ASSUMPTION: All users, including Tier 1 personnel, are able to read English.* Or, *ASSUMPTION: All users receive at least two hours of training prior to operating the system.* Once an assumptions is verified, the assumption is rewritten as a factual statement, incorporating any feedback from reviewers and approvers. In *2.6 Assumptions and dependencies,* list assumptions pertaining to the content and functionality of the product that cannot be verified because they pertain to future events that are outside the control of the development organization or the customer and which put success at risk. For example, - If the customer specifies that the product integrate or incorporate future releases of 3rd party hardware or software products, interfaces to these items are called out in the appropriate sections of *2.2 Target environment*. These items are also listed in *2.6 Assumptions and dependencies.* There may be a forward reference in *2.2* to *2.6*. - Similarly, if this product relies on the work products of another internal project or group, those products appear in *2.2* and *2.6*. - If the functions of a mathematical model are described in a clear and unambiguous manner, but if there is serious concern about the ability to create such a model, that concern is recorded in *2.6 Assumptions and dependencies.* There is another class of assumption, related to those cases in which the development team has concerns about the stability of agreed-upon, well-defined needs or requirements. For example, even if the customer states and confirms in response to a direct question that *all users are able to read English*, the development team may anticipate that at some point in the development process, the customer will request support for multiple languages. By documenting this assumption, the team may be able to create a design that addresses the immediate need without any unnecessary cost to the customer or the organization, but which does not require any rework to add support for additional languages. The most effective and efficient way to record these assumptions is through the stability rating and elaboration for the requirement in *3 Requirements*.
3	**Requirements**	*3. Requirements* begins with a description of how the requirements are organized into subsections. The subsections of *3* contain detailed requirements that supplement those in the previous sections of the SRS. The level of detail is correct when the information is: - Sufficient for designers to design products that the customer perceives as satisfying the requirements. - Not so voluminous that customer representatives are unable to confirm that their needs have been recorded correctly. It is the responsibility of the SRS authors, the systems designers and the customer representatives to determine whether this balance has been achieved through reviews of the SRS. Typically, as a design evolves, the designers raise additional questions and uncover unanticipated options that require revisions and re-reviews of the SRS. In addition, especially for longer-duration projects, customer-originated changes require changes to the SRS. The most effective means of addressing the evolving requirements is through short projects that define increments of functionality and through close, on-going cooperation and frequent, but controlled, contact between the customer representative(s)and the development team. In addition to the quality of the content, as described above in *About the content of an SRS*, the organization of the requirements statements contributes significantly to its effectiveness in communicating with reviewers and designers. ***Organizing requirements*** The organization of the earlier sections of the SRS identifies dimensions or variables available for organizing the detailed requirements: modes of operation, functions, and classes of users. While it is sometimes difficult to maintain design independence, the organization of the

	Section	Contents, Description, Examples, and Comments
		requirements in no way reflects the design of the product or its components. Based on past experience, as the detailed requirements are constructed and verified, the earlier sections of the SRS will require modification. In particular, the process of creating the detailed requirements may lead to changes in the way other sections are organized, including *2.2.2 Operating modes, 2.3 Functions.* Defining an initial organization for this section begins by selecting one dimensions as dominant: ▪ If the functions remain relatively stable within modes, the initial draft of the SRS may start with functions, describing any mode-based differences by function, and identifying user interactions within each function. ▪ If the system operation varies significantly from mode to mode, the initial draft of the SRS may group functions within modes, and identify user interactions within functions. ▪ If the system operation is driven by the different organizations, the initial draft of the SRS may group functions by users, and identify mode-based differences within the functions. Samples of requirements organized around each of these dominant dimensions are found in Sections C.1 through C.3, below.
	Appendixes	Supplementary material as appropriate.

C.1 Example 1: By function

This example presents an extract from a working draft of the requirements for R-SUPPLY, a new automated system for ordering computer supplies from AllSorts.

Function is the primary dimension for organizing the requirements. Users' responsibilities and the few variations based on mode are described in the context of function.

C.1.1 Background from the first two sections of the SRS

All of the following information is provided in first two sections of the SRS.

Authorized customers, who have little or no training or experience, currently order computer supplies by telephone. The customer finds the items in the current AllSorts paper catalogue, and calls an order taker at AllSorts who enters the order data for the customer. There are currently 8 order takers who work 06:00 to 19:00 PST. The customer has an AllCard, a "credit card", complete with encoded magnetic stripe, which is only good for ordering supplies from AllSorts. Customers get as many AllCards as they want – the security of the AllCards is the customer's responsibility. AllCards are issued by the First International Bank (FIB), which handles all cancellations, billing, aging, collections, and fraud investigations. AllSorts and FIB Information Systems are fully integrated:

- AllSorts reports AllCard transactions, charges and credits to FIB as if they were credit card transactions.
- Authorized AllSorts personnel have all required access to current account balances and aging by AllCard and by customer.

92% of the customers have PCs with Windows. Of those customers who have Windows PCs, 8% are running Windows 3.1; 28%, Windows 95; 52%, Windows 98 SR2; 22%, Windows 2000.

8% of the customers do not have PCs with Windows. Of those customers who do not have Windows PCs, 80% have a variety of Apple computers, 16% have an Intel platform with a version of Unix, 4% have an Intel platform with DOS. Actually, 2 customers have machines running CP/M.

C.1.2 The requirements

3.0 Requirements

This section of the SRS is organized by the major functions of R-SUPPLY.

3.1 General – for all of R-SUPPLY

R-SUPPLY shall:

- Allow customer personnel to access only those functions for which they are authorized.
- Allow AllCard access authorization verification at any workstation
- Require minimal training for successful operation.

- Operate 24x7x365.
- Allow authorized AllSorts personnel to perform all functions on behalf of authorized customer personnel, where authorization can be confirmed over the telephone.
- Allow 20 orders to be placed simultaneously and TBD order status checks and TBD account status checks.

R-SUPPLY should:

- Use all possible services of the Internet both to minimize costs and to ensure that AllSorts appears to its customers and institutional investors to be in tune with the current trends in technology.
- Mimic, as closely as possible, the look and feel of the current system (e.g., order forms, catalogue format) to minimize retraining.

3.2 Place an order

R-SUPPLY shall:

- Allow authorized customer personnel to order computer supplies from AllSorts without requiring the intervention of an AllSorts order taker. Authorization is provided based on the AllCard.
- Ensure that the AllCard is valid prior to accepting an order.
- If the supplied AllCard is not valid, halt processing and notify the 24-hour FIB customer service and fraud elimination staff
- Derive all delivery and accounting administration information from the AllCard number.
- Accept a customer-supplied part number and quantity.
- Respond to the customer with the part description unit price, a calculated extended price, an indicator of whether the item is on back order, and the current total of the order, excluding taxes, shipping, and handling.
- Allow the customer to
  - Start a new line item
  - Change the part number or quantity and continue working with the current line item
  - Delete the line item completely and start over
  - Delete the line item and quit
  - Review the current order and make any appropriate changes at any time during the order placement process
  - Allow the customer to authorize partial shipments
  - Allow the customer to specify a shipment method for the whole order or specify different shipment methods by line item

    …
- Present the total cost of each type of shipping and handling specified.
- Recalculate the order total to include the total for all types of shipping and handling specified.

  …

3.3 Order status check

R-SUPPLY shall:

- Allow authorized customer personnel to check on order status without requiring the intervention of an AllSorts order taker.
- ASSUMPTION: Anyone who can place an order can check on the status of any order placed using that AllCard.
- ASSUMPTION: A class of users needs authorization to check on any order placed for any AllCard issued to the customer.

  …

3.4 Account status check

R-SUPPLY shall:

- Allow authorized customer personnel to check on account status without requiring the intervention of an AllSorts Customer Account Service Representative.
- ASSUMPTION: Contain or have access to a list of authorized customer personnel and that some sort of password can be provided to those selected customers.

  …

C.2 Example 2: By user

This example presents an extract from a working draft of the requirements for a PPERS, an automated product problem reporting system for use at SoftCam.

User is selected as the primary dimension for organizing the requirements. Functions and the few variations based on mode are described in the context of users.

C.2.1 Background from the first two sections of the SRS

All of the following information is provided in first two sections of the SRS.

SoftCam's first product is currently completing beta test and nearing release. The product addresses the needs of a small, highly technical, niche market. SoftCam's product is a robust, low-cost, fully functional alternative to the mature products offered by its established competitors. These competitive products have not aged well and have become increasingly more difficult to use and to maintain.

In addition, SoftCam's few competitors have high overhead costs and they have been treating their customers like cash cows for the last five years. Based on the beta test results, the product is virtually bug free and SoftCam anticipates a relatively low volume of calls.

After extensive research, SoftCam management and the Senior Technical Committee decided to make rather than buy a problem reporting system. The principle reasons are because the unique circumstances of SoftCam's business make unnecessary most features of any of the commercial systems considered. SoftCam's customers have a high level of technical proficiency, and SoftCam's current business model calls for Engineers to handle customer calls. As part of the learning process, junior engineers will perform the initial screening and handle reports that involve: operator errors, previously resolved problems, and previously reported problems that are still being resolved. Senior engineers will handle those

While management recognizes that this support strategy will change, it will not happen for at least three years. At that time, a transition to a commercial product will be reconsidered.

C.2.2 The requirements

3.0 Requirements

3.1 General

PPERS should incorporate off-the-shelf tools whenever possible.

3.2 Customers

PPERS shall:

- Accept problems reports from customers.
- Provide a form with required and optional fields to ensure that contact information, product information, and problem information are gathered. The content of the form is TBD.
- Validate forms fields as they are entered: valid customer contact information, valid product and configuration information. Other validation TBD.
- Allow customers to enter a severity factor
- Assign a unique identifier and date and time stamp to the submitted form.
- Provide customers with a hard or soft copy of the completed form, with the unique identifier

3.3 Junior engineers

PPERS shall:

- Calculate a priority based on the input information
- Provide a list of prioritized reports which includes aging information
- Allow junior engineers to self-assign reports
- Allow junior engineers to record research and resolution information
- Allow junior engineers to escalate reports at any time
- Automatically escalate HIGH PRIORITY reports after 48 hours.
- Automatically assign HIGH SEVERITY reports after 24 hours.
- Automatically escalate any report after 5 days
- Allow junior engineers to CLOSE all except HIGH PRIORITY and HIGH SEVERITY reports

- Require an engineer's authorization to close HIGH PRIORITY and HIGH SEVERITY reports

…

3.4 Engineers

PPERS shall:

- Provide a list of prioritized, escalated reports which includes aging information
- Allow engineers to self-assign reports
- Allow engineers to record research and resolution information
- Allow engineers to close reports

…

3.4 Development manager

PPERS shall:

- Provide graphical summary and detailed reports on report trends, aging, by customer, by cause (product component), and by time to close.
- Include a query capability that allows the manager to create custom reports from the repository.

…

C.3 Example 3: By mode of operation

This example presents an extract from a working draft of the requirements for a Customer Support System (CSS) at SoftWest. The requirements specification will be the basis for soliciting proposals and for determining whether to make or buy the system.

Mode of operation is selected as the primary dimension for organizing the requirements. Functions and the roles and responsibilities of users are described in the context of users.

C.3.1 Background from the first two sections of the SRS

SoftWest develops software products which it sells as stand-alone products and pre-installed on Dahl ruggedized lap top computers running Windows QT. SoftWest is a Dahl distributor and preconfigures and tests each lap top before it is shipped. The SoftWest Technical Support organization currently offers 12 hours of free call-in or e-mail service for its software for a period of one year from the initial call. These limitations are not enforced or enforceable. Few customers exceed the 12-month/12-hour restriction, and those that do include the most committed customers, who have the highest referral value.

During the 3-month warranty period, hardware service is provided directly by Dahl through its network of licensed service providers. After 3 months, Dahl offers an extended contract with options for mail-in (to regional service centers) and for carry-in (to participating, licensed service providers). Dahl is currently planning a third option, for on-site service.

Based on input from its User Advisory Board, SoftWest is planning to supplement its 12/12 warranty service with 3 additional tiers of service, incorporating support and software maintenance.

- **Bronze Service** – offered at the time the software or system is sold as a one-time, non-renewable contract – unlimited telephone support for 1 month from the first call; unlimited e-mail support for 5 months from the end of the telephone support period; unlimited access to the web based knowledge base; access to download service packs (bug fixes) for 3 months from the first download.
- **Silver Service** – offered at any time under a one-year renewable contract – 24 hours of telephone support and unlimited e-mail support; unlimited access to the web based knowledge base; access to all service releases (bug fixes)
- **Gold Service** – offered at any time under a one-year renewable contract - unlimited telephone and e-mail support from an assigned Customer Support Engineer; unlimited access to the web based knowledge base; access to all service releases (bug fixes) and engine upgrades (new functionality)

SoftWest currently uses Clarify as its company-wide problem reporting and tracking system and the Talk2Me Automated Voice Mail Data Collection System (AVM-DCS) for both screening and directing calls to Technical Support.

C.3.2 The requirements

3.0 Requirements

3.1 General

CSS should incorporate and/or interface to the Automated Voice Mail Data Collection System (AVM-DCS) information gathering, screening, and CallQ call director

CSS shall:

- Interface to and incorporate Clarify services for recording incidents reported electronically.
- Virus check any electronic inputs prior to any processing
- Screen voice and electronic input to determine the authorized level of service (Warranty, Star-Warranty, Silver, Gold, Bronze)
- Control the level of service provided via Clarify or via call direction
- Provide an immediate "dispute" escalation to Service Account Management if the customer asserts that he or she is entitled to a level of service that exceeds that recognized by CSS
- Provide management with the Clarify reports currently described in WWS Procedure 24-05 – with the addition of TBD reports and/or data incorporating all calls and electronic submissions.
- During screening and via Clarify store and protect customer-proprietary information, including any remote log in information, any operational data provided for trouble shooting, and other categories TBD
- Provide facilities for all personnel to report problems and authorized personnel to approve and perform data maintenance based on sales of new product, new contracts, contract renewals, and for correcting errors in recorded eligibility data
- Control SoftWest employee access to data – Global Summary (all accounts, all incidents, summary data TBD), Global Detail (all accounts, all incidents), at the Account level (all incidents), at the incident level. Control field-level permissions across all of the access categories (no access, read, write-add, write-revise)

3.2 Warranty

When it is determined that Warranty Service is authorized, CSS shall:

- Assign a priority and direct the telephone call to appropriate personnel. Note that WWS procedure 24-02 describes the various routing options and criteria. This includes follow-up calls where the caller is calling back at the request of a SoftWest Support Engineer.
- Assign a priority, set appropriate incident tracking and notification parameters, and record the data from the received electronic incident report in the Clarify data base. Note electronic report data may include attachments.

…

3.3 Star Warranty

CSS shall:

- Maintain a list of customers for whom Warranty Service is provided on an unlimited basis
- Automatically place all customers active at the time the CSS system and the associated service level contracts are implemented in the list
- Ignore the 12/12 parameters for customers in the list

When it is determined that Star Warranty service is authorized, CSS shall proceed as for Warranty Service.

3.3 Bronze

When it is determined that Bronze service is authorized, CSS shall:

…

3.4 Silver

When it is determined that Silver service is authorized, CSS shall:

…

3.5 Gold

When it is determined that Gold service is authorized, CSS shall:

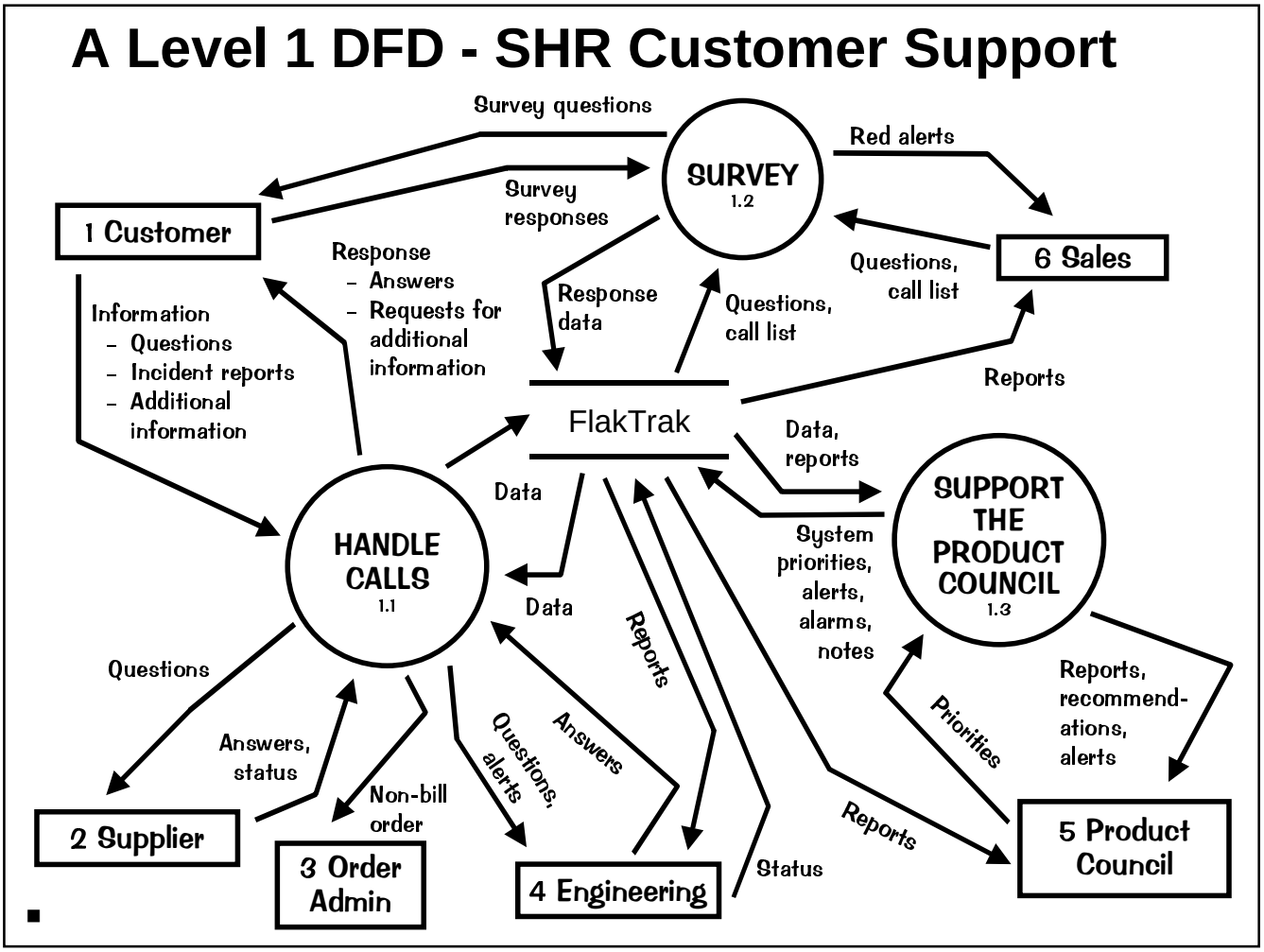
…

3.6 No service authorized

When it is determined that no service is authorized, CSS shall:

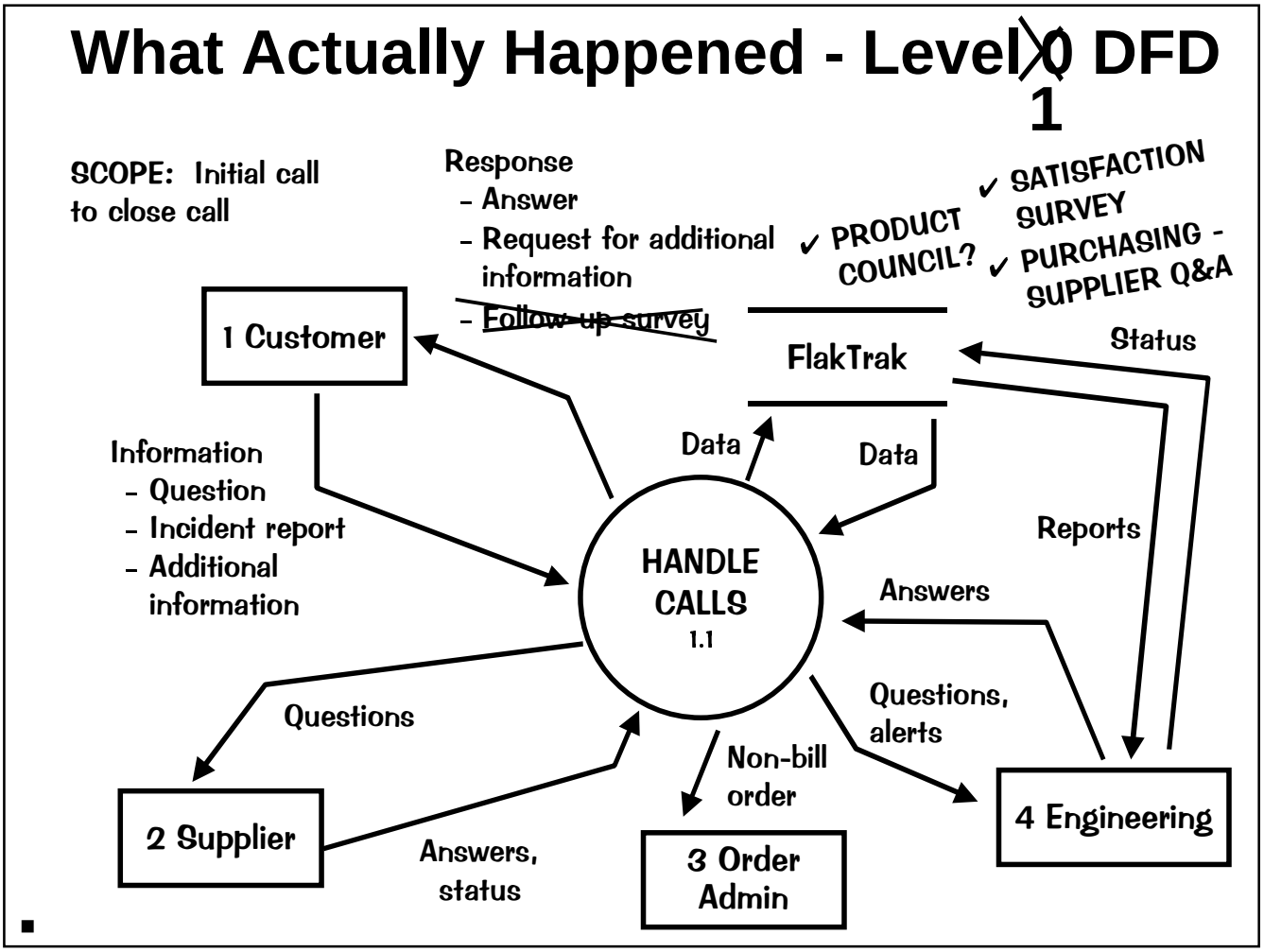
- Refer the report (telephone call or electronic report) to Service Contract Account Management (SCAM)
- Reprocess reports returned from the Manager of SCAM authorized for a particular level of service

…



The Question

Is this diagram consistent with the Level 0 DFD we created for SHR Customer Support? Is everything accounted for? Anything left out from the Level 0 DFD? Or added – that should also be in the Level 0 DFD?



The script

Person 1 [said with great authority and conviction] What we do is handle calls. ▶

Person 2 Most important - in handling calls - we interact with the customer. ▶

Person 1 We receive ▶ information - ▶ questions and incident reports ▶ and we ….

Person 2 … respond with ▶ answers ▶ to questions.

Person 3 Sometimes we have to ask for more information. ▶

Facilitator So, actually, I guess we better add "additional information" to what customers supply. ▶

Person 2 Twice a year we also do the Customer Service Customer Satisfaction Survey. ▶

Person 3 Wait just a minute. What are we talking about here? The survey is important, but what does it have to do with handling calls?

Facilitator What we've been talking about is the process that goes from when a call comes in to when it's closed in the call handling system. ▶ I propose we take the survey off the table for now for now and ▶ and start a list so we'll be sure to come back to it. ▶

All (Nod heads in agreement.)

Person 1 Something else we do in handling calls is work with suppliers whose products we resell as part of our products. ▶ In a lot of cases, our customers don't even know it's not something we developed. They don't want to know. We ask ▶ questions ▶ and (sometimes) actually get ▶ answers or the current status ▶ of a problem they're working on for us. That's always a problem. Sometimes we'll start selling someone else's product and when the first call comes in and we call the supplier, it's like they're surprised.

Facilitator Let's add this to our list of follow-up items. ▶ I'll make sure the team working on how we procure products and services hears about the problem.

Person 3 We also spend a lot of time working with FlakTrak, our call handling and tracking system. ▶ We input data ▶ and access ▶ data ▶ to help check on status or research customer questions or problems.

Person 2 We also work with Engineering. ▶ We ask ▶ questions and give them alerts ▶ when we think they need to know about something immediately.

Person 3 Engineering answers our questions. ▶ They're usually pretty good about that, but sometimes – like around a new release – they're too busy.

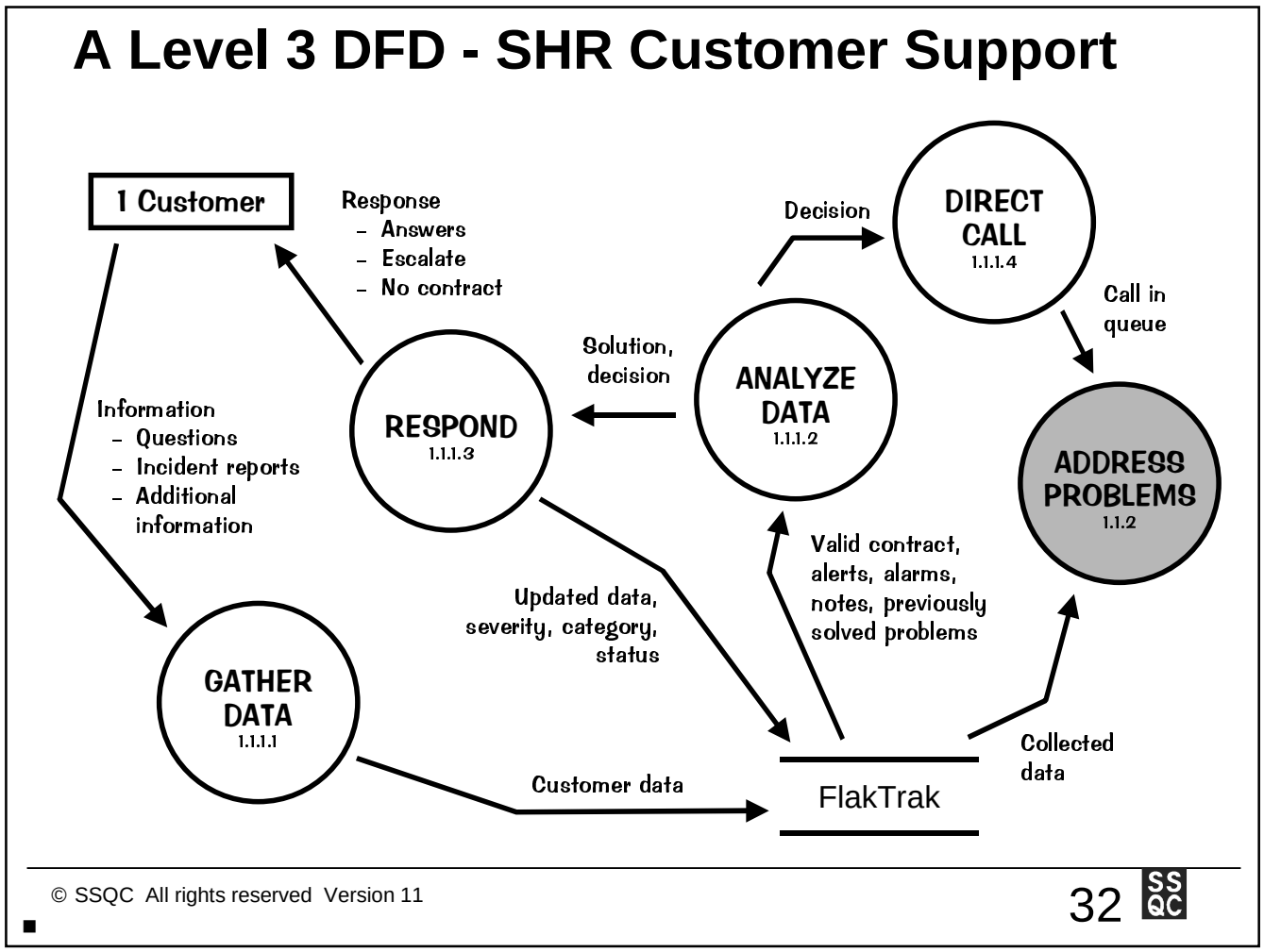
Person 1 By the way, Engineering has access to FlakTrak ▶ for pulling reports and they can also directly update ▶ the status of a problem or issue they're working.

Person 3 Sometimes, we have to work with Order Administration ▶. We'll initiate a non-bill order ▶ on the customer's behalf for an upgrade if that's the way we've determined we'll fix the problem.

Person 2 I don't think this qualifies as the top-level diagram anymore. We're going to have to go one step higher to add the survey. ▶

Person 4 While we're on the topic of other things we do, my biggest job is reporting to the Product Council and making sure that they add the features and make the changes we need to make the product supportable and keep our customers happy. We should probably add that to the follow-up list. ▶

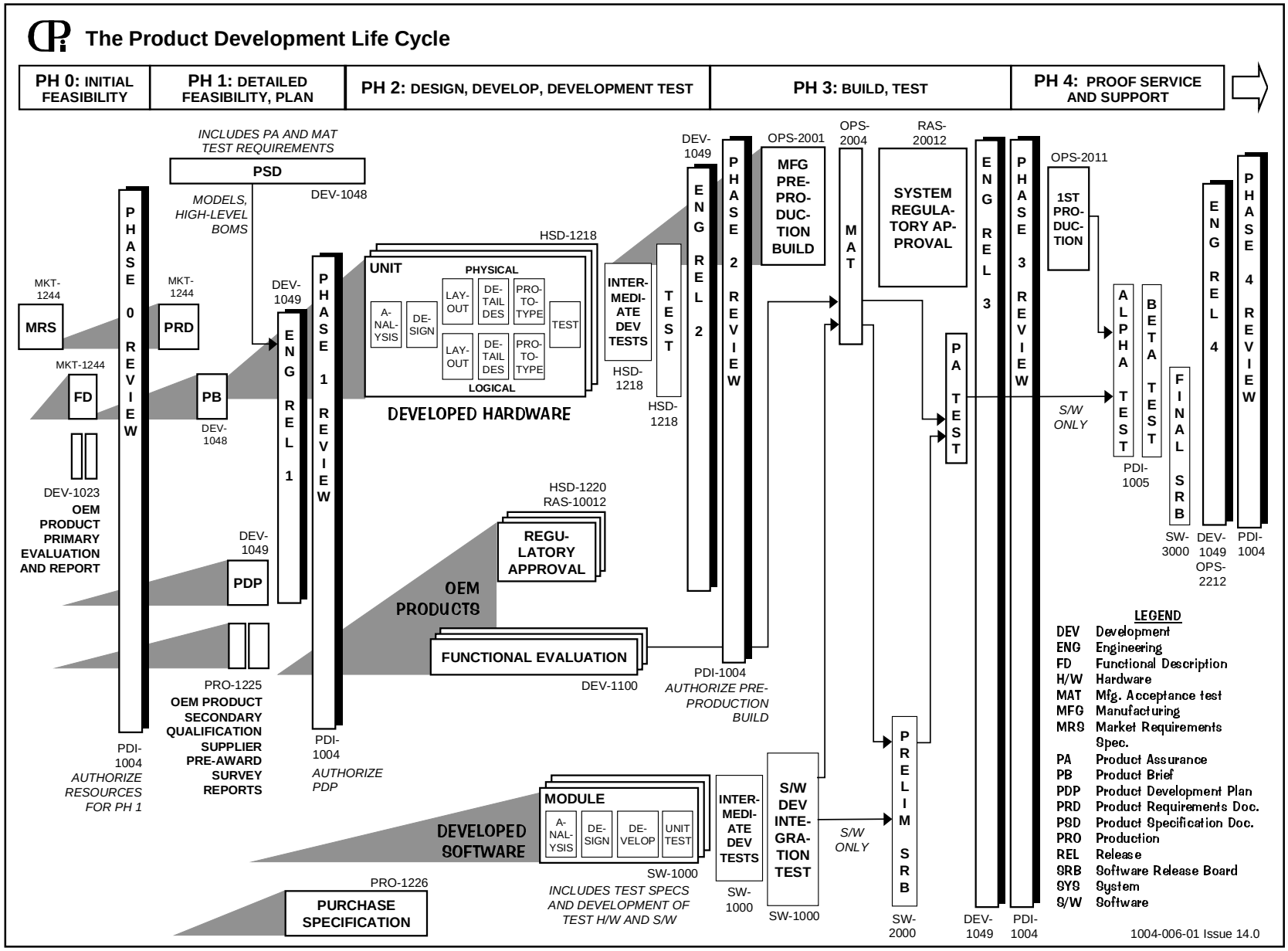
Facilitator ▶ Our time's just about up for this meeting – and I think we've got enough for me to go back and clean up my notes so we can pick up the discussion fresh next week. I'll have the diagrams to you by the day after tomorrow.



Exercise

Based on the information you have on SHR, create a top-level DFD for the Order Administration function.

Choose one of the bubbles and decompose it.



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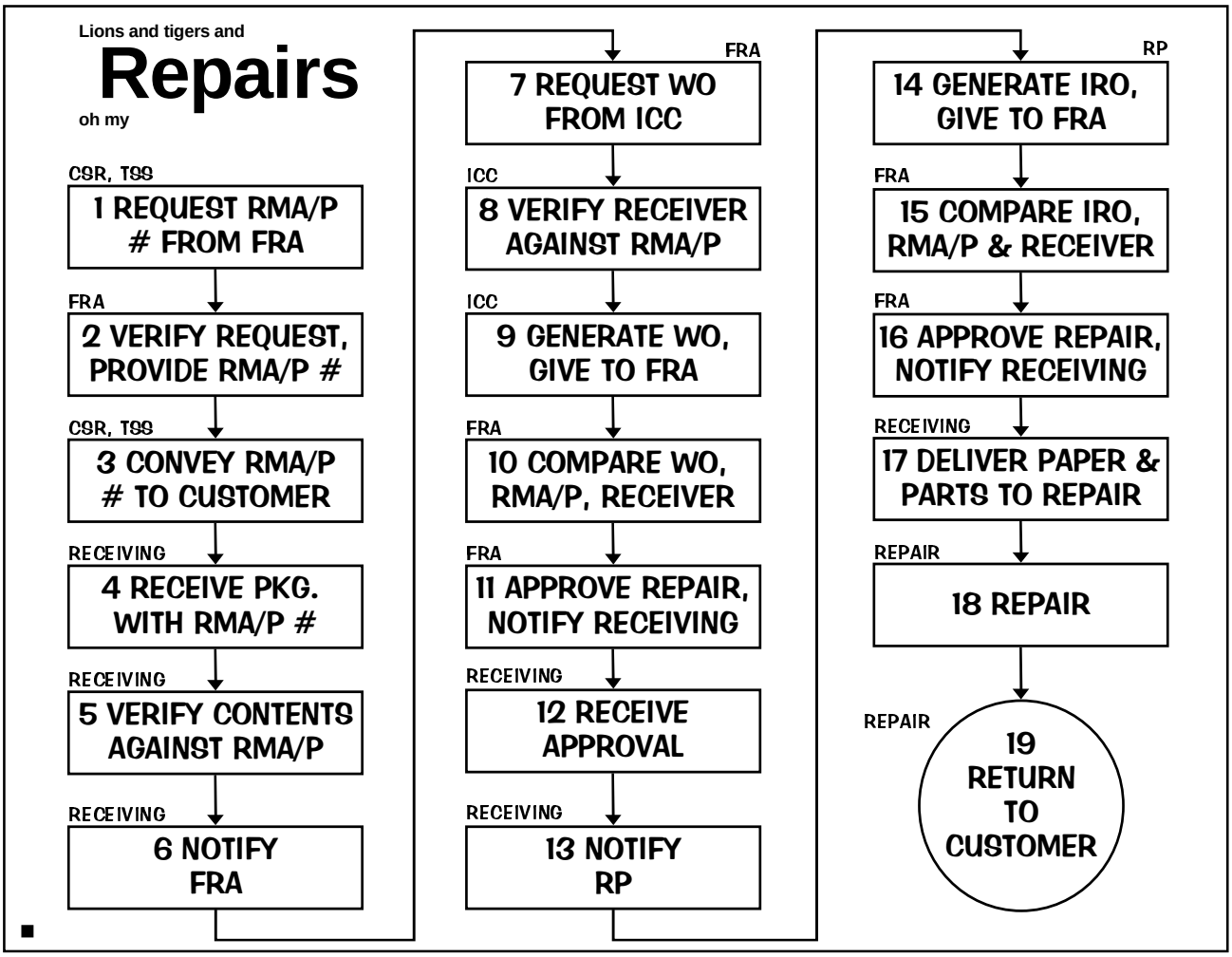
NOTES



CSR	**C**ustomer **S**upport **R**epresentative
FRA	**F**ield **R**eturn **A**dministrator
ICC	**I**nventory **C**ontrol **C**oordinator
IRO	**I**nternal **R**epair Order (adjusts inventory to account for item returned for repair)
RMA/P	**R**eturn **M**aterial **A**uthorization for Re**p**air (identifies the shipment as an authorized return)
RP	**R**epair **P**lanner
TSS	**T**echnical **S**upport **S**pecialist
WO	**W**ork **O**rder (puts the repair on the repair center schedule)

The Unified Modeling Language (UML)

The UML is a language for specifying, visualizing, constructing, and documenting the artifacts of software … [and] business … systems. It combines the work of Booch, Rumbaugh, Jacobson, and it is supported by the UML PARTNERS CONSORTIUM, made up of:

HP	IBM	ICON Computing
IntelliCorp	i-Logix	MCI Systemhouse
Microsoft	ObjecTime	Oracle
Platinum Technology	Ptech	Rational Software
Reich Technologies	Softeam	Sterling Software
Taskon	Unisys	

Rational Software is the Consortium administrator.

Background on the UML

During 1996, it became clear that several organizations saw UML as strategic to their business. A Request for Proposal (RFP) issued by the Object Management Group (OMG) provided the catalyst for these organizations to join forces around producing a joint RFP response. Rational established the UML Partners consortium with several organizations willing to dedicate resources to work toward a strong UML 1.0 definition. Those contributing most to the UML 1.0 definition included: Digital Equipment Corp., HP, i-Logix, IntelliCorp, IBM, ICON Computing, MCI Systemhouse, Microsoft, Oracle, Rational Software, TI, and Unisys. This collaboration produced UML 1.0, a modeling language that was well defined, expressive, powerful, and generally applicable. This was submitted to the OMG in January 1997 as an initial RFP response.

In January 1997 IBM, ObjecTime, Platinum Technology, Ptech, Taskon, Reich Technologies and Softeam also submitted separate RFP responses to the OMG. These companies joined the UML partners to contribute their ideas, and together the partners produced the revised UML 1.1 response. The focus of the UML 1.1 release was to improve the clarity of the UML 1.0 semantics and to incorporate contributions from the new partners. It was submitted to the OMG for their consideration and adopted in the fall of 1997.

OMG Background Information

The Object Management Group (OMG) was founded in April 1989 by eleven companies, including 3Com Corporation, American Airlines, Canon, Inc., Data General, Hewlett-Packard, Philips Telecommunications N.V., Sun Microsystems and Unisys Corporation. In October 1989, the OMG began independent operations as a not-for-profit corporation. Through the OMG's commitment to developing technically excellent, commercially viable and vendor independent specifications for the software industry, the consortium now includes over 800 members. The OMG is moving forward in establishing CORBA as the "Middleware that's Everywhere" through its worldwide standard specifications: CORBA/IIOP, Object Services, Internet Facilities and Domain Interface specifications.

Location and Sponsorships

The OMG is headquartered in Framingham, MA, USA and has international marketing offices in Australia, Bahrain, Brazil, Germany, India, Italy, Japan and the UK, along with a government representative in Washington, D.C. Additionally, the OMG is a sponsor of the COMDEX Enterprise series of Trade Shows and Conferences.

Mission

The OMG was formed to create a component-based software marketplace by hastening the introduction of standardized object software. The organization's charter includes the establishment of industry guidelines and detailed object management specifications to provide a common framework for

application development. Conformance to these specifications will make it possible to develop a heterogeneous computing environment across all major hardware platforms and operating systems.

Implementations of OMG specifications can be found on many operating systems across the world today. OMG's series of specifications detail the necessary standard interfaces for Distributed Object Computing. Its widely popular Internet protocol IIOP (Internet Inter-ORB Protocol) is being used as the infrastructure for technology companies like Netscape, Oracle, Sun, IBM and hundreds of others. These specifications are used worldwide to develop and deploy distributed applications for vertical markets, including Manufacturing, Finance, Telecoms, Electronic Commerce, Real-time systems and Health Care.

http://www.omg.org/omg

Tech Help desks wage internal war

Help desks duke it out

By Eve Tahmincioglu
New York Times

Debbie Bird, a help desk employee at the University of Cincinnati was prepared for rudeness from students and faculty members frustrated by frozen computer screens or software errors. But she never dreamed she would receive the same treatment from the computer wizards *she* had to turn to for help in solving her toughest problems.

"One woman downright yelled at me," Bird said about a software engineer who she said terrorized many of her call center colleagues. "She'd say, `Why are you calling? You should have handled this!' She was just pain nasty."

Bird is a Level 1 support technician, one of nearly 500,000 grunts in the United States who take your calls when your computer goes on the blink or stop by your desk to help you load new software. When their expertise fails them; they have to turn to Level 2 specialists, who make at least twice as much and sometimes have an attitude to match.

The disdain that Bird encounters is commonplace at help desks throughout the country, insiders say, with Level 1 personnel often disparaged as the hamburger flippers of the computer age.

Many managers are aware the friction and are trying to do something about it.

“The industry is struggling not to ghettoize support," said Jacque Rowden, operations manager for the Pittsburgh law firm of Buchanan Ingersoll. The people on the bottom of the hierarchy, she added, deserve "credibility and respect.”

Companies that do not take the clashes between the two groups seriously could end up paying a steep price, said Calvin Sun, founder of Technology Horizons, a consulting firm in Paoli, Pa., that trains technical-support workers. Level 1 technicians might be tempted to take out their frustrations on customers, he said, and their already sagging morale could sink even further.

These front-line workers, who make about $8 to $12 an hour, typically have little training and work long days. In addition to dealing with irate customers, many are under the gun by supervisors who monitor their calls and keep track of how much time they take to resolve problems. As a result, according to Steve Cain, benchmarking director for the help desk practice at the Gartner Group in Stamford, Conn., their turnover rate is close to 70 percent a year, one of the highest for any job category.

What really galls some of them are signs of incompetence from their supposed masters. Gianmarco Rossi, a Level 1 employee for a contractor in Orlando, Fla., recalled being unable to solve a customer's cable-modem problem, so he tried to forward the call. But the Level 2 technician refused to take it and instead proposed an endless stream of solutions, none of which worked. "I suppose the higher up you go, the lazier you are," Rossi said.

Some people worry that such mutual sniping can distract technicians of both Categories. Bill Artner, vice president for content development at Tech Republic of Louisville, Ky., which runs TechRepublic.com, says neither side should be made out as the bad guys. "Finding out what is truly wrong and not what the customer thinks is wrong is the tough part," Artner said. "Where Level 2 people get frustrated is when Level 1 techs don't accurately diagnose the problem. It's not an exact science and things can be misinterpreted. Sometimes the solution a Level 1 tech proposes can ultimately complicate the work for the Level 2."

Brian Bittner, a Level 2 technician at Dell Computer in Austin says he gets along well with Level 1 employees. He acknowledges that it gets under his skin, however, when they ask him basic technical questions or come back with a problem he has already gone over with them.

It probably helps that many people in Level 2 and even their bosses have worked in the trenches and know how grueling the experience can be. Everett Michaud, director of help desk services for Analysts International, an information technology concern in Minneapolis, says he just could not get any respect when he did time on the help desk at a Detroit automotive company in the early 1990s.

Every time Michaud showed initiative by asking questions that went beyond his immediate troubleshooting duties, he says, some higher-up would slap him down.

“You automatically become jealous and spiteful because you're put in a position where you can't even advance," he said.

With the bad old days in mind, he has taken a more democratic approach. He has gotten rid of the Level 1 and Level 2 categories, and he offers financial rewards to engineers and system specialists who go out of their way to be courteous to help desk workers. As a result, his help desk has a turnover rate of less than 5 percent, he said.

Michaud may have used persuasion to create a friendlier workplace, but sometimes a stick works best. Take the Level 2 technician who gave Bird and her colleagues at the University of Cincinnati a hard time. Clarence Smith, manager of operations at the school's help desk, finally confronted her and threatened to report her conduct to her supervisor. Since then, he says, she has mended her ways.

"They don't have to love us," he said, "but they've got to try to get along with us."

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FROM: H. Strasser, SAV Marketing Manager CP 03.004.01

TO: Engineering

VIA: B. Arnold, VP Marketing

SUBJECT: Modifications to SAV

REF: MRT-COM03 Presentation, 19 Feb, at Bethesda

ENCL: None

Background

There is a significant need to extend the application of technology developed and successfully deployed for the ship-board automated Spaces and Voids (SAV) Monitoring system. The released, deployed systems have sensors in the 155X SmartSensor family for intrusion (infrared – 1551, sound – 1552), fire (1553), temperature (1554), and humidity (1555). These sensors are hard wired to a SmartSensor LED panel, which offers a fixed, limited functionality. The panel firmware (not field modifiable) controls the reading or change in reading at which the LED corresponding to a sensor is illuminated and at which an audible (horn) and/or visible (light) alarm is activated. The points at which the light/alarm are triggered are set for each sensor (based on the pre-installation survey) when the firmware for the particular installation is burned. Each sensor is checked periodically by attaching a SmartSensorTestMeter to the test points on the sensor.

The PDI K9 ruggedized personal computer and battery power-supply (PDI UPS) are compatible with the S-BUS architecture. Any 155X sensor can be connected directly to an S-BUS I/O card. All three versions (ISA, PCI, or AGP) of the S-BUS I/O card that can be installed in the K9 can handle 12 sensors. The K9 has 3 open slots. The K9 can also be configured with up to three chassis extenders that will also accept the S-BUS I/O cards. Each chassis extender takes up one open slot in the K9 and adds slots for up to 4 S-BUS cards. The Coast Guard and SDCC (StarFleet Discount Caribbean Cruises) already deploy 1553 sensors with the K9 as beta versions of the Model 64 FDS (Fire Detection System) on ships in their fleets. The Model 64 issues alerts at the PC (operator console), which are then acted upon by whoever is responsible for monitoring the K9. Marketing had a contractor throw together a VisualBasic application to process the sensor inputs and issue the alerts from the K9.

In addition, YourAttic, Inc., which rents storage space on a monthly basis at very competitive prices, has standard SAV systems currently installed at five of its facilities with the panel in the Manager's Office.

The Market Requirements

What the market requires (see the data from the MRT-COM03 presentation) is a soft, user-configurable version of the hard wired SAV system for both ship-board and shore-based applications. It should probably

be driven from a PC with on-site user configurability. The market requires a PC-based system to have all the features of the hard-wired system (alarms, all different kinds of sensors, defined thresholds at which alarms are triggered – both for absolute values from the sensors and for rate of change over time for appropriate kinds of sensors, etc.).

The system should be able to fire off alerts about sensor status from the PC – and to be able to interface to AutoCall4Help to the AFSS (Automated Fire Suppression System).

Based on demographics and the competition, the largest warehouse facility in the target market will have 400,000 square feet of floor space. Based on IEEE-SPEC 1502/4 (Sensor Positioning for Optimum Detection), the system will need to support up to 196 sensors. Since the system will be going into warehouses and large open spaces that can have multiple, changeable layouts with varying contents, users require the ability to define up to 6 zones, where a zone is a collection of up to 54 sensors. This is more than will ever be needed for an install on a ship.

Due to the nature of the environments we anticipate serving with this system, customers (especially current users) still want the hard-wired panel as an off-line back-up in case the K9 fails. The system will need to provide 24 hours of off-line operation from the hard-wired panel. The K9 should operate for an hour. In at least the first phase, off-line operation can revert to the functionality currently available in the hard-wired, panel system (e.g., no zones). For future releases, we can get hardware involved and evaluate the feasibility of adding some sort of zone logic to the panel.

In addition to the configurability described above, customers require that, from the console, an authorized operator be able to poll the sensors, check status, and test operational status of the sensors, which is something the hard-wired panel can't do. Could such an operational status check be programmed into the panel firmware for a future release?

To keep budgets and time frames reasonable, the solution should require no hardware development.

	Source	Requirement

	Requirement							

Requirements Management Tools References

Product	Contact
Alta SPW	Cadence Design Systems 555 N. Mathilda Ave. Sunnyvale, CA 94086 http://www.cadence.com
Caliber-RM	Technology Builders, Inc. 400 Interstate North Parkway, Suite 1090 Atlanta, GA 30339 Phone: 800-937-0047 Fax: 770-937-7901 http://www.tbi.com/products/caliber.html
CORE	Vitech Corporation 2070 Chain Bridge Rd Suite 320 Vienna, VA 22182-2536 http://www.vtcorp.com
Cradle	Structured Software Systems P.O. Box 310 Olney MD 20830-0310 Structured Software Systems Craven House Michaelson Road Barrow-in-Furness Cumbria LA14 2RJ UK http://www.threesl.com
DOORS	Quality Systems & Software (QSS) North American Headquarters 200 Valley Road Suite 306 Mt. Arlington New Jersey 07856 Tel: +1 973 770 6400 Fax:+1 973 770 6401 http://www.qssinc.com/home.cfm
Extend	Imagine That, Inc. 6830 Via Del Oro, Suite 230 San Jose, CA 95119 http://www.imaginethatinc.com
Foresight	Nu Thena Systems, Inc 11824 Jollyville Road, Suite 101 Austin TX 78759 http://www.nuthena.com/
MetricCenter	2300 Fall Hill Avenue, Suite 100 Fredericksburg, VA 22401 http://www.distributive.com
RDD.COM	Ascent Logic Corporation 180 Rose Orchard Way Suite 200 San Jose, CA 94134 http://www.alc.com

Product	Contact
RDT	GEC Macron Systems PTA Limited 40-52 Talavera Rd, North Ryde, NSW 2113 AUSTRALIA http://www.ausnet.net.au/gecm/
RequisitePro	Rational Software Corp. 18880 Homestead Rd Cupertino CA 95014 http://www.rational.com
RTM	Integrated Chipware Inc. 1861 Wiehle Avenue, Suite 300 Reston, VA 20190 http://www.chipware.com
SLATE REquire	TD Technologies 2425 N. Central Expressway, Suite 200 Richardson, TX 75080 http://www.tdtech.com
Statemate MAGNUM	I-Logix, Inc. Three Riverside Drive Andover MA 01810 http://www.ilogix.com
Tofs	Tofs AB Fridhem 2 S-76040 Veddoe Sweden http://www.toolforsystems.com
VitalLink	Compliance Automation, Inc. 2703 West Long Drive Unit C Littleton CO 80120 http://www.complianceautomation.com
XTie-RT	Teledyne Brown Engineering 300 Sparkman Dr. Cummings Research Park PO Box 070007 Huntsville, Alabama 35807-7007 http://www.tbe.com/products/xtie/xtiertprod.html

Mapping Tools References

ABC FlowCharter	Business drawing and diagramming tool, http://www.micrografx.com
allClear	From SPSS, flow charting tool with links to Clear Process, http://www.spss.com/software/allclear/
Argo/UML	A free UML modeling tool, http://www.argouml.com
Bpwin	From LogicWorks, now part of Platinum Technologies, now part of Computer Associates, modeling tool used to analyze, document, and improve business processes, http://www.platinum.com
CorelFlow	From Corel, a diagramming tool, http://www.corel.com
GDPro	From Embarcadero Technology, visual UML modeling tool, includes design and code generation (Java, C++, IDL), priced as such, www.embarcadero.com
Inspiration	From Inspiration Software, Inc., for concept maps, web maps, idea organization, http://www.inspiration.com (free 30 day trial available)
MQSeries Workflow	Formerly FlowMark, from IBM, www.software.ibm.com/ad/flowmark
Optima	Integrated tool for creating presentation-quality process maps, modeling process behavior, doing simulation, and performing "what if?" analysis, http://www.micrografx.com/enterprise/optima/
Process98	From Scitor, the next generation of ProcessCharter, tool to design, simulate, and improve business and manufacturing processes, http://www.scitor.com
ProcessWise WorkBench	From International Computers Ltd. (ICL), now part of Fujitsu, modeling, simulation, and analysis tool, http://www.teamware-us.com/products/others.htm
TeamFlow	Process diagramming tool from CFM Inc., www.teamflow.com
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QSS2		**QSSNewsByte**, an RM journal published electronically by QSS, Inc. (supplier of DOORS). To subscribe or obtain more information, contact: http://www.qssinc.com/lists/qssnewsbyte/subscribe.cfm
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Springfield VA 22161

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Agile/ Lean Development and CMMI®

November 2005

Jeffrey L. Dutton
Richard S. McCabe

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the Systems and Software Consortium, Inc.

Biographies

- Jeff Dutton
  - Technical Director for Jacobs Sverdrup's Information Technology Support Services
  - Experience in software project management, systems and software process improvement, systems and software engineering, weapons systems modeling and simulation, operations research, test and evaluation, and systems and software acquisition
  - Member of the CMMI® Product Team
  - Authored a section of CMMI Distilled: A Practical Introduction to Integrated Process Improvement
  - SEI Visiting Scientist
  - Candidate SCAMPI℠ Lead Appraiser
- Rich McCabe
  - Principal member of the technical staff at the Systems and Software Consortium (formerly the Software Productivity Consortium)
  - Co-authored the Consortium' s Object-Oriented Approach to Software-Intensive Systems (OOASIS) methodology
  - Currently working on the Consortium's Disciplined Agility (integrates agile development with the CMMI)
  - Headed the Consortium' s pioneering work in the product-line approach for systematic reuse
  - Nearly 15 years of software and system development experience with Bell Laboratories and other firms

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Workshop Agenda

- Define the problem and set the context
- Review concepts of agile development
- Review concepts of lean software development
- Investigate applicability and usefulness of CMMI® model suite in agile/lean development efforts
- Develop summary conclusions

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Valuation Approach

- Gate 1: Does CMMI® model suite ALLOW agile/ lean dev?
  - Structural flexibility
  - Process areas
  - Goals
  - Practice flexibility
- Gate 2: Does the model suite SUPPORT agile/ lean dev?
  - Structural sufficiency
  - Process area sufficiency
  - Goal sufficiency
  - Practice sufficiency
- Gate 3: Does the model suite ENHANCE agile/ lean dev?
- Gate 4: Does agile/lean ENHANCE the model suite?

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Problem and Context

- **Define the problem and set the context**
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The Problem

Effective approaches to developing complex software-intensive systems

- Software Intensive System—relies on software to provide core or priority mission capability
- Typical attributes of SIS development projects
  - Large team (tens to hundreds of developers)
  - Long schedule (months to years)
  - High cost and commitment ($M)
  - Composed of multiple systems or subsystems, all or most of which contain software
  - Often incorporate many off-the-shelf components

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Challenges of SIS Development

- Software requirements
  - Vague and subtle, representing subjective tradeoffs; difficult to discover and pin down “in full”
  - Volatile, responding to budget and mission changes
  - Interdependent with solution concept and design tradeoffs
- Software design
  - Complex with many degrees of freedom
  - Architecture sensitive to detailed design tradeoffs
- Integration and communication
  - Coordination across groups often slow, dysfunctional
  - Test and integration often unpredictable, interminable

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Agile Development

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Workshop Discussion

What are the important attributes of an agile development effort?

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What Is Agile Development?

- Evolving systems in short iterations
  - Each release is a working system
  - Design for change
  - Focus on value
  - Actively guide to convergence
- Communicating efficiently
- Leveraging human strengths
  - Engage, align, and empower the team
  - Get power from each member

Comparing various interpretations of agile development, these themes seem to be common and essential (and non-specific to software

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Agile Manifesto*

We believe in practices that emphasize

- Individuals and interactions over processes and tools
- Working software over comprehensive documentation
- Customer collaboration over contract negotiation
- Responding to change over following a plan

While there is value in the items on the right,
the items on the left are more valuable

* Paraphrased from “Manifesto for Agile Software Development” at www.agilealliance.org

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Agile Principles*

- First and foremost: Satisfy the customer —
  Deliver working, valuable software early and frequently
- Measure progress primarily by working software
- Have business people and developers work together daily
- Welcome changing requirements
- Create a self-organizing team of motivated individuals
- Communicate using face-to-face conversation
- Avoid nonessential work
- Maintain a sustainable pace of development
- Attend continuously to good design
- Retrospect and adjust regularly

* Paraphrased from “Principles Behind the Agile Manifesto” at
www.agilealliance.org/principles.html

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Agile "Brand Name" Methodologies

- eXtreme Programming (XP) *[Beck]*
  - Widest known, developer-focused for small teams
- Crystal methodolgies *[Coburn]*
  - Set of methodologies conditional on circumstances—Only 2 defined: Crystal Clear, Crystal Orange
- Feature-Driven Development (FDD) *[Palmer]*
  - Agile approach closest to conventional development
- Scrum *[Schwaber]*
  - Focused on management practices
- Lean Software Development *[Poppendieck]*
  - Inspired by Toyota Production System, particularly its product development practices

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Crystal Methodologies*

- Crystal is a family of agile methodologies characterized by
  - Priorities
  - Principles
  - Properties
    - ***Frequent delivery***
    - ***Reflective improvement***
    - ***Close communication***
    - Personal safety
    - Focus
    - Easy access to expert users
    - Automated testing, CM, and frequent integration
  - Strategies and techniques in practice
- Crystal methodologies vary by project size and criticality
  - Crystal Clear is the most tolerant process for a small team

* Paraphrased from Crystal Clear by Alistair Cockburn

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XP Core "Xtudes" (Core Techniques)*

- Fine scale feedback
  - Test-driven development via programmer tests and customer tests
  - Planning game
  - Whole team
  - Pair programming
- Programmer welfare
  - Sustainable pace
- Shared understanding
  - Simple design
  - System metaphor
  - Collective code ownership
  - Coding standard or coding conventions
- Continuous process rather than batch
  - Continuous integration
  - Design improvement / refactoring
  - Small releases

* http://www.c2.com/cgi/wiki?ExtremeProgrammingCorePractices

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FDD* Processes

- Select domain experts, chief programmers and the chief architect
- Develop an overall model
  - What classes are in the domain, how are they connected to one another and under what constraints
- Build a features list
  - For each subject area, a list of the business activities
- Plan by feature
  - Development plan with completion dates and assignments
- Design by feature
  - Inspected design package
- Build by feature

* http://www.featuredrivendevelopment.com/

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Scrum

- Agile process to manage and control development work
  - Work from a backlog of prioritized features
  - Deliver in 30-day sprints
  - Coordinate via 15-minute daily status meeting
- Wrapper for existing engineering practices
- Oriented to rapidly-changing requirements
- Controls the chaos of conflicting interests and needs
- Maximizes productivity, communications, and cooperation — detects and removes obstacles to project success
- Scalable from single projects to entire organizations
- Want everyone to feel good about their job and their contributions

* Paraphrased from http://www.controlchaos.com/about/

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Typical Agile Development

- Applications evolve in multiple short iterations
  - Iterations are constant length, in range of 2-13 weeks
  - Release a working application at end of each iteration
  - Add as many of customer's highest priority features to each new release as can fit in an iteration
  - Requirements and design elaborated each release to support features in that release
  - Extensively test features in each iteration
- Customer (or customer surrogate) reviews each release—can redirect priorities for next iteration
- Track project progress by features completed
- Never slip a release date, instead slip features

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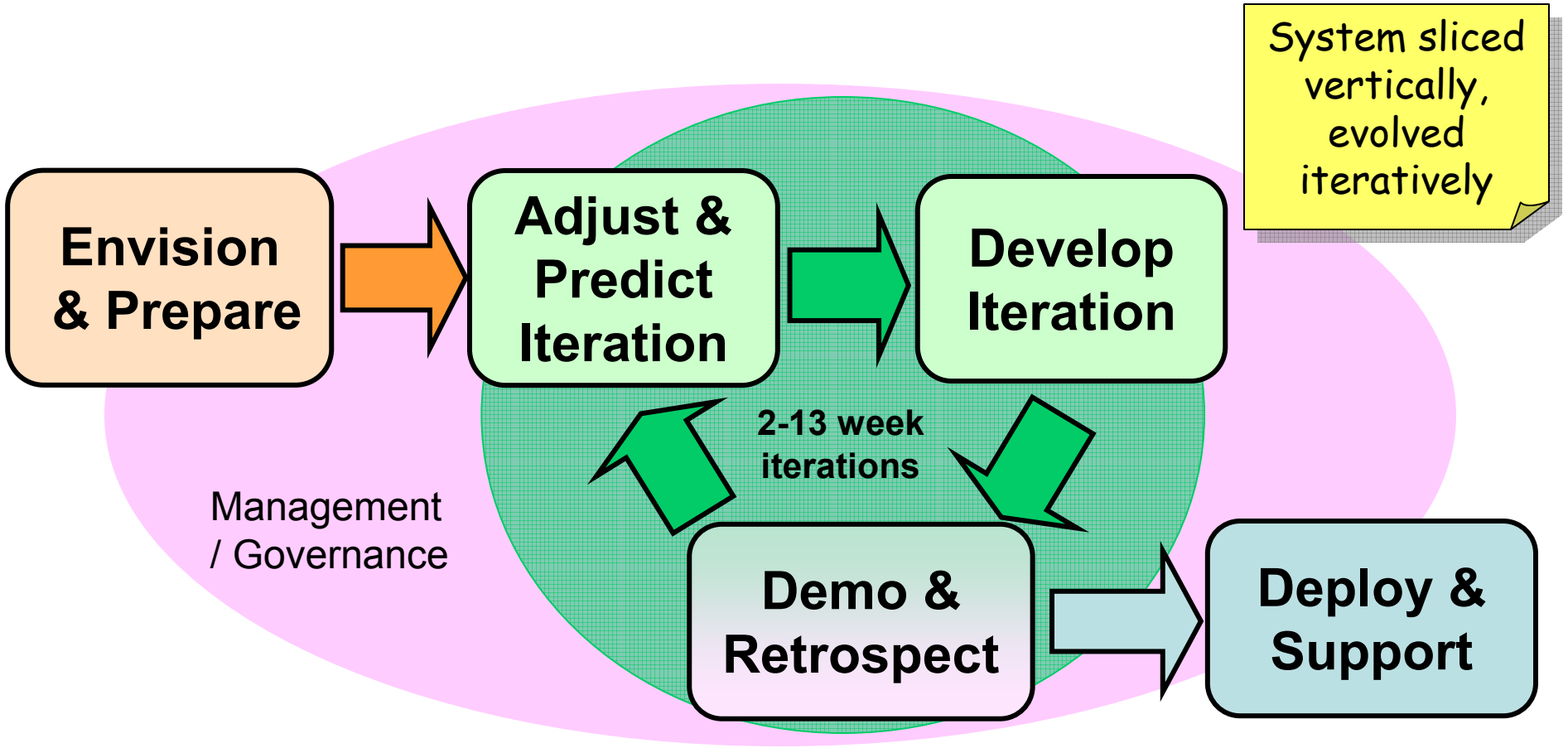
A Typical Agile Process Depiction



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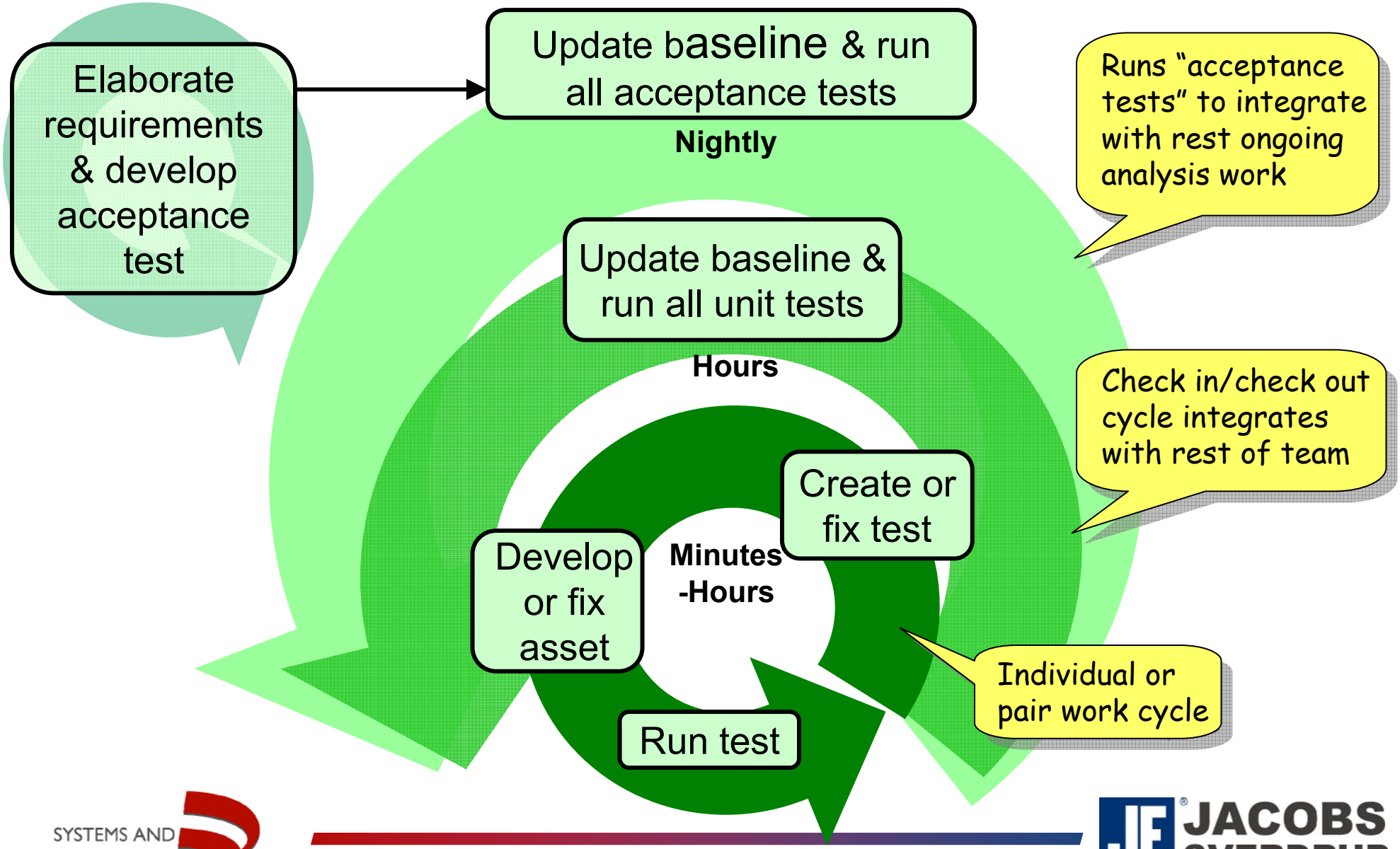
Typical Loops Within *Develop Iteration*



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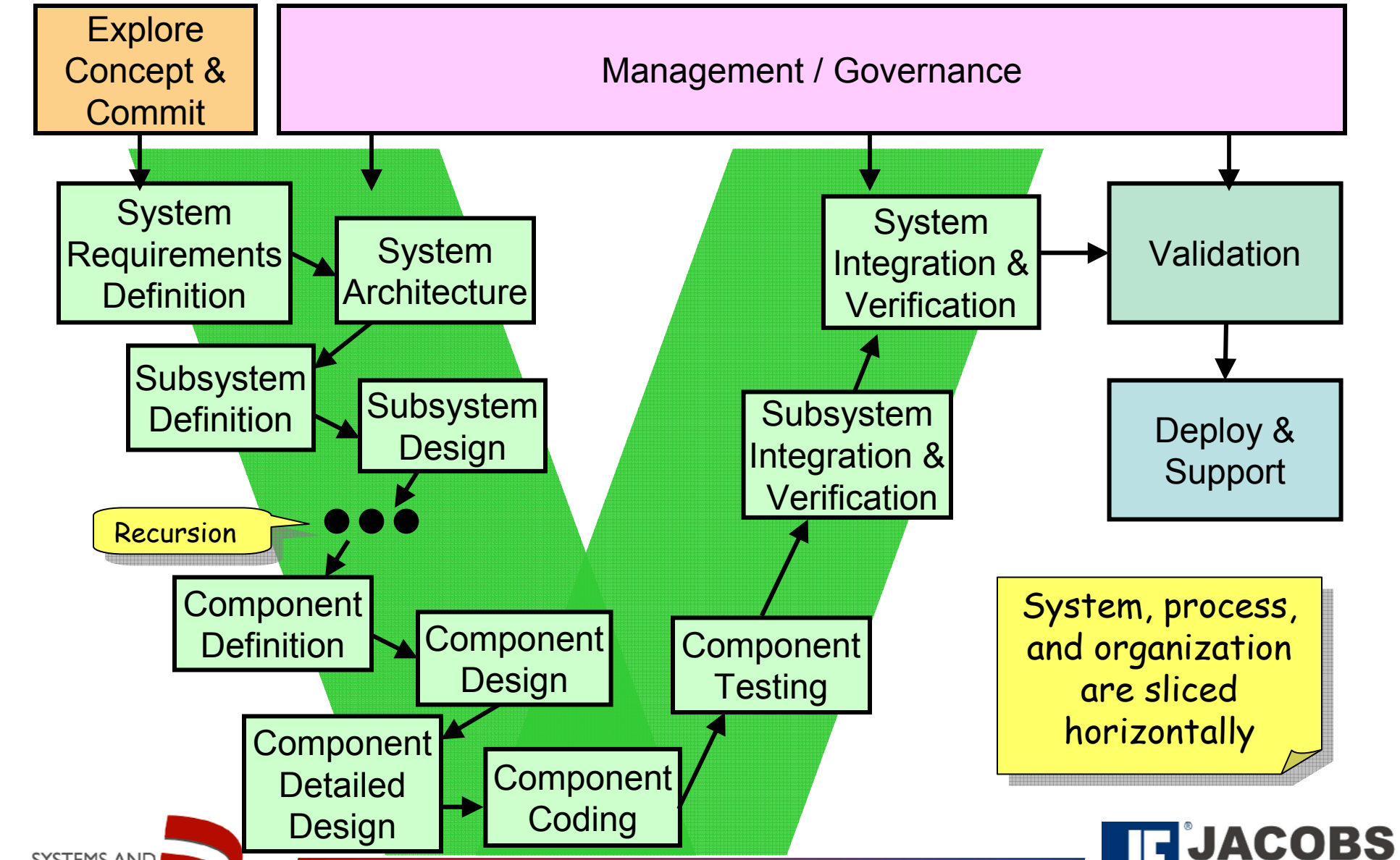
A Conventional Waterfall Process



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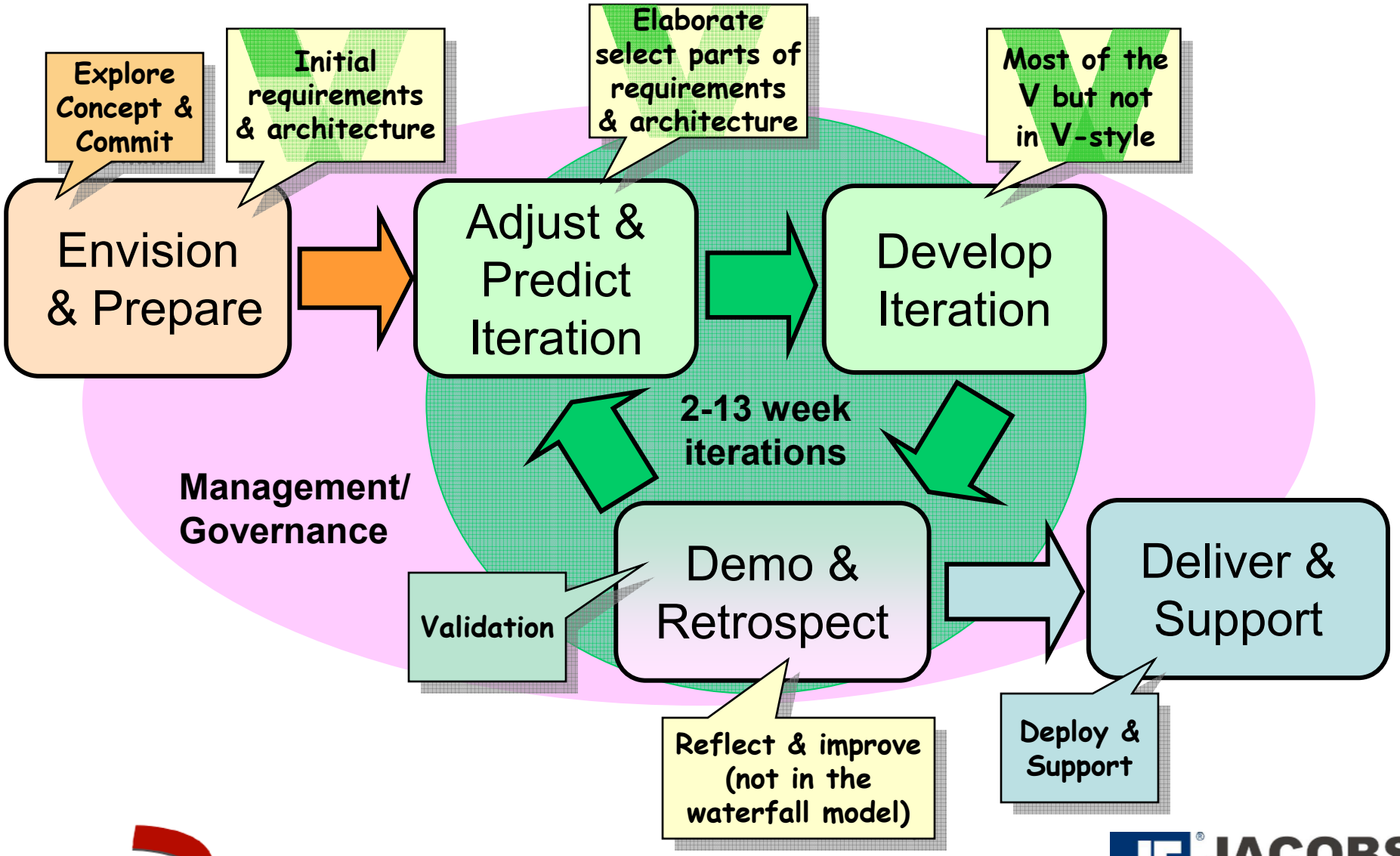
Rough Mapping: Waterfall to Agile



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Typical and Possible Agile Practices

- Automated testing
- Barely sufficient documentation
- Bottleneck management
- Coding standards
- Collective code ownership
- Colocation
- Continuous team integration and CM
- CRC cards
- Customer focus group review
- Customer onsite
- Daily standup
- Design metaphor
- Exploratory spikes
- Feature-based planning
- Group design
- Information radiators
- Inspections
- “Intentional” design
- Issue tracking
- Monitor and adjust
- Pair programming
- Project velocity
- Refactoring
- Retrospectives
- Risk management
- Self-tasking
- Simple, robust design
- Small releases
- Sustainable pace
- Test-driven development
- Test first
- Unit testing
- Unity statement
- Use cases
- User stories

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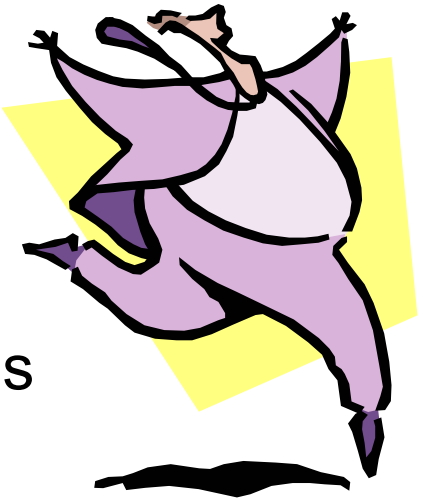
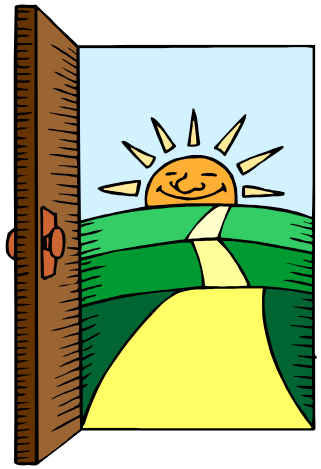
Potential Agile Benefits

- More predictable deliveries
- Early return on investment;
  working software delivered and in use sooner
- Quick response to changes in customer needs
- Risk mitigation provided by shorter delivery cycles
  - Multiple opportunities to recover from missteps
  - Validation of requirements
  - Confirmation of technical approach
  - Realistic assessment of progress
- High productivity and quality
- Satisfied customers, successful projects





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Lean Software Development

- Define the problem and set the context
- Review concepts of agile development
- **Review concepts of lean software development**
- Investigate applicability and usefulness of CMMI® model suite in agile/lean development efforts
- Develop summary conclusions

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Workshop Discussion

What are the important attributes of a lean development effort?

How does lean differ from agile development?

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Lean SW Development

- Quality Redefined
- User/Customer Involvement
- The Idea of Iterations
- Iteration Management and Convergence
- Options Thinking
- Decide as Late as Possible
- Deliver as Fast as Possible
- Tacit Knowledge (vs. Process) and Rapid Learning
- Concurrency and Communication (IPT)
- Agile Engineering Support
- Lean/Agile Project Management
- Waste in Lean/Agile Development

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Quality Redefined

- Variation is not (necessarily) bad
  - (Too) detailed processes can be restrictive
  - Software development is a creative process
- "Do it right the first time" is a BAD idea
  - Fast development drives out the "right" requirements
  - Fast development produces mistakes – which are the (very) basis for learning, product (quality) and value

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User/Customer Involvement

- (Near) continuous feedback and tight coupling to the users/customer is a hard requirement of lean/agile development
- User/customer “awakening” occurs over several iterations of the software
- Lack of user/customer coupling drastically reduces effectiveness of lean/agile approach

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The Idea of Iterations

- Basic idea: fast iterations drive out requirements clarity and lead to “better” code faster, and with fewer resources
- Iterations = lean “workflow”
- Iterations are not prototypes
- Fast iterations enable “decide as late as possible”
- Fast iterations enable “options thinking”
- “Fast” means days or weeks, perhaps a month or two

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Iteration Management and Convergence

- "Pure" agility carries a significant risk of "out of bounds" solutions
- Convergence relies on:
  - Reliance on software architecture as a "vision point"
  - High level design as an adjunct to SW architecture
  - Skilled practitioners
  - Project/technical leadership skills

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Options Thinking

- Idea based on root of decision making difficulties:
  - "Up front" full requirements baseline
  - Full detailed design early in life cycle
  - "Frozen" architecture
- Options include:
  - Requirements or features
  - Detailed design
  - Designing in a tolerance for change
  - Designing in acceptance for evolution
  - Many others

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Decide as Late as Possible

- Delaying decisions to the “last responsible moment” = high business value
- Depth-first approaches force premature low-level decisions
- Requirements development
  - Early decisions based on “criticality”
    - Hard-to-do’s
    - Technical challenges
    - High priority user needs
  - Spiral (sprint) requirements decisions evolve as the learning curve accelerates
- Early architecture decisions are necessary
  - Technical constraints
  - Critical user needs
  - System design constraints

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Deliver as Fast as Possible

- Fast delivery forces fast coding
- Fast delivery enables delayed decisions
- Fast delivery requires near-continuous integration
- Fast delivery requires near-continuous testing (drives out defects early)
- Fast delivery enables faster delivery of high value, high quality products at less cost
- Fast delivery leads to “steady state” workflow (and to efficiency and productivity increases)

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Tacit Knowledge and Rapid Learning

- Tacit Knowledge = project/domain/skills knowledge in the heads of team members
- Balance of tacit knowledge with training and defined process is key
- Lean/agile development mandates a rapid learning environment
  - Skills
  - Domains
  - Technologies
  - Improvement to high-level (lean) processes

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Concurrency & Communication

- Lean/agile development = crucible for concurrency and communication
- Concurrency = all team members and stakeholders have near-real-time “push” access to all project information
- Continuous push communication is critical
  - Technologies
  - Communication skill set

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Agile Engineering Support

- Engineering support = CM, QA, Metrics
- Agile Configuration Management
  - Agile check-in/check-out
  - Agile status accounting and configuration audits
  - Agile CM system
  - Agile change management
- Agile Quality Assurance
  - Add value by reducing risk or defects in hours or a day
  - Tight coupling to project activities
- Agile Metrics
  - Kanban or “pull” visualization for all team members
  - Project progress and design convergence

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- **Lean/Agile Project Management**
- Waste in Lean/Agile Development

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Lean/Agile Project Management

- (NOT) "Plan based" approaches (like "traditional" CMMI) skills:
  - Early detailed planning
  - Early requirements "understanding" and stability
  - Focused on project monitoring against the plan
- Lean/Agile Project Management skills:
  - Seeing waste
  - Value stream mapping
  - Feedback
  - Iteration leadership/management
  - Options thinking
  - Last responsible moment decision making
  - Pull/Kanban systems and measurements
  - Cost of delay awareness
  - Self determination/team empowerment
  - Motivation and leadership
  - Technical expertise
  - Refactoring (design against more stable architecture)

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- Lean/Agile Project Management
- **Waste in Lean/Agile Development**

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Waste in Lean/Agile Development

- Partially done work
- Extra processes
- Extra features
- Task switching
- Waiting
- Motion
- Defects
- Traditional oversight/control activities

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CMMI Interpretation

- Define the problem and set the context
- Review concepts of agile development
- Review concepts of lean software development
- **Investigate applicability and usefulness of CMMI® model suite in agile/lean development efforts**
- Develop summary conclusions

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Workshop Discussion

Can the CMMI® model suite be applied to agile/lean development organizations?

What problems or issues (or roadblocks) might arise?

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Previous Mapping Efforts

- Agile+ (AgileTek)
  - Extended XP to meet CMMI Level 3
- Microsoft Solutions Framework
  - Methodology, management training, and tool
  - Version 4 was agile “with some overhead” to achieve CMMI Level 3 consistency
- ASCEND (BAE Systems)
  - Variant of agile development for small project team
  - Uses Fagan inspections, Earned Value tracking
  - Claims CMMI Level 5 compatibility

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Model Components

- What model components are **required**?
  - Specific goals
    (the actual goal – not the title or explanatory information)
  - Generic goals
- What model components are **expected**?
  - Specific practices
  - Generic practices
- What model components are **informative**?
  - Subpractices
  - Typical work products
  - Discipline amplifications
  - GP elaborations
  - Goal and practice titles
  - Goal and practice notes
  - References

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Specific and Generic Goals

- **Required*:**
  Specific goals and generic goals are required model components. These components must be achieved by an organization's planned and implemented processes. Required components are essential to rating the achievement of a process area. Goal achievement (or satisfaction) is used in appraisals as the basis upon which process area satisfaction and organizational maturity are determined. *Only the statement of the specific or generic goal is a required model component*. The title of a specific or generic goal and any notes associated with the goal are considered informative model components.

*CMMI SE/SW V1.1

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Specific and Generic Practices

- **Expected*:**
  Specific practices and generic practices are expected model components. Expected components describe what an organization will typically implement to achieve a required component. Expected components guide those implementing improvements or performing appraisals. *Either the practices as described, or acceptable alternatives to them, are expected to be present in the planned and implemented processes of the organization before goals can be considered satisfied. Only the statement of the practice is an expected model component.* The title of a practice and any notes associated with the practice are considered informative model components.

*CMMI SE/SW V1.1

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Informative Elements

- **Informative*:**
  Subpractices, typical work products, discipline amplifications, generic practice elaborations, goal and practice titles, goal and practice notes, and references are informative model components that help model users understand the goals and practices and how they can be achieved. *Informative components provide details that help model users get started in thinking about how to approach goals and practices.*

*CMMI SE/SW V1.1

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Agile/Lean Interpretation of the CMMI

Challenge Everything

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CMMI Process Areas

Project Planning
Project Monitoring and Control
Supplier Agreement Management
Integrated Project Management
Risk Management
Quantitative Project Management
Requirements Management
Requirements Development
Technical Solution
Product Integration
Verification
Validation
Measurement and Analysis
Process and Product Quality Assurance
Configuration Management
Decision Analysis and Resolution
Causal Analysis and Resolution
Organizational Process Focus
Organizational Process Definition
Organizational Training
Organizational Process Performance
Organizational Innovation and Deployment

	Process Mgt.	Project Mgt.	Engr.	Engr. Support.
ML 5	OID			CAR
ML 4	OPP	QPM		
ML 3	OPF OPD OT	IPM RSKM	RD TS PI Ver Val	DAR
ML 2		PP PMC SAM	REQM	M&A PPQA CM

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Process Area Valuation Approach

- **Goal Level Insufficiency** — **Unacceptable**
  - Goals do not allow or support conduct of accepted lean/agile practices
- **Goal Level Sufficiency**: — **Acceptable**
  - Goals allow or support conduct of accepted lean/agile practices
  - One or more specific practices must be replaced with one or more alternative practices to support conduct of lean/agile practices
- **Practice Level Sufficiency**: — **Supportive**
  - Goals allow or support conduct of accepted lean/agile practices
  - Practices, as stated, fully support conduct of accepted lean/agile practices
  - Informative elements are largely unhelpful
- **Informative Element Level Sufficiency**: — **Enabling**
  - Goals allow or support conduct of accepted lean/agile practices
  - Practices, as stated, fully support conduct of accepted lean/agile practices
  - Informative elements are largely helpful

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Practice Valuation Approach

- **Alternative practice required** — **Alternative**
  - Practice does not allow or support conduct of accepted lean/agile practices – Alternative practice is required
- **Supportive**: — **Supportive**
  - Practice, as stated, fully supports conduct of accepted lean/agile practices
  - Informative elements are largely unhelpful
- **Enabling**: — **Enabling**
  - Practice, as stated, fully supports conduct of accepted lean/agile practices
  - Informative elements are largely helpful

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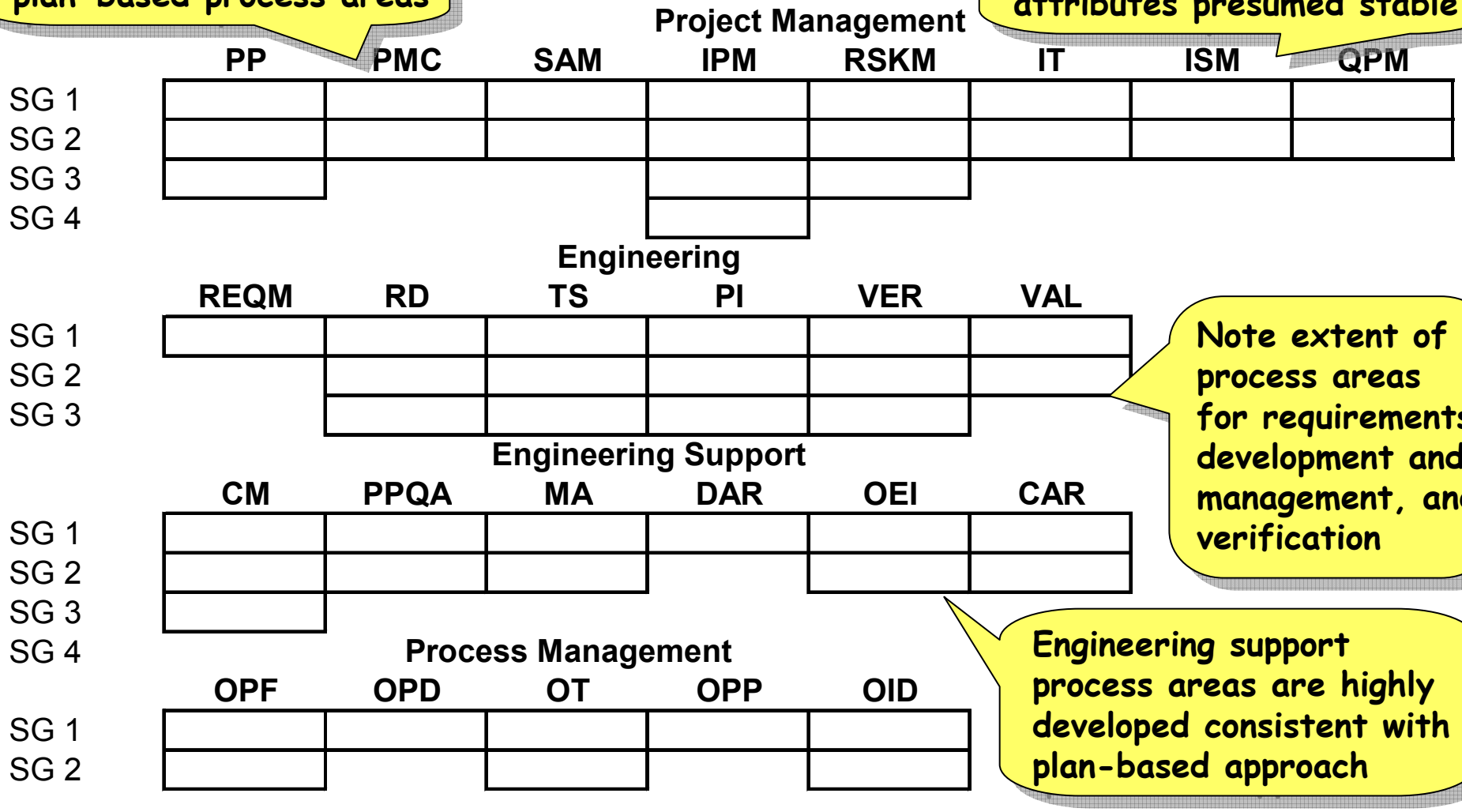
Overview of CMMI to Agile/Lean Match

Note heavy focus on plan-based process areas

Detailed project plans and oversight against project attributes presumed stable



Note extent of process areas for requirements development and management, and verification

Engineering support process areas are highly developed consistent with plan-based approach

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Apparent Areas of Friction

- Empowerment and trust versus micromanagement
  - Process and Product Quality Assurance
- Organization standards versus project standards
  - Quantitative Project Management
  - All the "Organizational" process areas
- Elaboration and review of intermediate work products
  - Requirements Management
  - Requirements Development
  - Technical Solution
  - Verification

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Empowerment and Trust

- Agile/Lean enhances productivity by empowerment (team and each member has both responsibility *and* authority)
  - Bottom-line results of each iteration provide external accountability across iterations
  - Peer pressure provides internal accountability
  - Improvements in process are a team responsibility
- External audits undercut this agile/lean philosophy
  - QA is independent—self-discipline is demotivated
  - Auditing is non-value-added, justified only by lack of trust
  - Compliance becomes the focus, not effective practices justified by results
- Agile Coach is a hybrid role—challenges team behaviors but does not dictate resolutions—can QA become a coach?

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Organization Versus Project Standards

- Agile/Lean teams determine their own process and practices by consensus
- Does CMMI tailoring guidance allow project team data *or* consensus to overrule
  - Organizational standards?
  - Accumulated organizational performance data?
- Otherwise, process performers are no longer the process owners
  - See previous discussion of empowerment and trust

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Intermediate Work Products

- Agile/Lean suspects any non-deliverable is waste
  - Code is a necessary “detailed spec” for executable delivery
  - Tests drive code development, define and verify requirements
  - But conventional requirements and design docs only support understanding, hence “barely sufficient” documentation
- Does CMMI demand “complete” system representations in intermediate work products?
  - How much is enough to “define” and “elaborate”…
    - Requirements before …
    - Design and interfaces before …
    - Implementation and testing
  - What is sufficient review?
  - Is bi-directional traceability necessary? To what level?

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Project Management

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Project Planning

✓SG 1 Estimates of project planning parameters are established and maintained.
✓SG 2 A project plan is established and maintained as the basis for managing the project.
✓SG 3 Commitments to the project plan are established and maintained.

- Good match to agile and lean!
- However, must interpret in light of
  - Large-grained initial release plan (features roughly allocated to iterations)
  - More detailed planning to begin each iteration
  - Work Breakdown Structure likely different (distinctions between testing and development less important)

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Project Planning

Acceptable

SG 1	**Establish Estimates**		Acceptable
●	SP 1.1	Estimate the Scope of the Project — Options thinking and workflow synchronization	Supportive
●	SP 1.2	Establish Estimates of Work Product and Task Attributes — Iteration planning, Closure criteria & mechanisms	ve
●	SP 1.3	Define Project Life Cycle — Interpretation of phases, iterations or hybrids, Value stream mapping	Alternative
	SP 1.4	Determine Estimates of Effort and Cost	Supportive
SG 2	**Develop a Project Plan**		Supportive
●	SP 2.1	Establish the Budget and Schedule — Workflow, options analysis, Stopping points, exit criteria	Enabling
	SP 2.2	Identify Project Risks	Enabling
	SP 2.3	Plan for Data Management	Enabling
	SP 2.4	Plan for Project Resources	Enabling
	SP 2.5	Plan for Needed Knowledge and Skills	Enabling
●	SP 2.6	Plan Stakeholder Involvement — Close coupling or stakeholders to project activities	Enabling
	SP 2.7	Establish the Project Plan	Supportive
SG 3	**Obtain Commitment to the Plan**		Acceptable
	SP 3.1	Review Plans that Affect the Project	Alternative
	SP 3.2	Reconcile Work and Resource Levels	Alternative
	SP 3.3	Obtain Plan Commitment	Enabling

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Project Monitoring and Control

✓ SG 1 Actual performance and progress of the project are monitored against the project
✓ SG 2 Corrective actions are managed to closure when the project's performance or results deviate significantly from the plan.

- Good match to agile and lean!
  - Progress tracked by tested, completed features
  - Plans and priorities reset with each iteration based on current information, customer's ongoing guidance
- However, agile/lean is biased to different "corrective actions"
  - Drop features rather than slip an iteration release date
  - Original plan treated as an outdated prediction

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Project Monitoring and Control

Supportive

SG 1 Monitor Project Against Plan — Supportive

- SP 1.1 Monitor Project Planning Parameters — Waste, progress, convergence — Enabling
- SP 1.2 Monitor Commitments — Enabling
- SP 1.3 Monitor Project Risks — Enabling
- SP 1.4 Monitor Data Management — Enabling
- SP 1.5 Monitor Stakeholder Involvement — Enabling
- SP 1.6 Conduct Progress Reviews — Continuous review, continuous waste elimination, pull Kanban metrics — Alternative
- SP 1.7 Conduct Milestone Reviews — Enabling

SG 2 Manage Corrective Action to Closure — Enabling

- SP 2.1 Analyze Issues — Enabling
- SP 2.2 Take Corrective Action — Agile record keeping, continuous corrective action — Enabling
- SP 2.3 Manage Corrective Action — Enabling

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Supplier Agreement Management

Enabling

- SG 1 Establish Supplier Agreements — Enabling — Tight coupling of suppliers; Fast response times
  - SP 1.1 Determine Acquisition Type — Enabling
  - SP 1.2 Select Suppliers — Enabling
  - SP 1.3 Establish Supplier Agreements — Enabling
- SG 2 Satisfy Supplier Agreements — Enabling — Fast, agile practices
  - SP 2.1 Review COTS Products — Enabling
  - SP 2.2 Execute the Supplier Agreement — Enabling
  - SP 2.3 Accept the Acquired Product — Enabling
  - SP 2.4 Transition Products — Enabling

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Integrated Project Management

Supportive

SG 1 Use the Project's Defined Process — Supportive

- SP 1.1 Establish the Project's Defined Process — Agile tailoring criteria, Learn internally and through organization. Tailor very fast — Enabling
- SP 1.2 Use Organizational Process Assets for Planning Project Activities — Supportive
- SP 1.3 Integrate Plans — Supportive
- SP 1.4 Manage the Project Using the Integrated Plans — Supportive
- SP 1.5 Contribute to the Organizational Process Assets — Extremely rapid contribution to organization's process assets — Enabling

SG 2 Coordinate and Collaborate with Relevant Stakeholders — Enabling

- SP 2.1 Manage Stakeholder Involvement — Key to agile/lean efforts; Close, continuously coupled coordination and collaboration — Enabling
- SP 2.2 Manage Dependencies — Enabling
- SP 2.3 Resolve Coordination Issues — Enabling

SG 3 Use the Project's Shared Vision for IPPD — Enabling

- SP 3.1 Define Project's Shared-Vision Context — Enabling
- SP 3.2 Establish the Project's Shared Vision — Consider shared vision point architectures — Enabling

SG 4 Organize Integrated Teams for IPPD — Consider agile team structure; Critical for self-motivating teams — Enabling

- SP 4.1 Determine Integrated Team Structure for the Project — Enabling
- SP 4.2 Develop a Preliminary Distribution of Requirements to Integrated Teams — Enabling
- SP 4.3 Establish Integrated Teams — Enabling

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Risk Management

Enabling

SG 1 Prepare for Risk Management — Enabling

- SP 1.1 Determine Risk Sources and Categories — Enabling
- SP 1.2 Define Risk Parameters — Enabling
- SP 1.3 Establish a Risk Management Strategy — Enabling

Good fit
Ramp up to agile/lean record keeping
Migrate to continuous mitigation and action

SG 2 Identify and Analyze Risks — Enabling

- SP 2.1 Identify Risks — Enabling
- SP 2.2 Evaluate, Categorize, and Prioritize Risks — Enabling

SG 3 Mitigate Risks — Enabling

- SP 3.1 Develop Risk Mitigation Plans — Enabling
- SP 3.2 Implement Risk Mitigation Plans — Enabling

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Integrated Teaming

Enabling

SG 1	Establish Team Composition	Enabling
SP 1.1	Identify Team Tasks	Enabling
SP 1.2	Identify Needed Knowledge and Skills	Enabling
SP 1.3	Assign Appropriate Team Members	Enabling
SG 2	Govern Team Operation	Enabling
SP 2.1	Establish a Shared Vision	Enabling
SP 2.2	Establish a Team Charter	Enabling
SP 2.3	Define Roles and Responsibilities	Enabling
SP 2.4	Establish Operating Procedures	Enabling
SP 2.5	Collaborate among Interfacing Teams	Enabling

Best CMMI support for management of tacit knowledge
Overall extremely good fit for agile/lean efforts

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Integrated Supplier Management

Enabling

SG 1 Analyze and Select Sources of Products — Enabling

- SP 1.1 Analyze Potential Sources of Products — Enabling
- SP 1.2 Evaluate and Determine Sources of Products — Enabling

SG 2 Coordinate Work with Suppliers — Enabling

- SP 2.1 Monitor Selected Supplier Processes — Enabling
- SP 2.2 Evaluate Selected Supplier Work Products — Enabling
- SP 2.3 Revise the Supplier Agreement or Relationship — Enabling

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Quantitative Project Management

✓ SG 1 Quantitatively manage using quality and process-performance objectives.
- ? SP 1.2 Select the subprocesses that compose the project's defined process based on historical stability and capability data.

? SG 2 The performance of selected subprocesses within the project's defined process is statistically managed.
- ? SP 2.2 Establish and maintain an understanding of the variation of the selected subprocesses …
- ? SP 2.3 Monitor the performance of the selected subprocesses to determine their capability to satisfy their … objectives, and identify corrective action as necessary.

- Agile focus: reliably valuable results despite uncertainty and volatility—not predictability through invariance
- What subprocess in agile development should be "statistically managed"? Iterations? (E.g., feature points/iteration, or convergence)
- What "historical data"? From the project? From other projects?

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Quantitative Project Management

Acceptable

SG 1 Quantitatively Manage the Project — Acceptable

- SP 1.1 Establish the Project's Objectives — Limited number of subprocesses E.G., workflow control — Supportive
- SP 1.2 Compose the Defined Process — Iteration length, Architecture convergence — Alternative
- SP 1.3 Select the Subprocesses that Will Be Statistically Managed — Supportive
- SP 1.4 Manage Project Performance — Enabling

SG 2 Statistically Manage Subprocess Performance — Acceptable

- SP 2.1 Select Measures and Analytic Techniques — Enabling
- SP 2.2 Apply Statistical Methods to Understand Variation — Enabling
- SP 2.3 Monitor Performance of the Selected Subprocesses — Enabling
- SP 2.4 Record Statistical Management Data — Agile/lean record keeping — Alternative

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Summary Valuation for Project Management

	PP	PMC	SAM	IPM	RSKM	IT	ISM	QPM
	Acceptable	Supportive	Enabling	Supportive	Enabling	Enabling	Enabling	Acceptable
SG 1	Acceptable	Supportive	Enabling	Supportive	Enabling	Enabling	Enabling	Acceptable
SG 2	Supportive	Enabling	Enabling	Enabling	Enabling	Enabling	Enabling	Supportive
SG 3	Acceptable			Enabling	Enabling	Enabling	Enabling	
SG 4				Enabling				

Process Area Valuation Approach

- **Goal Level Insufficiency** — Unacceptable
  - Goals do not allow or support conduct of accepted lean/agile practices
- **Goal Level Sufficiency**: — Acceptable
  - Goals allow or support conduct of accepted lean/agile practices
  - One or more specific practices must be replaced with one or more alternative practices to support conduct of lean/agile practices
- **Practice Level Sufficiency**: — Supportive
  - Goals allow or support conduct of accepted lean/agile practices
  - Practices, as stated, fully support conduct of accepted lean/agile practices
  - Informative elements are largely unhelpful
- **Informative Element Level Sufficiency**: — Enabling
  - Goals allow or support conduct of accepted lean/agile practices
  - Practices, as stated, fully support conduct of accepted lean/agile practices
  - Informative elements are largely helpful

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Requirements Management

✓ SG 1 Requirements are managed and inconsistencies with project plans and work products are identified.

? SP 1.4 Maintain bidirectional traceability among the requirements and the project plans and work products.

- Agile addresses consistency with lower-overhead practices
  - Acceptance tests tied to features
  - Group Design, Code/Design Standards
  - Clean Design and Refactoring
  - Collective Code Ownership
  - Continuous Integration and high level of communication among team members
- But is bi-directional traceability necessary for large projects?
  - And if so, to what level of granularity? To local team level?

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Requirements Management

Acceptable

SG 1 Manage Requirements — Acceptable

- SP 1.1 Obtain an Understanding of Requirements — "Fuzzy set" at SW/system level; Clarity at iteration level
- SP 1.2 Obtain Commitment to Requirements — At each iteration — Enabling
- SP 1.3 Manage Requirements Changes — Tie group design, collective code ownership, and acceptance tests to features (very high level) — Enabling
- SP 1.4 Maintain Bidirectional Traceability of Requirements — Manage "fuzzy set" as design is refactored toward acceptable solution — native
- SP 1.5 Identify Inconsistencies between Project Work and Requirements — Enabling

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Requirements Development

Supportive

SG 1 Develop Customer Requirements — Enabling

- SP 1.1 Elicit Needs — Enabling
- SP 1.2 Develop the Customer Requirements — Enabling

SG 2 Develop Product Requirements — Enabling

- SP 2.1 Establish Product and Product-Component Requirements
  - "Fuzzy set" at "SW system" level
  - Prioritize at iteration level (by technical challenge, importance, functional precedence
  - Validate only those accepted into interations
- SP 2.2 Allocate Product-Component Requirements — Enabling
- SP 2.3 Identify Interface Requirements — Enabling

SG 3 Analyze and Validate Requirements — Supportive

- SP 3.1 Establish Operational Concepts and Scenarios — Enabling
- SP 3.2 Establish a Definition of Required Functionality
  - Much less functional analysis needed
  - What is done is at a much higher level of abstraction
- SP 3.3 Analyze Requirements — Enabling
- SP 3.4 Analyze Requirements to Achieve Balance — Enabling
- SP 3.5 Validate Requirements with Comprehensive Methods — Enabling

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Technical Solution

Supportive

Informative elements imply
Full-design-before-coding

SG 1	Select Product-Component Solutions	Supportive	
	SP 1.1	Develop Detailed Alternative Solutions and Selection Criteria	Supportive
	SP 1.2	Evolve Operational Concepts and Scenarios	Supportive
	SP 1.3	Select Product-Component Solutions	Supportive
SG 2	Develop the Design	Supportive	
	SP 2.1	Design the Product or Product Component	Supportive
	SP 2.2	Establish a Technical Data Package	Supportive
	SP 2.3	Design Interfaces Using Criteria	Supportive
	SP 2.4	Perform Make, Buy, or Reuse Analyses	Supportive
SG 3	Implement the Product Design	Supportive	
	SP 3.1	Implement the Design	Supportive
	SP 3.2	Develop Product Support Documentation	Supportive

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Product Integration

Supportive

Informative elements are based on a systems approach that appears somewhat biased against agile/lean

SG 1	Prepare for Product Integration	Supportive
SP 1.1	Determine Integration Sequence	Supportive
SP 1.2	Establish the Product Integration Environment	Supportive
SP 1.3	Establish Product Integration Procedures and Criteria	Supportive
SG 2	Ensure Interface Compatibility	Supportive
SP 2.1	Review Interface Descriptions for Completeness	Supportive
SP 2.2	Manage Interfaces	Supportive
SG 3	Assemble Product Components and Deliver the Product	Supportive
SP 3.1	Confirm Readiness of Product Components for Integration	Supportive
SP 3.2	Assemble Product Components	Supportive
SP 3.3	Evaluate Assembled Product Components	Supportive
SP 3.4	Package and Deliver the Product or Product Component	Supportive

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Verification

SG1: Preparation for verification is conducted.
SG2: Peer reviews are performed on selected work products.
SG3: Selected work products are verified against their specified requirements.

- What work products? How are they verified?
- Suppose
  - We only verify software (and hardware, and their integration) with tests … good enough?
  - The entire team participates in
    - Defining features (requirements), and then …
    - Creating the initial design in "whiteboard UML" …

  Does that verify design against its requirements?

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Verification

Acceptable

In general, informative elements Imply highle detailed data and plan-rich verification activities

SG 1	Prepare for Verification	Enabling
SP 1.1	Select Work Products for Verification	Enabling
SP 1.2	Establish the Verification Environment	Enabling
SP 1.3	Establish Verification Procedures and Criteria	Enabling
SG 2	Perform Peer Reviews	Acceptable
SP 2.1	Prepare for Peer Reviews	Supportive
SP 2.2	Conduct Peer Reviews	Alternative
SP 2.3	Analyze Peer Review Data	Alternative
SG 3	Verify Selected Work Products	Acceptable
SP 3.1	Perform Verification	Supportive
SP 3.2	Analyze Verification Results and Identify Corrective Action	Alternative

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Validation

Acceptable

SG 1 Prepare for Validation — Enabling

- SP 1.1 Select Products for Validation — Enabling
- SP 1.2 Establish the Validation Environment — Enabling
- SP 1.3 Establish Validation Procedures and Criteria — Enabling

SG 2 Validate Product or Product Components — Acceptable

- SP 2.1 Perform Validation — Supportive
- SP 2.2 Analyze Validation Results — Alternative

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Summary Valuation for Engineering

	Acceptable	Supportive	Supportive	Supportive	Acceptable	Acceptable
	REQM	RD	TS	PI	VER	VAL
SG 1	Acceptable	Enabling	Supportive	Supportive	Enabling	Enabling
SG 2		Enabling	Supportive	Supportive	Acceptable	Acceptable
SG 3		Supportive	Supportive	Supportive	Acceptable	

Process Area Valuation Approach

- **Goal Level Insufficiency** — Unacceptable
  - Goals do not allow or support conduct of accepted lean/agile practices
- **Goal Level Sufficiency**: — Acceptable
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Engineering Support

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Configuration Management

✓ SG 1 Baselines of identified work products are established.
✓ SG 2 Changes to the work products under CM are tracked and controlled.
✓ SG 3 Integrity of baselines is established and maintained.
? SP 3.2 Perform configuration audits to maintain integrity of the configuration baselines.

- Good match to goals, but what about CM audits practice?
- Agile/Lean preference
  - Automated controls (check-in, nightly build/test)
  - Peer pressure to enforce practices (audits are expensive)
  - Communication supported by “barely sufficient” and non-definitive documents (agile modeling)
- Good enough for software artifacts?
- But audits still necessary for large, distributed teams?
  - More communication by documentation

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Configuration Management

By our definitions, these practices are enabling However, information elements to encourage agile, focused, lean CM are not present

SG 1	Establish Baselines	Enabling
SP 1.1	Identify Configuration Items	Enabling
SP 1.2	Establish a Configuration Management System	Enabling
SP 1.3	Create or Release Baselines	Enabling
SG 2	Track and Control Changes	Enabling
SP 2.1	Track Change Requests	Enabling
SP 2.2	Control Configuration Items	Enabling
SG 3	Establish Integrity	Enabling
SP 3.1	Establish Configuration Management Records	Enabling
SP 3.2	Perform Configuration Audits	Enabling

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Process and Product Quality Assurance

By our definitions, these practices are enabling However, information elements to encourage agile, focused, lean evaluation practices are not present

Acceptable

SG 1 Objectively Evaluate Processes and Work Products — Enabling

- SP 1.1 Objectively Evaluate Processes — Enabling
- SP 1.2 Objectively Evaluate Work Products and Services — Enabling

Both the practices and the information elements imply systemic, plan-based, monolithic resolution of problems

- SG 2 Provide Objective Insight — Acceptable
  - SP 2.1 Communicate and Ensure Resolution of Noncompliance Issues — Alternative
  - SP 2.2 Establish Records — Alternative

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Measurement and Analysis

Supportive

SG 1 Align Measurement and Analysis Activities

Emphasis on voluminous metric data
Seems moot on all but large and complex programs

- SP 1.1 Establish Measurement Objectives — Enabling
- SP 1.2 Specify Measures — Enabling
- SP 1.3 Specify Data Collection and Storage Procedures — Supportive
- SP 1.4 Specify Analysis Procedures — Supportive

SG 2 Provide Measurement Results — Enabling

- SP 2.1 Collect Measurement Data — Enabling
- SP 2.2 Analyze Measurement Data — Enabling
- SP 2.3 Store Data and Results — Enabling
- SP 2.4 Communicate Results — Enabling

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Decision Analysis and Resolution

Enabling

SG 1	Evaluate Alternatives	Enabling
SP 1.1	Establish Guidelines for Decision Analysis	Enabling
SP 1.2	Establish Evaluation Criteria	Enabling
SP 1.3	Identify Alternative Solutions	Enabling
SP 1.4	Select Evaluation Methods	Enabling
SP 1.5	Evaluate Alternatives	Enabling
SP 1.6	Select Solutions	Enabling

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Organizational Environment for Integration

Enabling

SG 1	Evaluate Alternatives	Enabling
SP 1.1	Establish Guidelines for Decision Analysis	Enabling
SP 1.2	Establish Evaluation Criteria	Enabling
SP 1.3	Identify Alternative Solutions	Enabling
SP 1.4	Select Evaluation Methods	Enabling
SP 1.5	Evaluate Alternatives	Enabling
SP 1.6	Select Solutions	Enabling

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Causal Analysis and Resolution

Enabling

SG 1	Determine Causes of Defects	Enabling
SP 1.1	Select Defect Data for Analysis	Enabling
SP 1.2	Analyze Causes	Enabling
SG 2	Address Causes of Defects	Enabling
SP 2.1	Implement the Action Proposals	Enabling
SP 2.2	Evaluate the Effect of Changes	Enabling
SP 2.3	Record Data	Enabling

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Summary Valuation for Engineering Support

	Enabling	Acceptable	Supportive	Enabling	Enabling	Enabling
	CM	PPQA	MA	DAR	OEI	CAR
SG 1	Enabling	Enabling	Supportive	Enabling	Enabling	Enabling
SG 2	Enabling	Acceptable	Enabling		Enabling	Enabling
SG 3	Enabling					

Process Area Valuation Approach

- **Goal Level Insufficiency** — Unacceptable
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Process Management

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Organizational Process Focus

By our definitions, these practices are enabling However, information elements to encourage agile, focused, lean and rapid process improvement are not present

SG 1 Determine Process-Improvement Opportunities — Enabling

- SP 1.1 Establish Organizational Process Needs — Enabling
- SP 1.2 Appraise the Organization's Processes — Enabling
- SP 1.3 Identify the Organization's Process Improvements — Enabling

SG 2 Plan and Implement Process-Improvement Activities — Supportive

- SP 2.1 Establish Process Action Plans — Supportive
  Informative elements are contrary to rapid continuous improvement
- SP 2.2 Implement Process Action Plans — Enabling
- SP 2.3 Deploy Organizational Process Assets — Enabling
- SP 2.4 Incorporate Process-Related Experiences into the Organizational Process Assets — Enabling

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Organizational Process Definition

Supportive

SG 1 Establish Organizational Process Assets — Supportive

- SP 1.1 Establish Standard Processes — Enabling
- SP 1.2 Establish Life-Cycle Model Descriptions — Life cycle informative elements are not all helpful in agile/lean efforts
- SP 1.3 Establish Tailoring Criteria and Guidelines — Informative elements are too focused on systemic tailoring
- SP 1.4 Establish the Organization's Measurement Repository — Enabling
- SP 1.5 Establish the Organization's Process Asset Library — Enabling

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Organizational Training

Although these are all rated as enabling, informative elements that support the identification and application of tacit knowledge are missing

SG 1	Establish an Organizational Training Capability	Enabling
SP 1.1	Establish the Strategic Training Needs	Enabling
SP 1.2	Determine Which Training Needs Are the Responsibility of the Organization	Enabling
SP 1.3	Establish an Organizational Training Tactical Plan	Enabling
SP 1.4	Establish Training Capability	Enabling
SG 2	Provide Necessary Training	Enabling
SP 2.1	Deliver Training	Enabling
SP 2.2	Establish Training Records	Enabling
SP 2.3	Assess Training Effectiveness	Enabling

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Organizational Process Performance

Enabling

SG 1	Establish Performance Baselines and Models	Enabling
SP 1.1	Select Processes	Enabling
SP 1.2	Establish Process Performance Measures	Enabling
SP 1.3	Establish Quality and Process-Performance Objectives	Enabling
SP 1.4	Establish Process Performance Baselines	Enabling
SP 1.5	Establish Process Performance Models	Enabling

Although these are all rated as enabling, elements such as improvement of skills-based teams with highly developed tacit knowledge are missing

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Organizational Innovation and Deployment

Enabling

SG 1	Select Improvements	Enabling
SP 1.1	Collect and Analyze Improvement Proposals	Enabling
SP 1.2	Identify and Analyze Innovations	Enabling
SP 1.3	Pilot Improvements	Enabling
SP 1.4	Select Improvements for Deployment	Enabling
SG 2	Deploy Improvements	Enabling
SP 2.1	Plan the Deployment	Enabling
SP 2.2	Manage the Deployment	Enabling
SP 2.3	Measure Improvement Effects	Enabling

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Summary Valuation for Process Management

	Supportive	Supportive	Enabling	Enabling	Enabling
	OPF	OPD	OT	OPP	OID
SG 1	Enabling	Supportive	Enabling	Enabling	Enabling
SG 2	Supportive		Enabling	Enabling	Enabling

Process Area Valuation Approach

- **Goal Level Insufficiency** — Unacceptable
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Summary of Ratings

Project Management

	PP	PMC	SAM	IPM	RSKM	IT	ISM	QPM
	Acceptable	Supportive	Enabling	Supportive	Enabling	Enabling	Enabling	Acceptable
SG 1	Acceptable	Supportive	Enabling	Supportive	Enabling	Enabling	Enabling	Acceptable
SG 2	Supportive	Enabling	Enabling	Enabling	Enabling	Enabling	Enabling	Supportive
SG 3	Acceptable			Enabling	Enabling	Enabling	Enabling	
SG 4				Enabling				

Engineering

	REQM	RD	TS	PI	VER	VAL
	Acceptable	Supportive	Supportive	Supportive	Acceptable	Acceptable
SG 1	Acceptable	Enabling	Supportive	Supportive	Enabling	Enabling
SG 2		Enabling	Supportive	Supportive	Acceptable	Acceptable
SG 3		Supportive	Supportive	Supportive	Acceptable	

Engineering Support

	CM	PPQA	MA	DAR	OEI	CAR
	Enabling	Acceptable	Supportive	Enabling	Enabling	Enabling
SG 1	Enabling	Enabling	Supportive	Enabling	Enabling	Enabling
SG 2	Enabling	Acceptable	Enabling		Enabling	Enabling
SG 3	Enabling					

Process Management

	OPF	OPD	OT	OPP	OID
	Supportive	Supportive	Enabling	Enabling	Enabling
SG 1	Enabling	Supportive	Enabling	Enabling	Enabling
SG 2	Supportive		Enabling	Enabling	Enabling

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Generic Practices

- ***GP 1.1 Perform the base practices of the process area to develop work products and provide services to achieve the specific goals of the process area.***
- ***GP 2.1 Establish and maintain an organizational policy for planning and performing the process.***
- ***GP 2.2 Establish and maintain the plan for performing the process.***

  GP 2.2 A plan for performing the process will have to be intelligently applied to avoid undue burden on agile/lean processes
- ***GP 2.3 Provide adequate resources for performing the process, developing the work products, and providing the services of the process.***
- ***GP 2.4 Assign responsibility and authority for performing the process, developing the work products, and providing the services of the process.***
- ***GP 2.5 Train the people performing or supporting the process as needed.***

  GP 2.5 Training of agile/lean teams and team members should take advantage of continuous project/ organizational learning mechanisms – and support the building and extension of tacit knowledge and advanced skill sets.
- ***GP 2.6 Place designated work products of the process under appropriate levels of configuration management.***

  GP 2.6 Judicious choice of what work products to place under CM. In addition, CM practices must be agile.
- ***GP 2.7 Identify and involve the relevant stakeholders as planned.***
- ***GP 2.8 Monitor and control the process against the plan for performing the process and take appropriate corrective action.***

  GP 2.8 Careful selection and definition of processes should make this GP helpful.
- ***GP 2.9 Objectively evaluate adherence of the process against its process description, standards, and procedures, and address noncompliance.***

  GP 2.9 QA of processes is helpful- if the processes are agile/lean- and the practice of QA is agile as well.
- ***GP 2.10 Review the activities, status, and results of the process with higher level management and resolve issues.***

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Generic Practices

- ***GP 3.1 Establish and maintain the description of a defined process.***
- ***GP 3.2 Collect work products, measures, measurement results, and improvement information derived from planning and performing the process to support the future use and improvement of the organization's processes and process assets.***

  GP 3.2 Care must be taken in the application of this GP in agile/lean environments. Process must be carefully selected and made lean. Support of "future use" must be immediate, to the project itself as well as other projects.
- ***GP 4.1 Establish and maintain quantitative objectives for the process that address quality and process performance based on customer needs and business objectives.***
- ***GP 4.2 Stabilize the performance of one or more subprocesses to determine the ability of the process to achieve the established quantitative quality and process-performance objectives.***

  GP 4.2 As previously discussed, selection of processes to stabilize must be done with great care, as some agile/lean process are necessarily uncontrolled.
- ***GP 5.1 Ensure continuous improvement of the process in fulfilling the relevant business objectives of the organization.***
- ***GP 5.2 Identify and correct the root causes of defects and other problems in the process.***

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Conclusions

- Define the problem and set the context
- Review concepts of agile development
- Review concepts of lean software development
- Investigate applicability and usefulness of CMMI® model suite in agile/lean development efforts
- **Develop summary conclusions**

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CMMI Interpretation—Bottom Line

- Primarily focused on processes and practices
- Largely ignores human aspects of (exc. IT, OEI)
  - Knowledge acquisition
  - Collaboration
- Thorough and systemic treatment of
  - Technologies
  - Informational elements and relationships
  - (Very) early "full" development of requirements
- Structure of required, expected, and information elements provides a great deal of flexibility

Does CMMI Model suite ALLOW agile/lean dev?
YES

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Value Added From CMMI

- Decision Analysis and Resolution is a counterpoint to agile bias toward “resolve by building”
- Organizational improvement beyond the project team (Organizational Environment for Integration, Training, Process Focus and Definition, Innovation and Deployment, and Process Performance)
- Hardware awareness—agile/lean ignore coordinating long-lead time efforts (Product Integration)
- Supplier interactions (ISM, SAM)
  - But note relevant agile/lean ideas
- Integrated Teaming and Organizational Environment for Integration are significant enablers for agile/lean efforts
- Robust set of practices ensures most are addressed in agile/lean efforts (where tendency may be to ignore or lessen effectiveness)

Thus, CMMI tends to reduce risk in agile/lean development

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Value Added from Lean and Agile

- Iteration release rather than phased development
- Value of fast as possible production, work flow, and minimal Work In Progress
- Testing and continuous integration as essential drivers for implementation (and testing interleaved with other development activities)
- Waste reduction as a goal—testing and pair development as cost-effective options to inspection and review
- "Last responsible moment" decisions, options thinking, and incremental commitment [Gilb]
- Focus and synergy of technical leadership and technical management—practical concepts for engaging developers through empowerment
- Recognition and effective use of advanced skill sets

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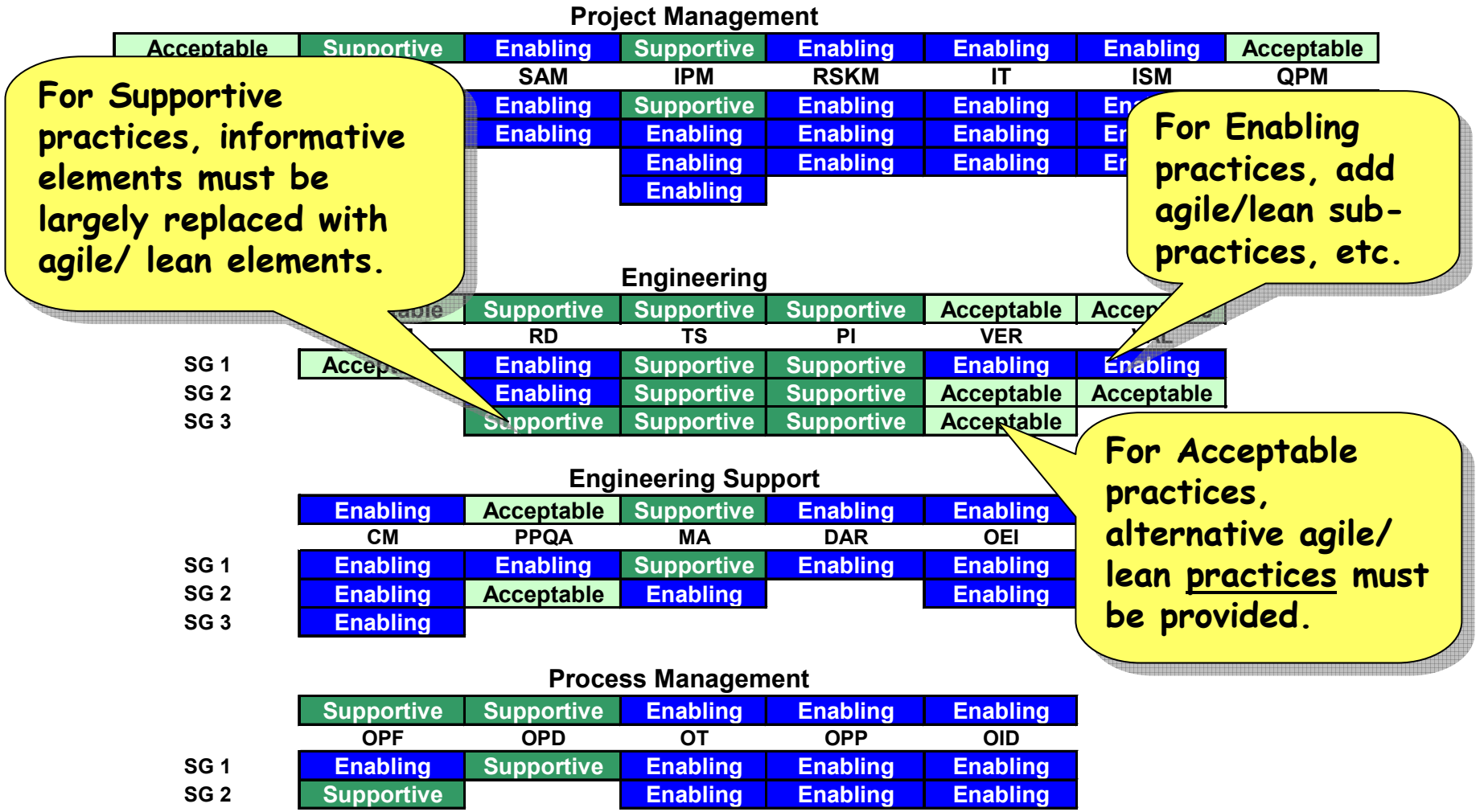
To Apply CMMI in Agile/Lean Environments



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Workshop Discussion

Review CMMI® issues charts for closure.

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A Practical Guide to Implementing Levels 4 and 5

CMMI Technology Conference & User Group
14-17 November 2005

Rick Hefner, Ph.D.
Northrop Grumman Corporation

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Agenda

- **An Overview of Levels 4 and 5**
  - New Behaviors
  - Benefits – Project, Organizational, Customer
  - Making the Business Case
- **Understanding the CMMI Process Areas**
  - Organizational Process Performance
  - Quantitative Project Management
  - Causal Analysis & Resolution
  - Organizational Innovation & Deployment
- **Strategies for Adoption**
  - Lessons Learned
  - Links to Six Sigma

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Management Styles in the CMMI

Project

Organizational

Predictive Management

Proactive management

Reactive mgmt. (plan, track, and correct)

Level	Process Areas
5 Optimizing	Causal Analysis and Resolution Organizational Innovation and Deployment
4 Quantitatively Managed	Quantitative Project Management Organizational Process Performance
3 Defined	Requirements Development Technical Solution Product Integration Verification Validation Organizational Process Focus Organizational Process Definition Organizational Training Risk Management Integrated Project Management (for IPPD*) Integrated Teaming* Integrated Supplier Management** Decision Analysis and Resolution Organizational Environment for Integration*
2 Managed	Requirements Management Project Planning Project Monitoring and Control Supplier Agreement Management Measurement and Analysis Process and Product Quality Assurance Configuration Management
1 Performed	

Quantitative improvement

Qualitative improvement

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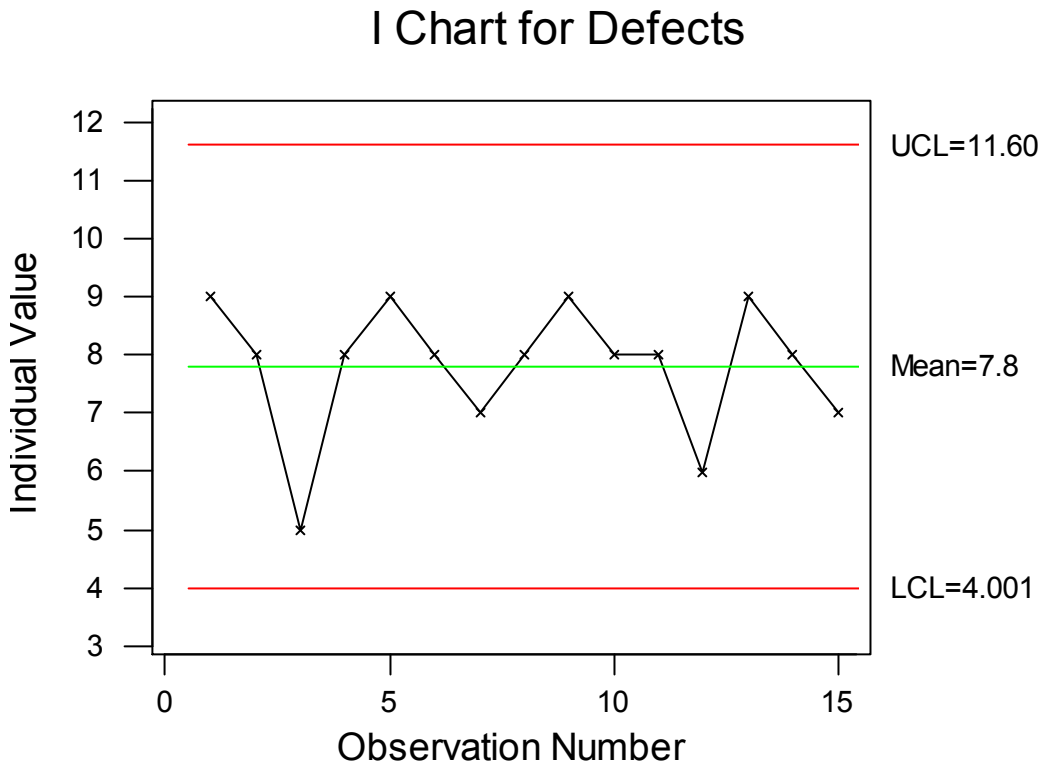
Exercise – What is Managing by Variation?

- **Suppose your project conducted several peer reviews of similar code, and analyzed the results**
  - Mean = 7.8 defects/KSLOC
  - +3σ = 11.60 defects/KSLOC
  - -3σ = 4.001 defects/KSLOC



- **What would you expect the next peer review to produce in terms of defects/KSLOC?**
- **What would you think if a review resulted in 11 defects/KSLOC?**
- **3 defects/KSLOC?**

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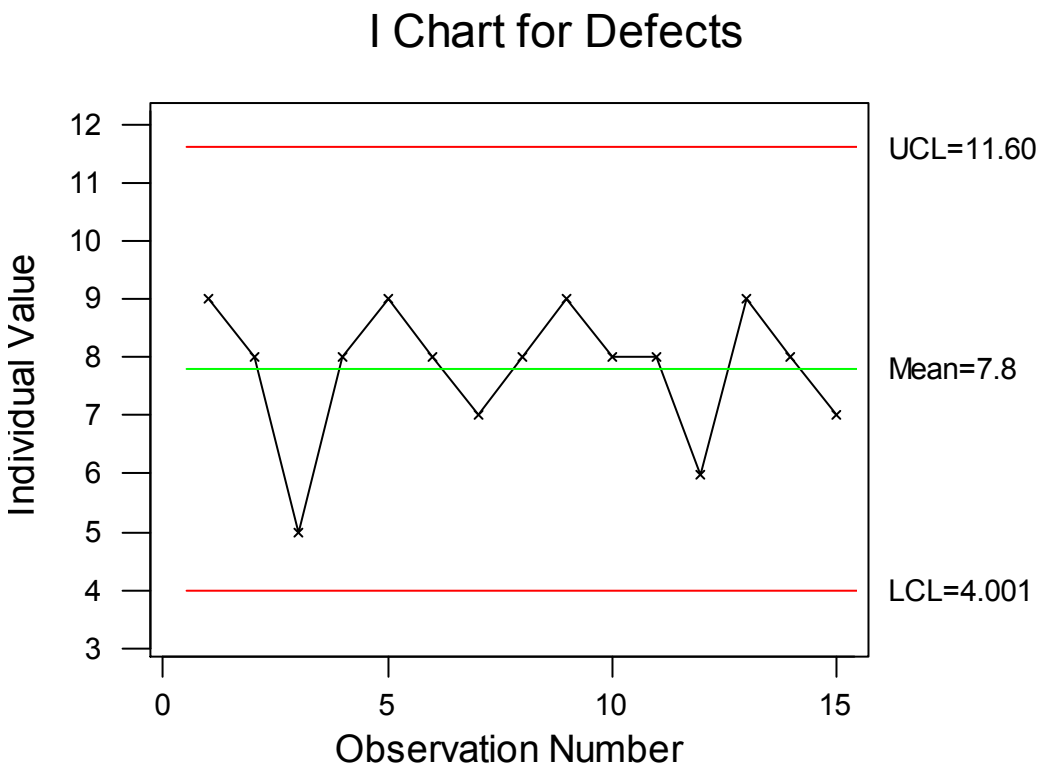
Exercise – What is Required to Manage by Variation?

- **What is needed to develop the statistical characterization of a process?**



- **The process has to be stable (predictable)**
  - Process must be consistently performed
  - Complex process may need to be stratified (separated into simpler processes)
- **There has to be enough data points to statistically characterize the process**
  - Processes must occur frequently within a similar context (project or organization)
  - May need to stratify the data

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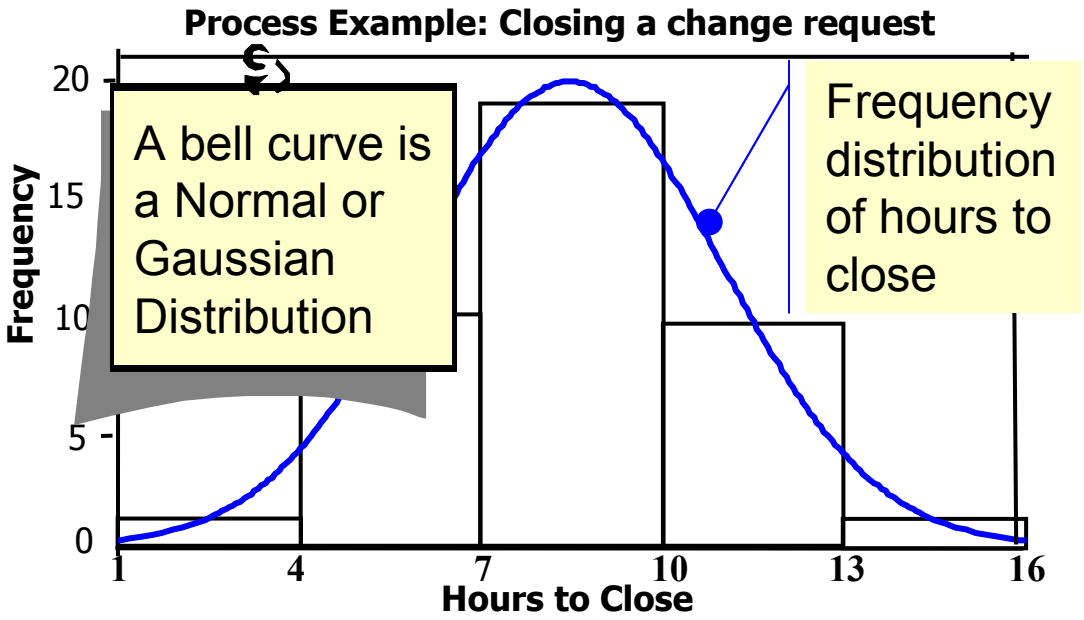
What Is a Data Distribution?



- The data distribution gives a frequency of occurrence of each value in a data set
- Once we characterize the data distribution, we can predict future values or assign a probability to any specific value
- Data distributions may represent population or process data
- When applied to process data - assumes statistical stability

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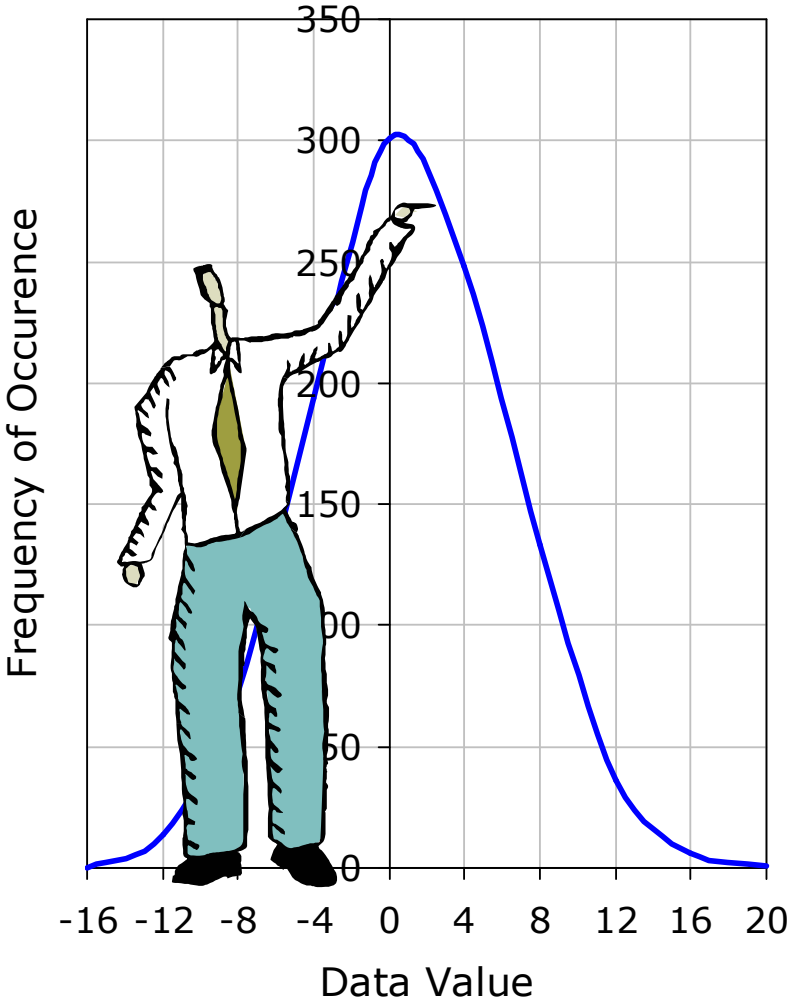
The Normal Distribution



- **Commonly called a bell curve; formally called a Gaussian distribution**
- **Applies to continuous data (e.g. time, weight, distance)**
- **Characteristic shape:**
  - Mean, mode, and median are all the same value
  - Standard deviation is independent of the mean
- **Normal distributions are not a law, but they are often observed in natural data**
  - Often the distribution of difference between plan and actual dates or budget versus actual

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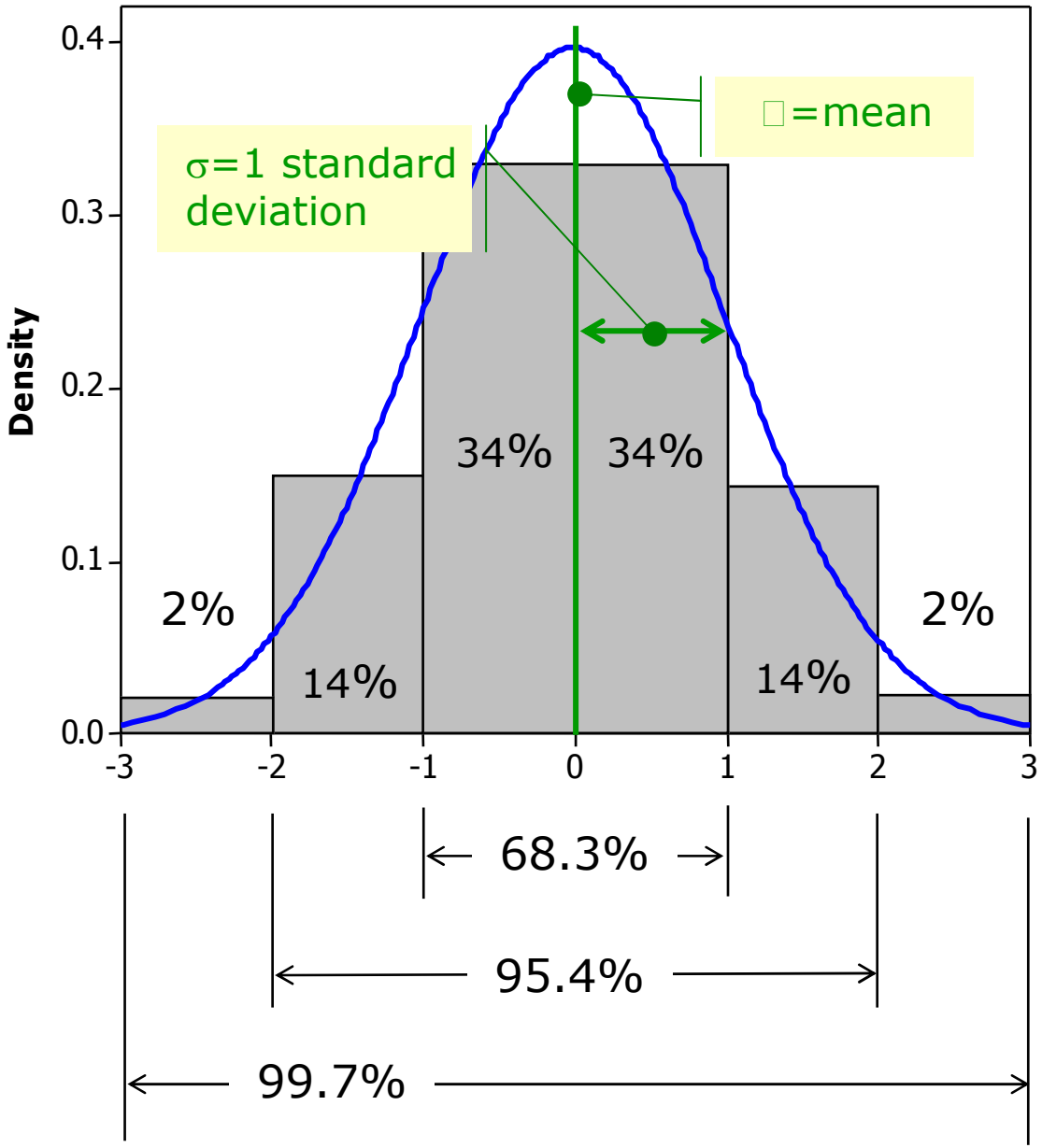
Characteristics of a Normal Curve



Once we understand what kind of distribution our data comes from, we can predict future values or assign a probability to any specific point

- **Probability x will occur**
- **Probability a value < x**
- **Probability a value > x**
- **Probability a value will occur between x and y**

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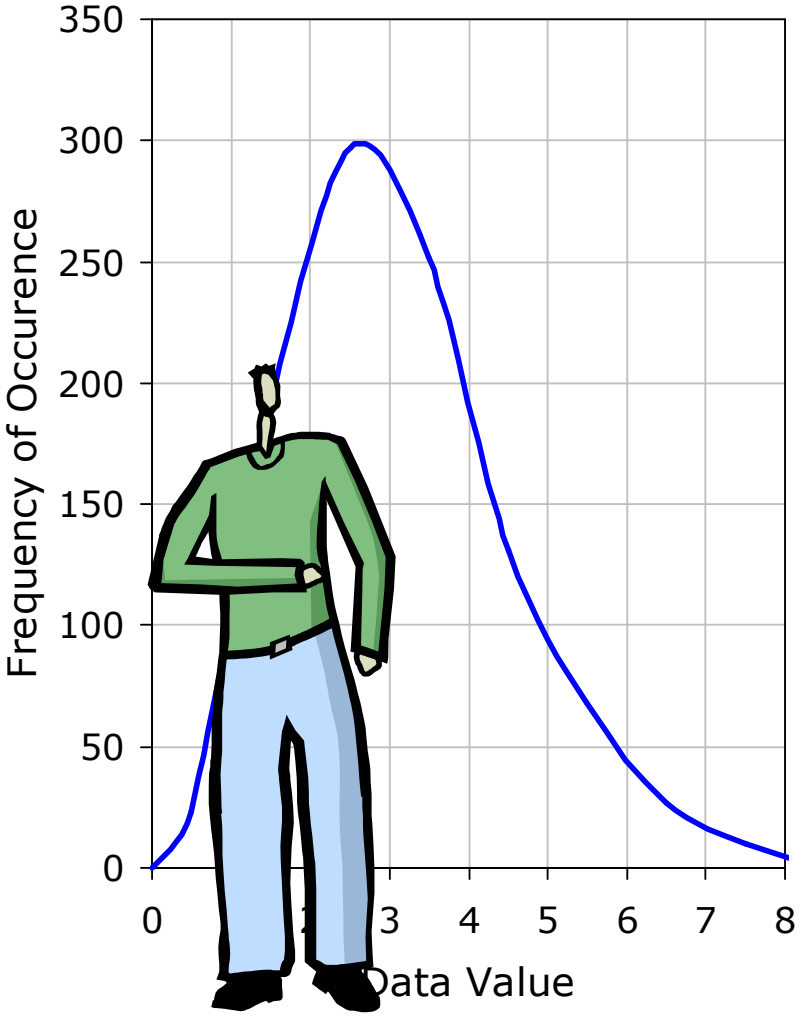
The Rayleigh Distribution…



- A skewed distribution
- Used to model effort or defect density in software development where the abscissa represents development phase if they are roughly the same duration
- Rayleigh distribution is a special case of the Weibull distribution

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What Is a Control Chart?

- A time-ordered plot of process data points with a centerline based on the average and control limits that bound the expected range of variation
- Control charts are one of the most useful quantitative tools for understanding variation

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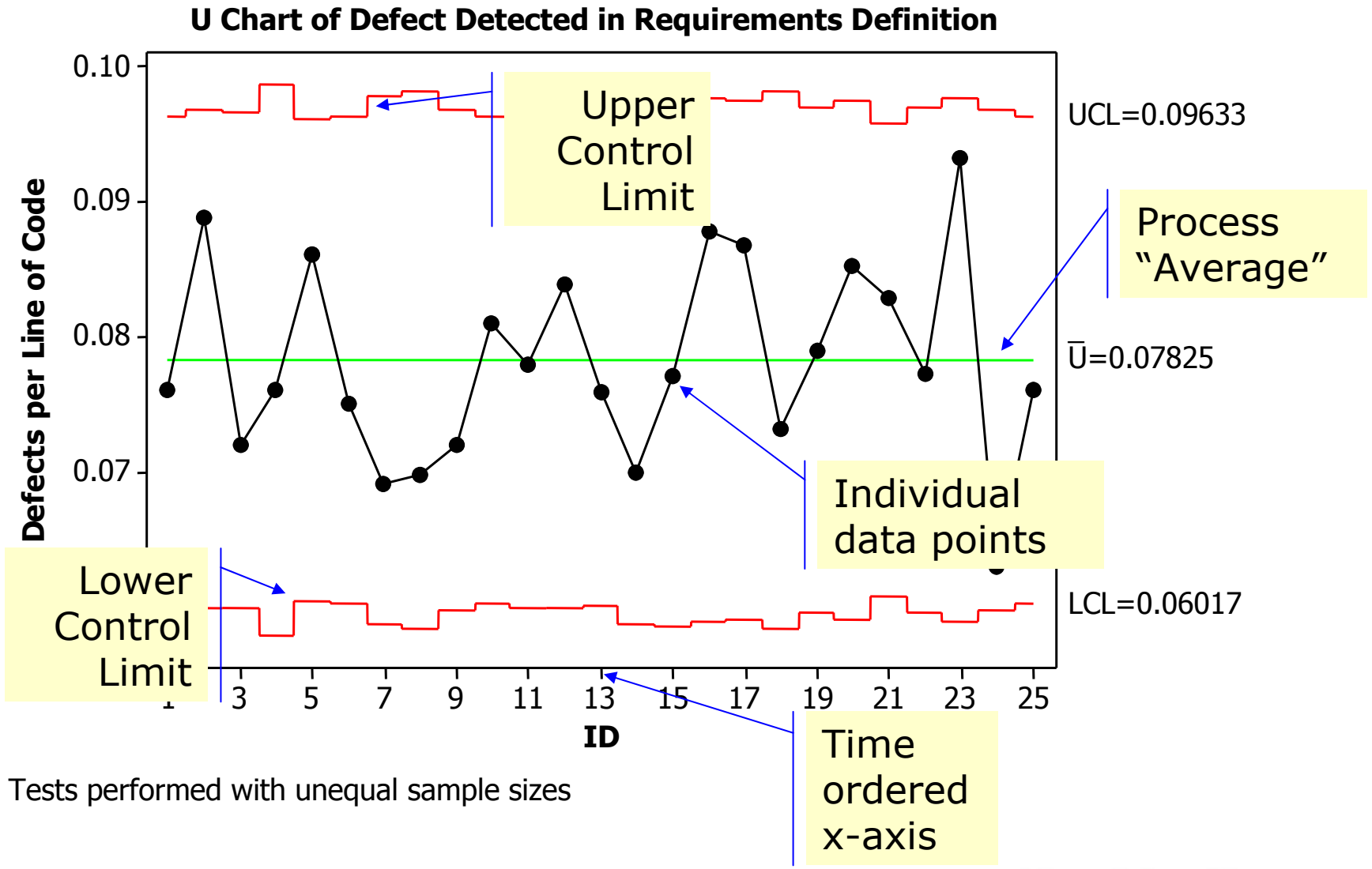
What Are the Key Features of a Control Chart?



Tests performed with unequal sample sizes

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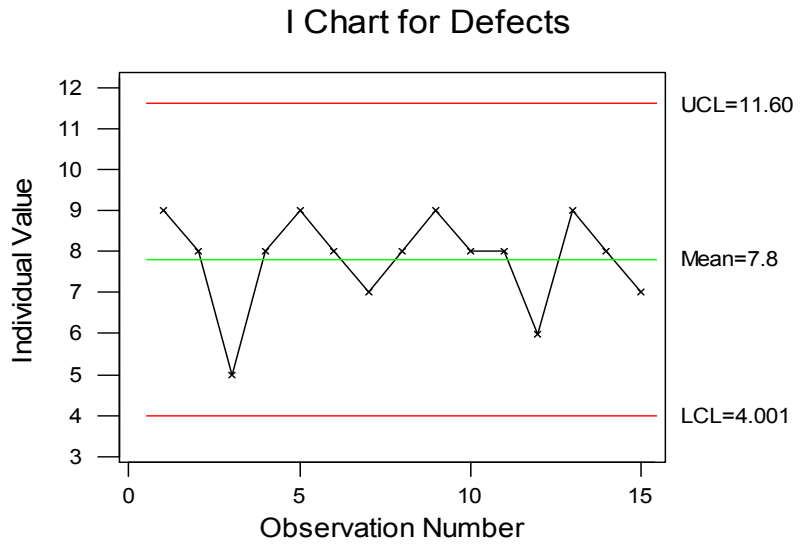
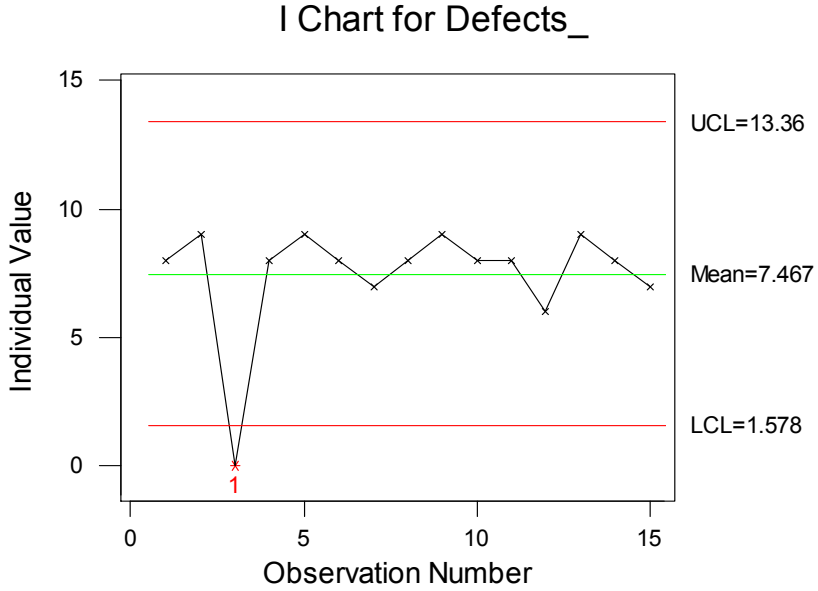
What is *Special Cause* and *Common Cause* Variation?



- **Common Cause Variation**
  - *Routine* variation that comes from within the process
  - Caused by the natural variation in the process
  - Predictable (stable) within a range



- **Special Cause Variation**
  - *Assignable* variation that comes from outside the process
  - Caused by a unexpected variation in the process
  - Unpredictable

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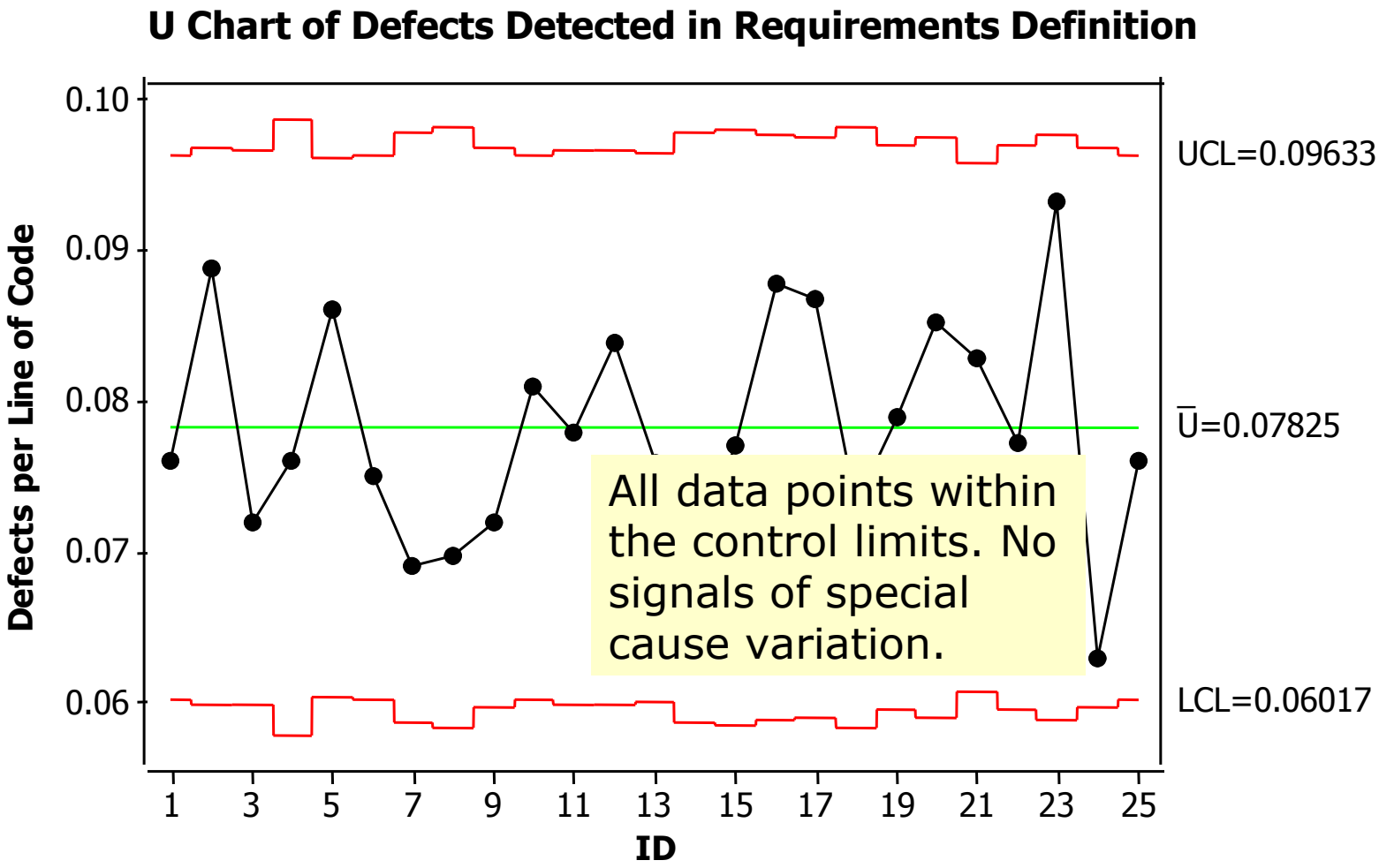
What Is a *Stable* Process?



Tests performed with unequal sample sizes

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Hearing Voices

- **Voice of the process = the natural bounds of process performance**
- **Voice of the customer = the goals established for the product and process performance**

Capable process = stable process + product conformance

- **Process capability may be determined for the**
  - Organization
  - Product line
  - Project
  - Individual
- **Typically, the higher the level of analysis, the greater the variation**

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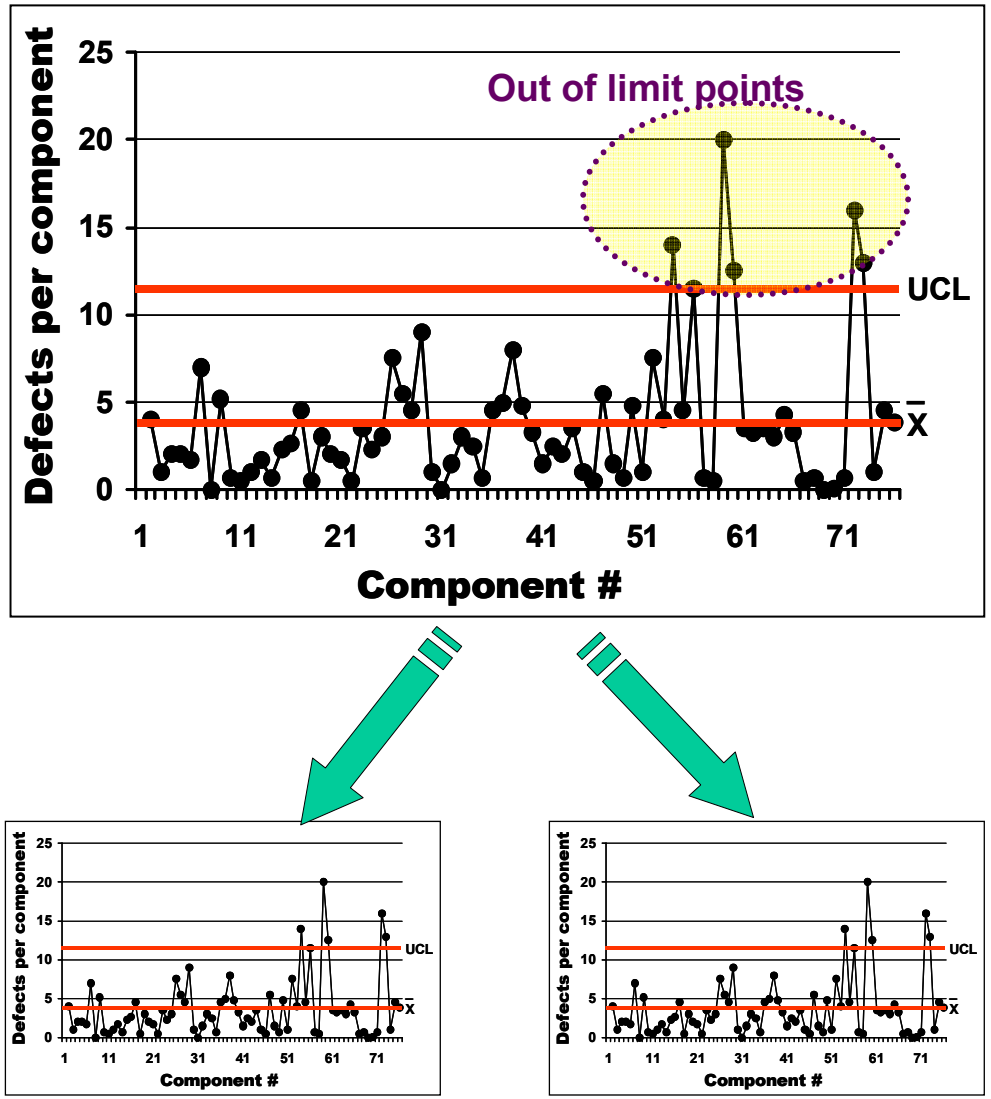
What if the Process Isn't Stable?

- **You may be able to explain out of limit points by observing that they are due to an variation in the process**
  - E.g., peer review held on Friday afternoon
  - You can eliminate the points from the data, if they are not part of the process you are trying to predict

- **You may be able to stratify the data by an attribute of the process or attribute of the corresponding work product**
  - E.g., different styles of peer reviews, peer reviews of different types of work products



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Common Challenges for Engineering

- Data are often discrete rather than continuous, e.g., defects
- Observations often are scarce
- Processes are aperiodic
- Size of the the object often varies, e.g., software module
- Data distributions may not be normal

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How Do I Address These Challenges?

- Employ control chart types that specifically deal with discrete data distributions, e.g., *u*-charts and *p*-charts
- Use control charts that compensate for widely variable areas of opportunity
- Transform non-normal continuous data to normal data before constructing a control chart (Black Belt topic)
- Cross check control charts with hypothesis tests (later module) where few data points exist

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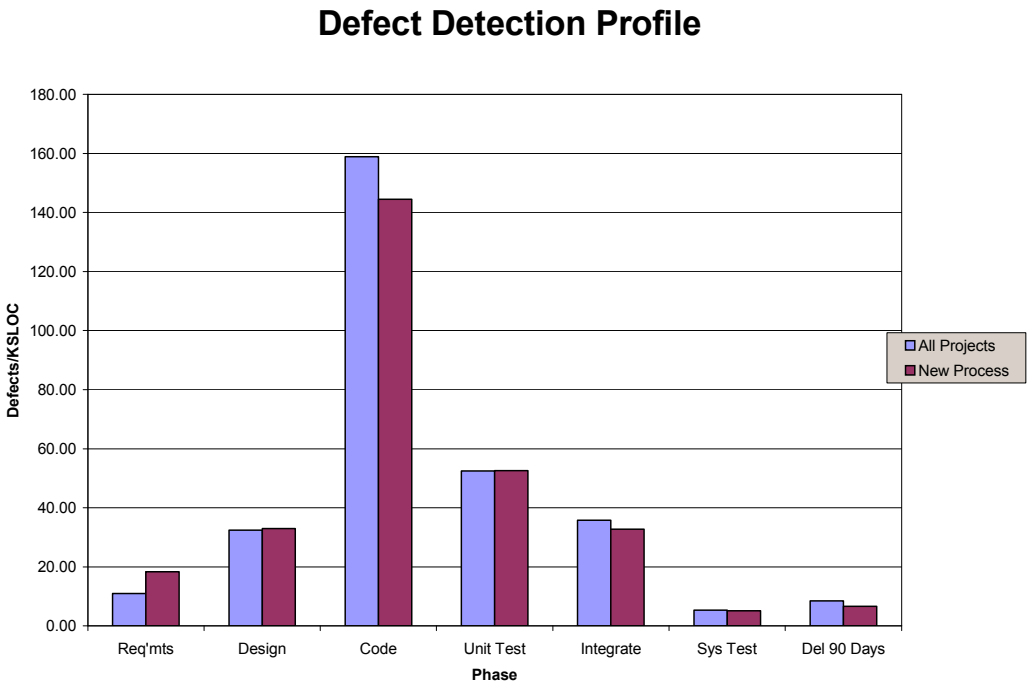
Typical Choices in Industry

- **Most customers care about:**
  - Delivered defects
  - Cost and schedule
- **So organizations try to predict:**
  - Defects found throughout the lifecycle
  - Effectiveness of peer reviews, testing
  - Cost achieved/actual (Cost Performance Index – CPI)
  - Schedule achieved/actual (Schedule Performance Index – SPI)



Process performance

- **Process measures** (e.g., effectiveness, efficiency, speed)
- **Product measures** (e.g., quality, defect density).

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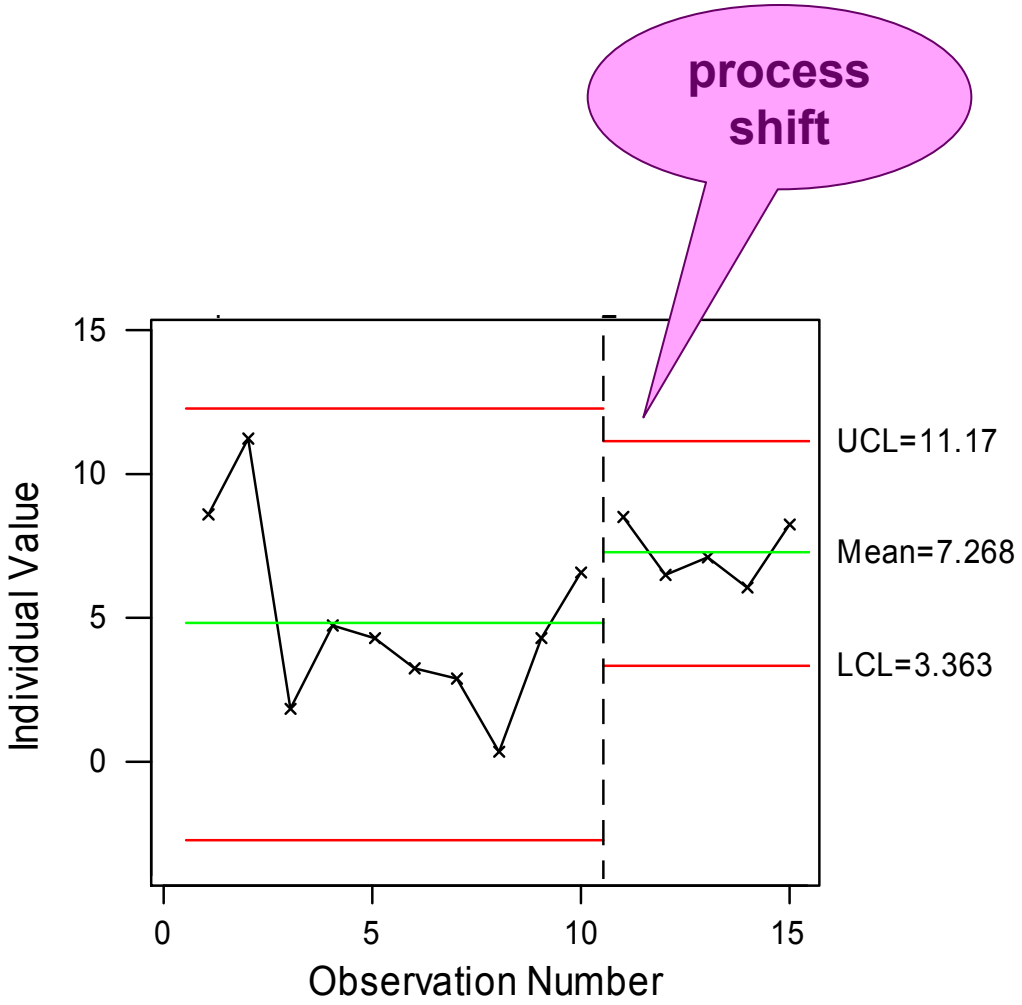
How Can High Maturity Help?

- **By measuring both the mean and variation, the project/ organization can assess the full impact of an "improvement"**
- **Can focus on reducing the variation (making the process more predictable)**
  - Train people on the process
  - Create procedures/checklists
  - Strengthen process audits
- **Can focus on increasing the mean (e.g., increase effectiveness, efficiency, etc.)**
  - Train people
  - Create checklists
  - Reduce waste and re-work
  - Replicate best practices from other projects
- **Can do both**



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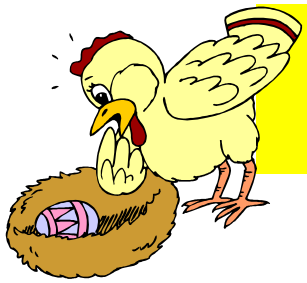
What Can a Level 4 Organization/Project Do?

- **Both can:**
  - Determine whether processes are behaving consistently or have stable trends (i.e., are predictable)
  - Eliminate special causes of variation
  - Identify processes that show unusual (e.g., unpredictable) behavior
  - Identify the implementation of a process which performs best
- **The organization can:**
  - Characterize the process performance of the organization's standard process
  - Develop models to predict process performance
- **The organization's projects can:**
  - Use this data to decide how to tailor the organization's standard process
  - Statistically manage selected subprocesses to achieve project quality and process objectives



Would your organization/projects find this valuable?

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What Does Level 5 Add?

Builds on Level 4 capabilities

Causal Analysis

- Both the project and organization can better determine cause and effect relationships
- This can be used to focus process improvements and preventive actions

Level 3

Organizational Process Focus

- Goals are qualitative (e.g., get better)
- The effects of the improvements are not estimated or measured

Level 5

Organizational Innovation & Deployment

- Goals are quantitative (e.g., reduce variation by X%, reduce mean by Y%)
- Incremental improvements
- Innovative improvements - cause a major shift in process capability
- Potential improvements are analyzed to estimate costs and impacts (benefits)
- Improvements are piloted to ensure success
- Improvements are measured in terms of variation and mean

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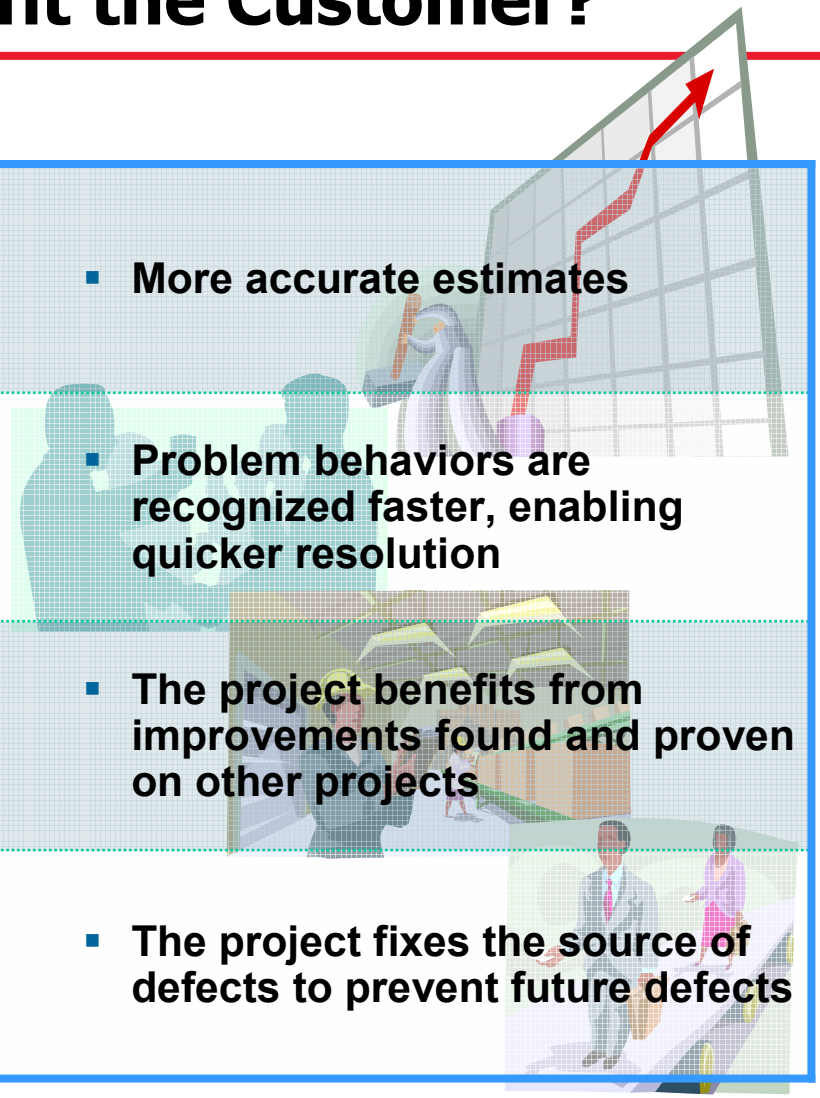
How Does Level 4 & 5 Benefit the Customer?

▪ Organizational process performance	▪ More accurate estimates
▪ Quantitative project management	▪ Problem behaviors are recognized faster, enabling quicker resolution
▪ Organizational innovation and deployment	▪ The project benefits from improvements found and proven on other projects
▪ Causal analysis	▪ The project fixes the source of defects to prevent future defects



Better Products and Services Produced Faster And Cheaper

"How Does How Does High Maturity Benefit the Customer", R. Hefner, Systems & Software Technology Conference,. 2005

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  - Causal Analysis & Resolution
  - Organizational Innovation & Deployment
- **Strategies for Adoption**
  - Lessons Learned
  - Links to Six Sigma

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The Project Manager's Dilemma at Level 3

I want to use the organization's standard process, but…

… Does it's performance and quality meet my customer's expectations?

… If not, how should I tailor the process?

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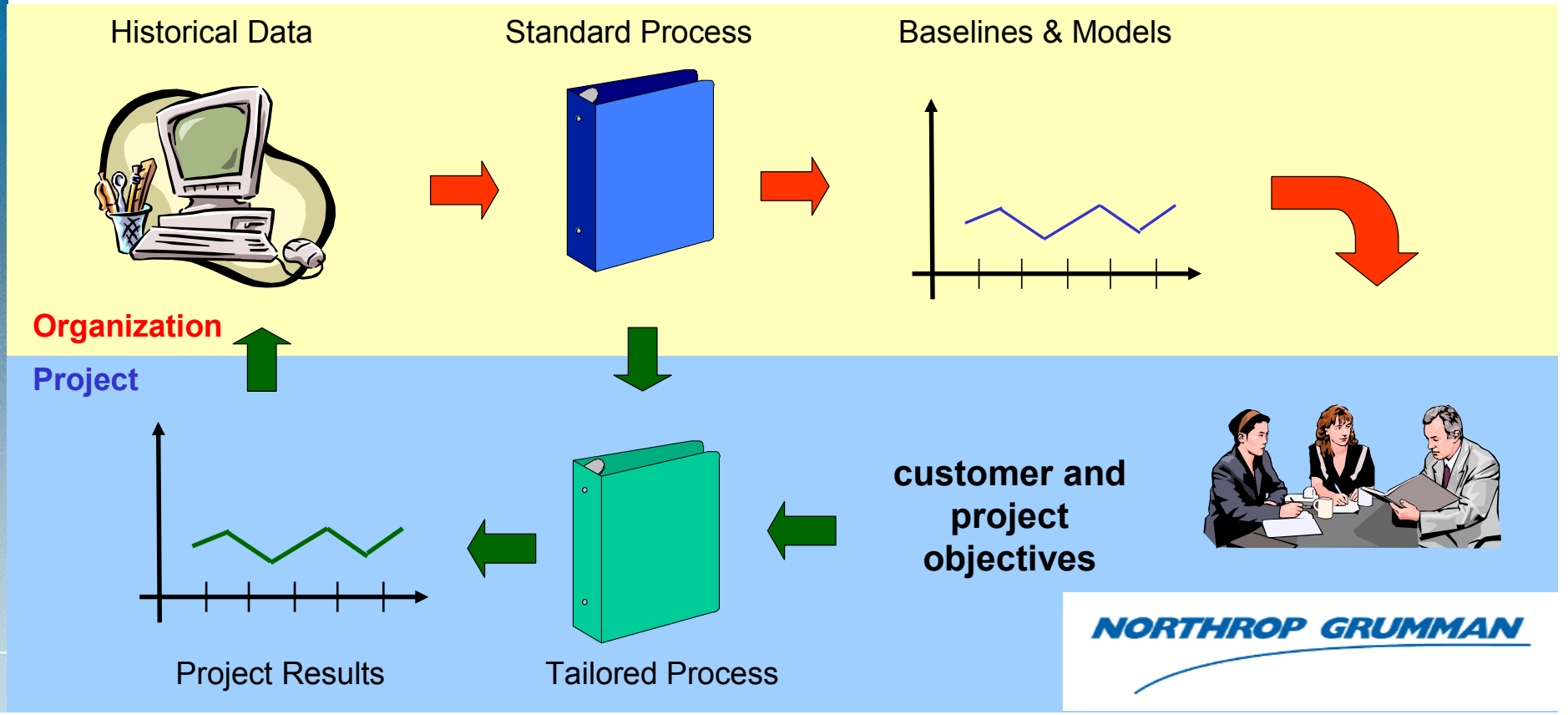
What Should the Organization Do to Help the Project Manager?

- Characterize the performance of the organization's standard process statistically
- Develop models to help a project manager determine the performance they would be likely to get by using the standard organizational process model, given their project's characteristics



Organizational Process Performance

SG 1 Establish Performance Baselines and Models

Baselines and models that characterize the expected process performance of the organization's set of standard processes are established and maintained.

SP 1.1 Select Processes

Select the processes or process elements in the organization's set of standard processes that are to be included in the organization's process performance analyses.

SP 1.2 Establish Process Performance Measures

Establish and maintain definitions of the measures that are to be included in the organization's process performance analyses.

SP 1.3 Establish Quality and Process-Performance Objectives

Establish and maintain quantitative objectives for quality and process performance for the organization.

SP 1.4 Establish Process Performance Baselines

Establish and maintain the organization's process performance baselines.

SP 1.5 Establish Process Performance Models

Establish and maintain the process performance models for the organization's set of standard processes.

Selected subprocesses, NOT the whole process

Objectives deal with eliminating sources of variation, not setting "stretch" goals

The organization meets these goals by modifying the standard process, not driving the projects

Baselines characterize the "voice of the process", based on the existing historical data

- What is the current mean and variation?

May need to subgroup the data

Models allow projects to estimate their quantitative performance based on the historical data of other projects executing the process

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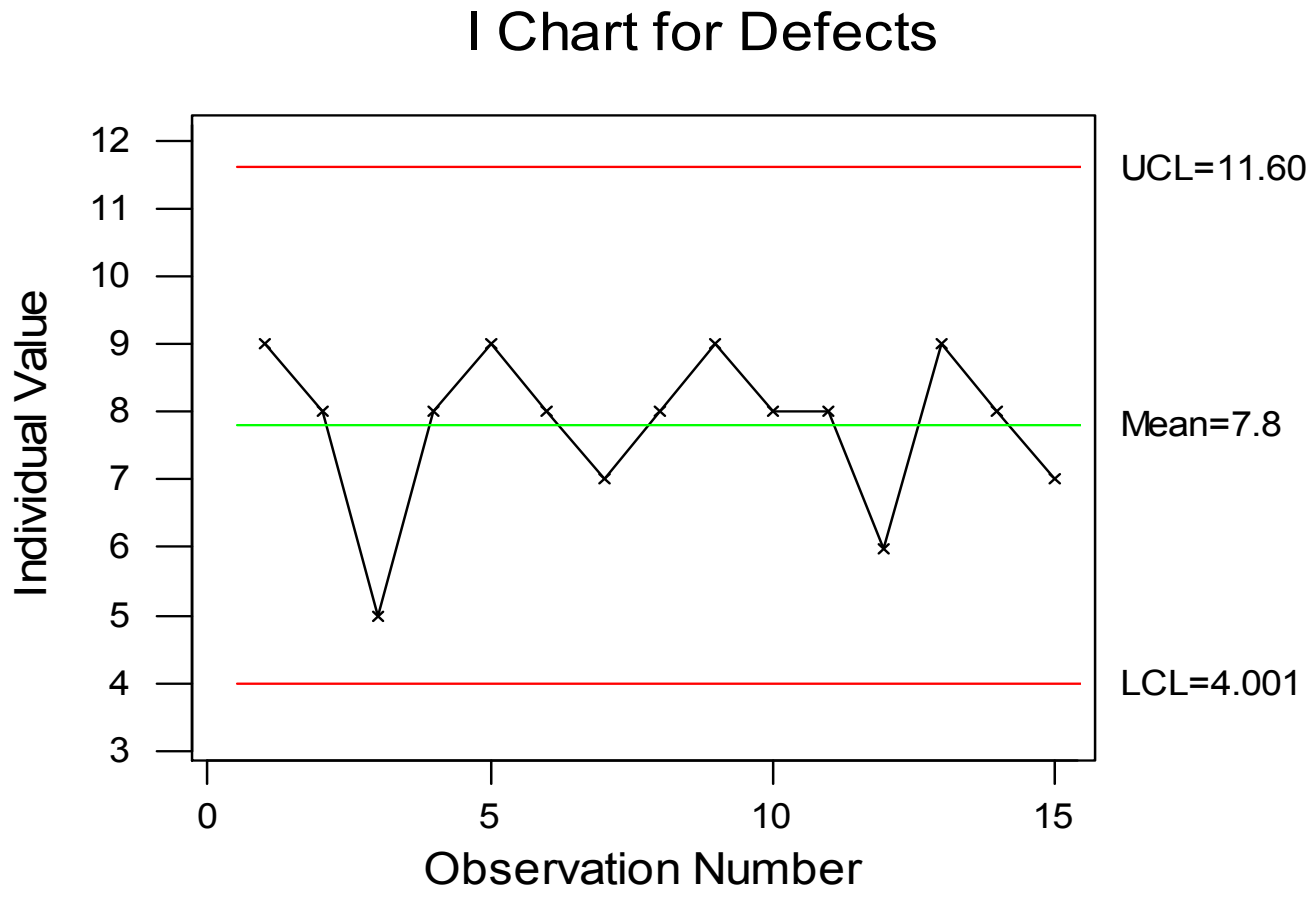
Quantitative Baselines and Models

- From this baseline (and model), what would you predict the next peer review to produce in terms of defects/KSLOC?
- What other models could be developed to help predict?



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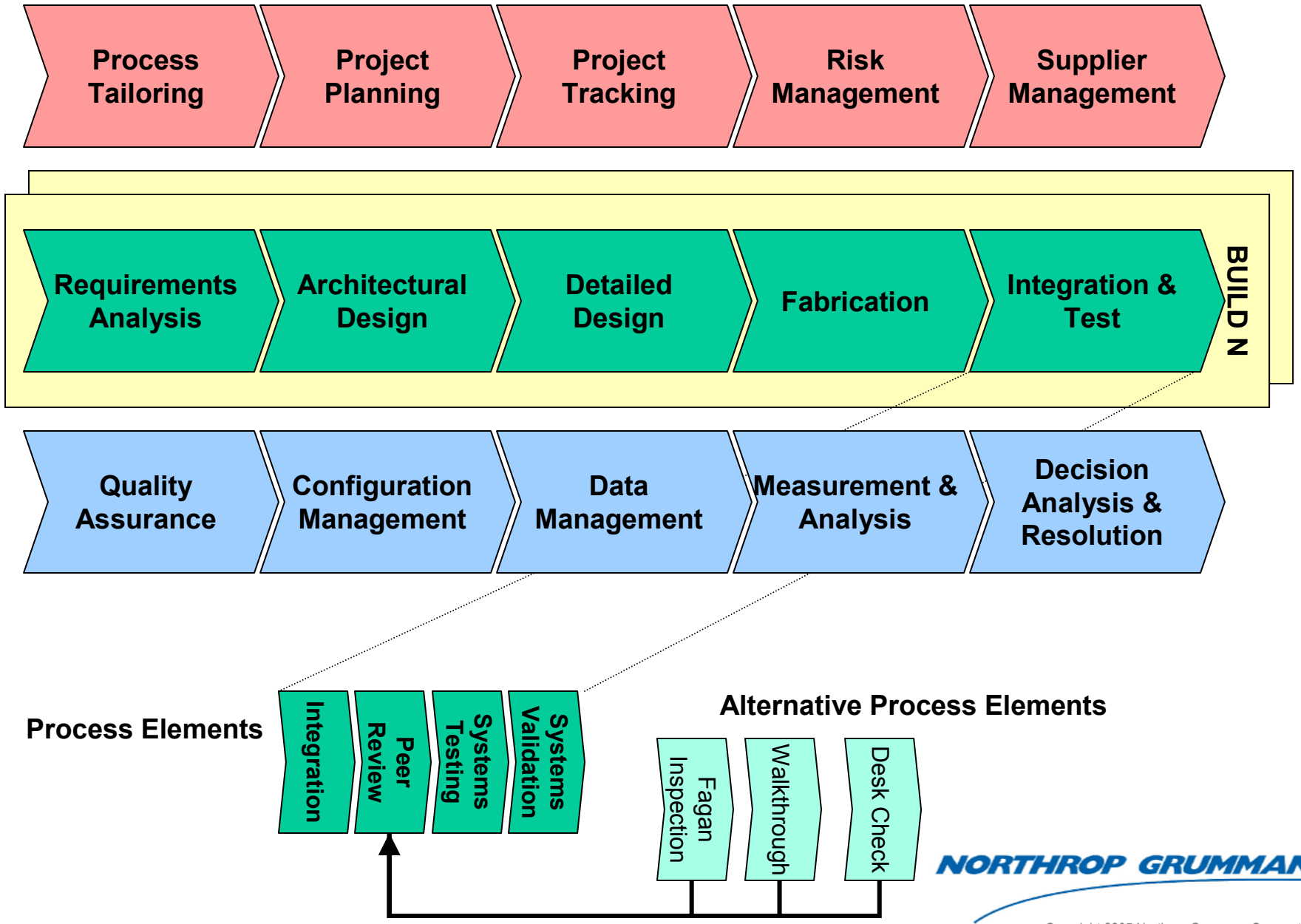
Process Architecture



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The Project Manager's Challenge at Level 4

I understand the capabilities of the organization's standard process, but…

… What are the project's quality and process performance objectives?

… How should I tailor the process?

… What project subprocesses do I need to quantitatively manage?

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Quantitative Project Management (Goal 1)

SG 1 Quantitatively Manage the Project

The project is quantitatively managed using quality and process-performance objectives.

SP 1.1 Establish the Project's Objectives

Establish and maintain the project's quality and process performance objectives.

SP 1.2 Compose the Defined Process

Select the subprocesses that compose the project's defined process based on historical stability and capability data.

SP 1.3 Select the Subprocesses that Will Be Statistically Managed

Select the subprocesses of the project's defined process that will be statistically managed.

SP 1.4 Manage Project Performance

Monitor the project to determine whether the project's objectives for quality and process performance will be satisfied, and identify corrective action as appropriate.

Quality: defect levels of key work products or deliverables

Process: productivity, efficiency, effectiveness of the project's processes

Rationale for how the project tailored the organization's standard process, in order to meet their quality & process performance objectives

- E.g., adding procedures to reduce variation

Assumes the standard process includes subprocesses to select from

Only some subprocesses selected for statistical management

- Need not be the same as those selected by the organization, or other projects

Monitoring against the objectives established in SP 1.1

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Outer Loop

SP 1.1 Establish the Project's Objectives

Establish and maintain the project's quality and process performance objectives.

SP 1.3 Select the Subprocesses that Will Be Statistically Managed

Select the subprocesses of the project's defined process that will be statistically managed

SP 1.4 Manage Project Performance

Monitor the project to determine whether the project's objectives for quality and process performance will be satisfied, and identify corrective action as appropriate.

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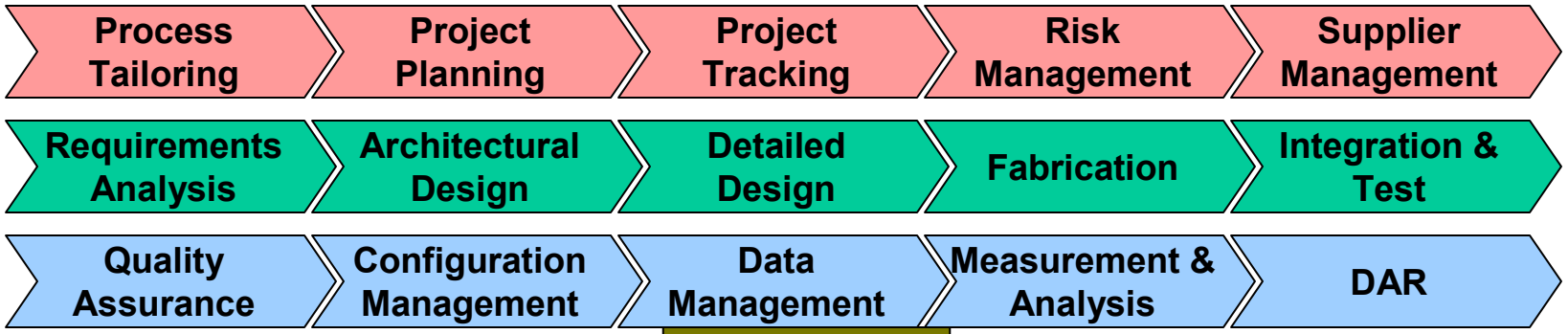
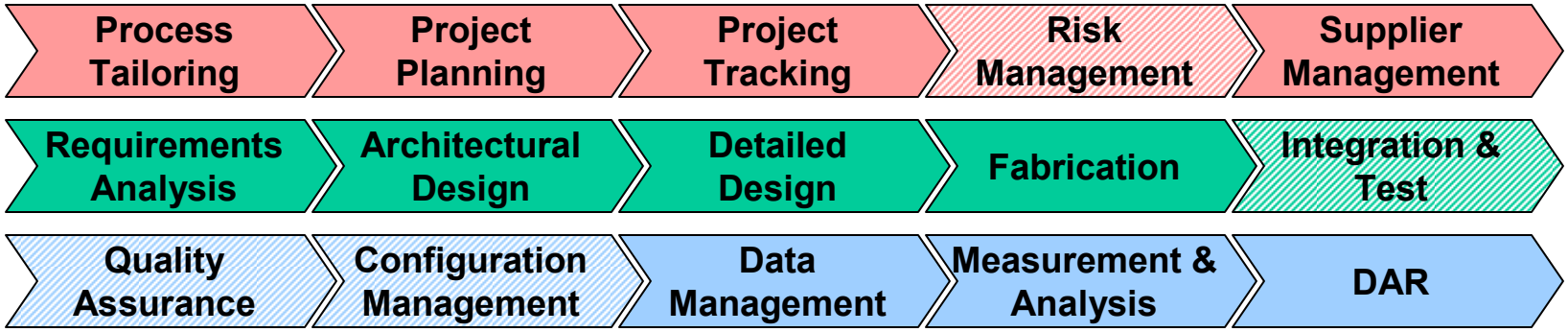
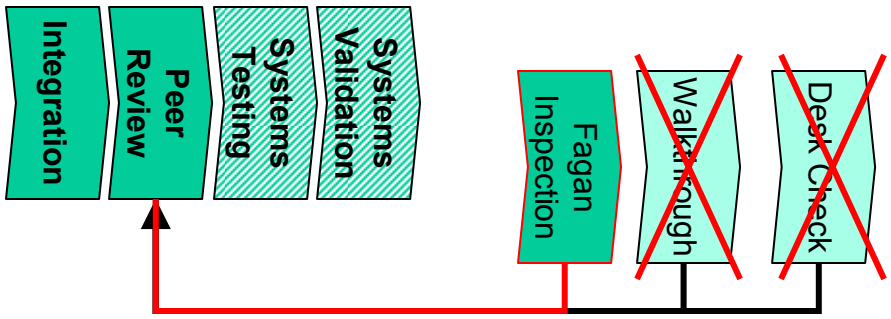
Tailoring

Organization



Project





SP 1.2 Compose the Defined Process

Select the subprocesses that compose the project's defined process based on historical stability and capability data.

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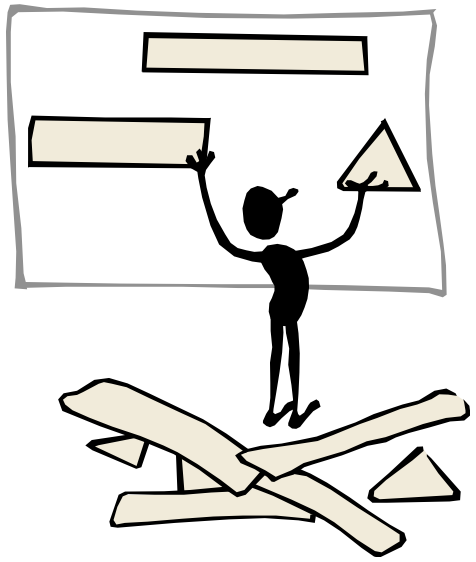
Selecting Subprocesses to be Statistically Managed

SP 1.3 Select the Subprocesses that Will Be Statistically Managed
Select the subprocesses of the project's defined process that will be statistically managed

- **Which processes do you need to be stable (predictable) in order to achieve your project's objectives?**
  - For these, eliminate special causes, characterize the process, and predicatively manage
- **The time needed to perform this practice is long and often unpredictable**
  - Many processes can not be made predictable
- **Example – objectives for delivered defects**
  - Defect detection (peer review, unit testing, system testing)
  - Defect insertion (requirement definition, architecture, design, integration)



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Quantitative Project Management (Goal 2)

SG 2 Statistically Manage Subprocess Performance

The performance of selected subprocesses within the project's defined process is statistically managed.

SP 2.1 Select Measures and Analytic Techniques

Select the measures and analytic techniques to be used in statistically managing the selected subprocesses.

SP 2.2 Apply Statistical Methods to Understand Variation

Establish and maintain an understanding of the variation of the selected subprocesses using the selected measures and analytic techniques.

SP 2.3 Monitor Performance of the Selected Subprocesses

Monitor the performance of the selected subprocesses to determine their capability to satisfy their quality and process performance objectives, and identify corrective action as necessary.

SP 2.4 Record Statistical Management Data

Record statistical and quality management data in the organization's measurement repository.

Type of analysis to be performed (e.g., control charts)

Key is understanding variation in the selected subprocesses (e.g., be able to compute standard deviation), NOT just metrics

Given the stability and variation in the subprocesses, will we be able to meet our project-level quality and process performance objectives?

This data is used to help select subprocesses in tailoring (SP 1.2)

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Inner Loop

SP 1.1 Establish the Project's Objectives

Establish and maintain the project's quality and process performance objectives.

SP 1.3 Select the Subprocesses that Will Be Statistically Managed

Select the subprocesses of the project's defined process that will be statistically managed

SP 2.2 Apply Statistical Methods to Understand Variation

Establish and maintain an understanding of the variation of the selected subprocesses using the selected measures and analytic techniques.

SP 2.3 Monitor Performance of the Selected Subprocesses

Monitor the performance of the selected subprocesses to determine their capability to satisfy their quality and process performance objectives, and identify corrective action as necessary.

SP 1.4 Manage Project Performance

Monitor the project to determine whether the project's objectives for quality and process performance will be satisfied, and identify corrective action as appropriate.

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Sample Measures for Quantitative Analysis

- Time between failures
- Critical resource utilization
- Number and severity of defects in the released product
- Number and severity of customer complaints concerning the pro-vided service
- Number of defects removed by product verification activities (per-haps by type of verification, such as peer reviews and testing)
- Defect escape rates
- Number and density of defects by severity found during the first year following product delivery or start of service
- Cycle time
- Amount of rework time
- Requirements volatility (i.e., number of requirements changes per phase)
- Ratios of estimated to measured values of the planning parameters (e.g., size, cost, and schedule)
- Coverage and efficiency of peer reviews (i.e., number/amount of products reviewed compared to total, number of defects found per hour)
- Test coverage and efficiency (i.e., number/amount of products tested compared to total, number of defects found per hour)
- Effectiveness of training (i.e., percent of planned training completed and test scores)
- Reliability (i.e., mean time-to-failure usually measured during inte-gration and systems test)
- Percentage of the total defects inserted or found in the different phases of the project life cycle
- Percentage of the total effort expended in the different phases of the project life cycle
- Profile of subprocesses under statistical management (i.e., number planned to be under statistical management, number currently being statistically managed, and number that are statistically stable)
- Number of special causes of variation identified

Source: Interpreting the CMMI, Margaret Kulpa and Kent Johnson

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New Questions at Level 4

- What characteristics of the organizational standard process would be useful to understand?
- Which subprocesses would be useful to understand, for predictive purposes?
- Are these subprocesses predictable (stabilizable)?
- What data should the organization collect?
- To what level of detail should the organizational standard process go?
- What differences in project subprocesses are permissible? How do they impact the historical data?

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What Does Level 5 Add to the Project/ Organization?

- **Casual Analysis & Resolution**
  - Identify and analyze causes of defects and other ~~problems~~ effects
  - Take specific actions to remove the causes

- **The project may take actions to prevent the occurrence of those types of defects and problems in the future**
- **Most projects use CAR-type methods and tools at Level 4, to identify and eliminate special cause variations, i.e., to stabilize the processes**
- **At Level 5, CAR is used to eliminate common cause variation**

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Causal Analysis & Resolution

SG 1 Determine Causes of Defects

Root causes of defects and other problems are systematically determined.

SP 1.1 Select Defect Data for Analysis

Select the defects and other problems for analysis.

SP 1.2 Analyze Causes

Perform causal analysis of selected defects and other problems and propose actions to address them.

SG 2 Address Causes of Defects

Root causes of defects and other problems are systematically addressed to prevent their future occurrence.

SP 2.1 Implement the Action Proposals

Implement the selected action proposals that were developed in causal analysis.

SP 2.2 Evaluate the Effect of Changes

Evaluate the effect of changes on process performance.

SP 2.3 Record Data

Record causal analysis and resolution data for use across the project and organization.

Can apply to any cause and effect relationship, not just defects

Typically, projects will establish a list of potential areas in which to apply CAR, and select some from that list

Determine cause and effect (e.g., fishbone diagram, brainstorming) and potential improvement action list

Select some actions on the list to implement

Implemented for each selected action
- Evidence will provide samples

Measures the effect of the change

The effect need not be positive

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Organizational Innovation and Deployment

SG 1 Select Improvements

Process and technology improvements that contribute to meeting quality and process-performance objectives are selected.

SP 1.1 Collect and Analyze Improvement Proposals

Collect and analyze process- and technology-improvement proposals.

SP 1.2 Identify and Analyze Innovations

Identify and analyze innovative improvements that could increase the organization's quality and process performance.

SP 1.3 Pilot Improvements

Pilot process and technology improvements to select which ones to implement.

SP 1.4 Select Improvements for Deployment

Select process- and technology-improvement proposals for deployment across the organization.

SG 2 Deploy Improvements

Measurable improvements to the organization's processes and technologies are continually and systematically deployed.

SP 2.1 Plan the Deployment

Establish and maintain the plans for deploying the selected process and technology improvements.

SP 2.2 Manage the Deployment

Manage the deployment of the selected process and technology improvements.

SP 2.3 Measure Improvement Effects

Measure the effects of the deployed process and technology improvements.

The effects should be measured quantitatively (as opposed to qualitatively in OPF)

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Agenda

- **An Overview of Levels 4 and 5**
  - New Behaviors
  - Benefits – Project, Organizational, Customer
  - Making the Business Case
- **Understanding the CMMI Process Areas**
  - Organizational Process Performance
  - Quantitative Project Management
  - Causal Analysis & Resolution
  - Organizational Innovation & Deployment
- **Strategies for Adoption**
  - Lessons Learned
  - Links to Six Sigma

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Achieving Levels 4 and 5 is Less Predictable

- **The time it takes to achieve Levels 2 and 3 is driven by the resources available**
  - Learn/implement new project practices
  - Create organizational assets - policies, processes, training, etc.
  - Practices are first performed; *effectiveness is improved over time*
- **The time it takes to achieve Levels 4 and 5 is driven by the ability to stabilize processes**
  - Choosing processes that can be stabilized
  - Establishing the right metrics and methods
  - Collecting enough data
  - *Effectiveness is required to perform the practices*

Level	Process Areas
5 Optimizing	Causal Analysis and Resolution Organizational Innovation and Deployment
4 Quantitatively Managed	Quantitative Project Management Organizational Process Performance
3 Defined	Requirements Development Technical Solution Product Integration Verification Validation Organizational Process Focus Organizational Process Definition Organizational Training Risk Management Integrated Project Management (for IPPD*) Integrated Teaming* Integrated Supplier Management** Decision Analysis and Resolution Organizational Environment for Integration*
2 Managed	Requirements Management Project Planning Project Monitoring and Control Supplier Agreement Management Measurement and Analysis Process and Product Quality Assurance Configuration Management
1 Performed	

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Lessons Learned

Based on 20 Northrop Grumman CMMI Level 5 organizations

- **Level 3 metrics, measurement processes, and goal setting are generally inadequate for Levels 4 and 5**
  - Better definitions of the measures
  - Lower level metrics of lower level subprocesses
  - Stratifying the data properly
- **When operating at Level 3, it is difficult to predict the measurement improvements needed**
  - Trying to understand and stabilize the key subprocesses will naturally drive you to the right metrics
- **Projects have different quality and process performance needs, and should select different subprocesses to quantitatively manage**
  - This will also slow adoption, and complicate the organizational baselines and models
- **Six Sigma is an enabler for higher maturity**
  - Focus on data, measurement systems, process improvement
  - Tying improvements to business goals
  - Tools and methods support the level 4/5 analysis tasks

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What is Six Sigma?

- **Six Sigma is a management philosophy based on meeting business objectives by striving for perfection**
  - A disciplined, data-driven methodology for decision making and process improvement
- **Six Sigma consists of several integrated methods:**
  - Process Management
  - Voice of the Customer
  - Change Management
  - Tools for Measuring Variation and Change
  - Business Metrics
- **Leading-edge companies are applying Six Sigma to engineering work**

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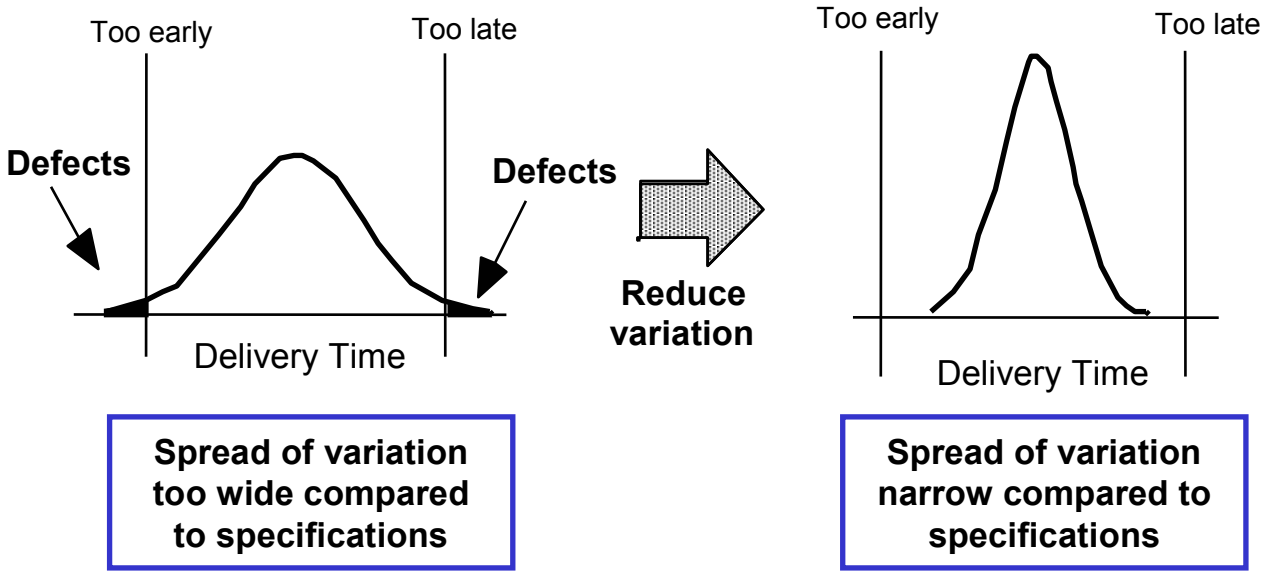
Importance of Reducing Variation

- **To increase process performance, you have to decrease variation**



- **Less variation means**
  - Greater predictability in the process
  - Less waste and rework, which lowers costs
  - Products and services that perform better and last longer
  - Happier customers

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A Typical Six Sigma Project in Engineering

- Customers express concern that software defects are causing frequent failures in the field
- A Six Sigma team is formed to scope the problem, collect data, and determine the root cause
- The team's analysis of the data determines that poorly understood interface requirements account for 90% of the problems in the field
- The interface problems are corrected
- The organization's requirements solicitation process is modified to ensure future projects do not encounter similar problems

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DMAIC Process Steps

DEFINE	**Set project goals and objectives**
MEASURE	**Narrow range of potential causes and establish baseline capability level**
ANALYZE	**Evaluate data/information for trends, patterns, causal relationships and "root causes“**
IMPROVE	**Develop, implement and evaluate solutions targeted at identified root causes**
CONTROL	**Make sure problem stays fixed and new methods can be further improved over time**

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How Six Sigma Helps Level 4-5 Organizations

- **Six Sigma provides specific methods and tools for:**
  - Quantitative process management of Level 4
  - Causal Analysis and Resolution of Level 5
- **Six Sigma projects provide a mechanism for selecting and implementing improvements**
  - Addresses Organizational Innovation and Deployment
  - Can extend beyond Level 5

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Leveraging ITIL Services (Support and Delivery) Capability and Maturity with the CMMI

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Welcome

WelKom

Huan Yín

Bienvenido

Bienvenue

Wilkommen

ΚΑΛΟΣ ΟΡΙΣΑΤΕ

Bienvenuto

Välkommen

Witamy

Tervetuloa

ברוכים הבאים

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ITIL Scope

- Developed by the British Government - 1989
- Public Domain
- Best Practices
- Covers IT Services
  - Organization and Processes
  - IT Infrastructure
    - Hardware, Software, Networks,
    - Application Software
- 1996 – Launched in North America

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ITIL Aims

- Facilitate Quality Management of IT Services
- Improve Efficiency
- Increase Effectiveness
- Reduce Risk
- Codes of Practice Supporting Total Quality
- CMMI Compliant

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ITIL – How It Works

- Provides guidance books on strategic, tactical and operational management of IT infrastructure
- Provides a systematic, process-based approach, supported by procedures
- Suggests implementation strategies
- Acts as a training aid
- Complies with many requirements for CMMI

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ITIL Principles

ITIL is all about which processes need to be realized within the organization for management and operation of the IT infrastructures to promote optimal service provision to the customer at justifiable costs.

ITIL & CMMI

- Processes in Place
- Documented
- Trained
- Followed
- Corporate Appraisal

- Processes
- Documentation
- Training
- Integrated
- Best Practice
- Individual Certification

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Leverage From Applying CMMI & ITIL

- ITIL uses practices and best practices to create well defined process and instructs you how to do it according to it
- CMMI gives the framework and guidelines to evaluate and create quality and efficient process, and guides you in the way that it will work for you

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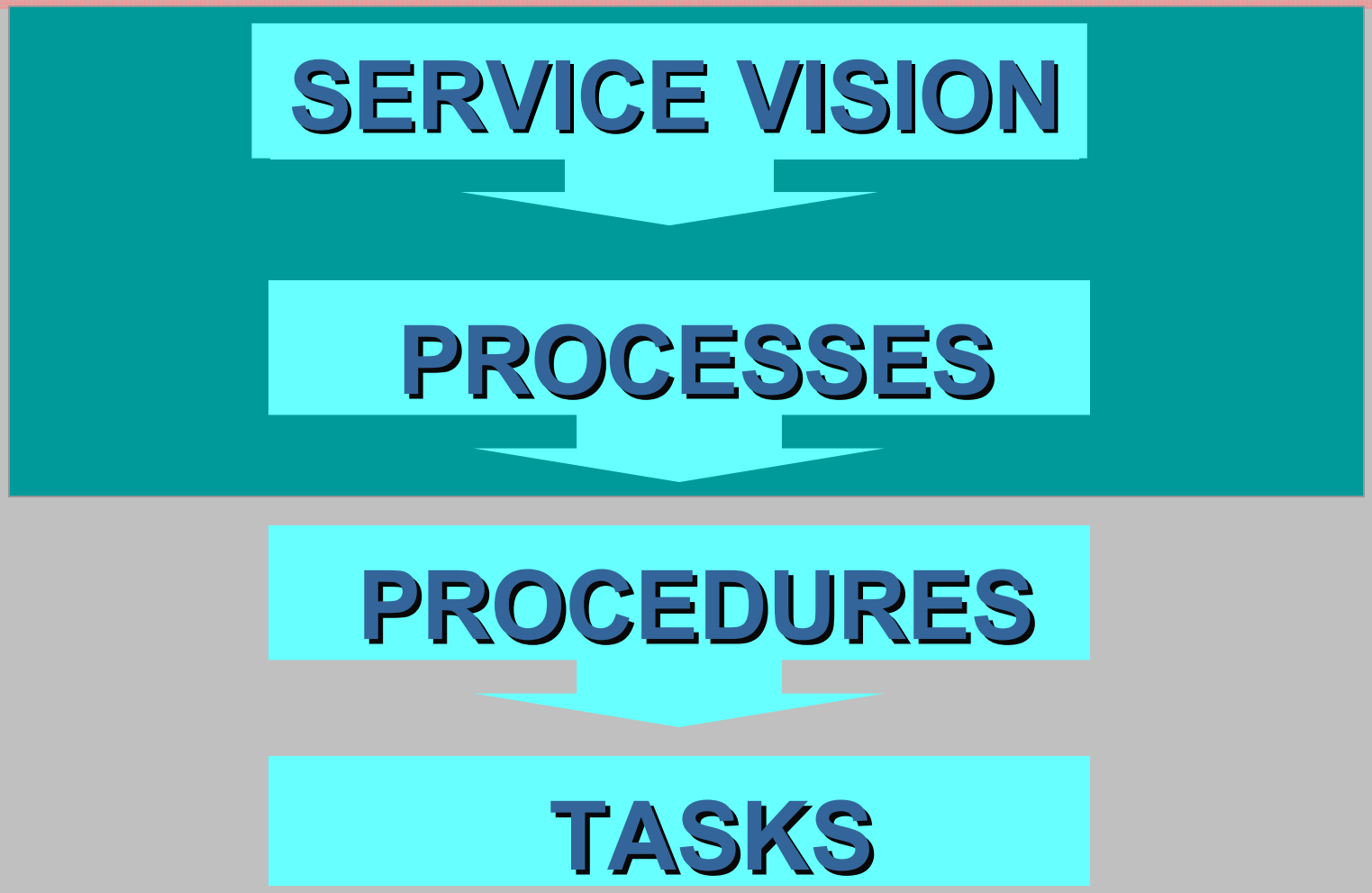
The Service Model



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ITIL Modules

SERVICE DELIVERY Tactical Management	SERVICE SUPPORT Operational Management
◆ Service Level Management	◆ Configuration Management
◆ Capacity Management	◆ Service Desk
◆ Availability Management	◆ Incident Management
◆ Contingency Planning	◆ Problem Management
◆ Financial Management	◆ Change Management
	◆ Release Management

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Service Management "A Process Led Approach"

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Service Management Benefits

- Service Management benefits include:
  - Improved quality of service – more reliable business support
  - Clearer view of current IT capability
  - Better information on current services (and possibly on where Changes would bring most benefits)
  - More motivated staff; improved job satisfaction through better understanding of capability and better management of expectations
  - Enhanced Customer satisfaction as service providers know and deliver what is expected of them
  - System-led benefits, e.g. improvements in security, accuracy, speed, availability as required for the required level of service
  - Improved cycle time for Changes and greater success rate.

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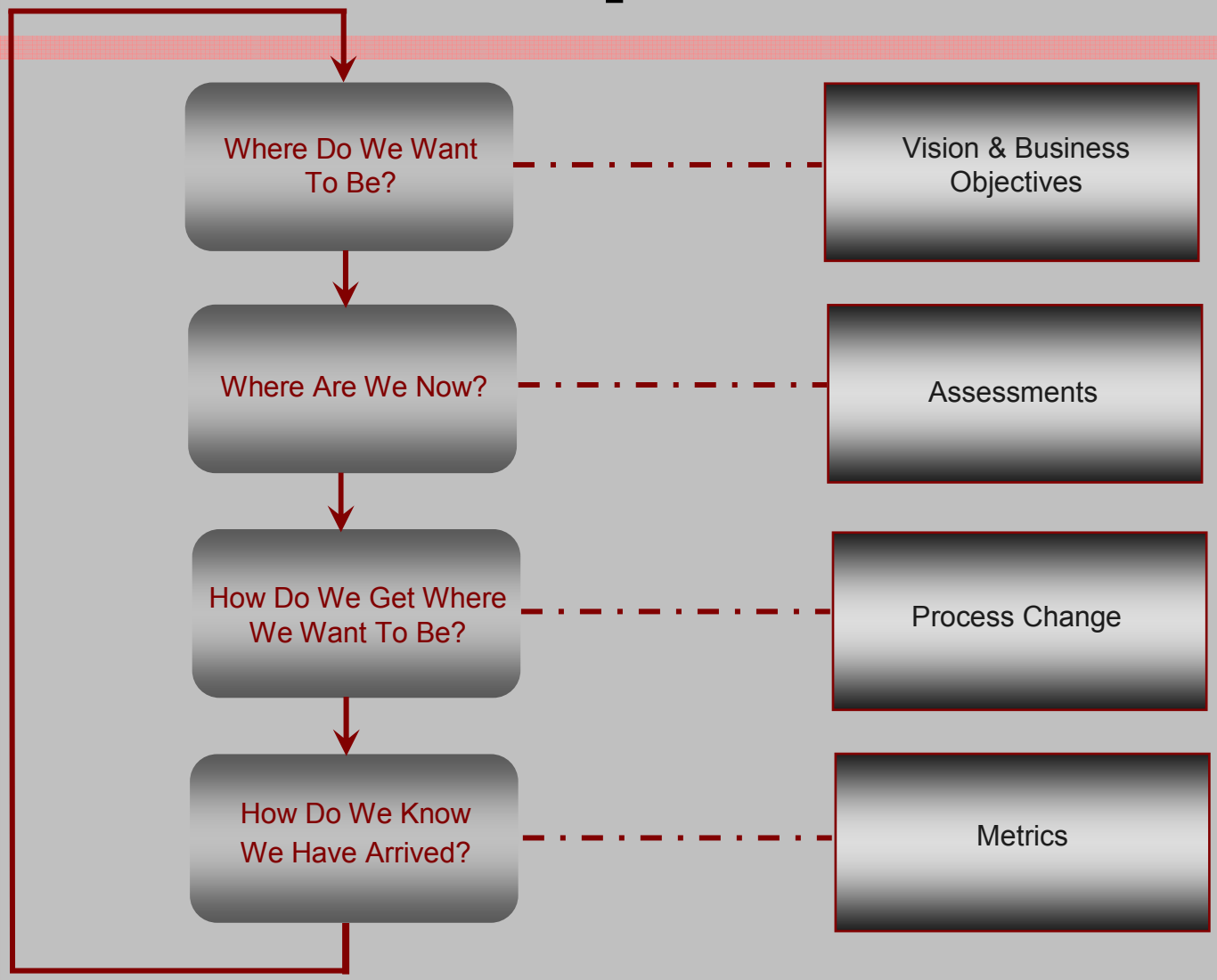
A Process Improvement Model



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Management Commitment

- Management commitment is about motivating and leading by example.
  - Managers must support the use of best practice openly and demonstrably,
  - Without full management commitment to change and innovation the staff cannot be expected to improve themselves, Service Management processes or service to Customers.
- A total quality approach to leadership is required from managers. The different aspects of management commitment can be found in commonly used Total Quality Models such as the EFQM (in Europe) or Baldridge (in North America)

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Management Commitment - 2

- **Why do implementations fail?**
  - It is not enough for management to provide the funds for the implementation process and then sit back expecting everything to work → Management must be committed during the entire '*plan-do-check-act*' cycle
- Common reasons for failure include:
  - Lack of staff commitment and understanding (GP 2.1)
  - Lack of training (GP 2.5, OT))
  - Staff given the responsibility for implementation but not given sufficient authority to make the required decisions (GP 2.4)
  - Lack of the Service Management 'champion' (the person driving the implementation) (OPF)
  - Lack of initial funding and lack of quantifiable long term cost benefits (GP 2.3)
  - Overly ambitious expectations of immediate benefits or try to do everything at once
  - Unrealistic implementation timetable (PP)
  - Difficulties of changing the culture of the organisation
  - Tools unable to support the process (GP 2.3)

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Cultural Aspects

- In order to prosper, a business organisation should have Customer satisfaction as its prime objective
- The provision of quality IT services with high levels of availability and performance can be achieved with the correct hardware, software and underlying support disciplines.
  - This level of service may satisfy, but may not delight, the Customer!
  - Customer delight will only be achieved if the people involved are responsive to their Customers' needs, are attentive, reliable, and courteous, delivering the service in the way they themselves would like to receive it
  - Customer service therefore is concerned with performing acts that will benefit the Customer in a way that will encourage him to purchase service again and again
  - This can only be achieved if the organisation's culture demands it

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ITIL
IT Infrastructure Library
Overview

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Vocabulary

- Incident - any event which is not part of the standard operation of a service and which causes or may cause an interruption to or reduction in the quality of that service
- Problem - The **unknown root cause** of one or more incidents
- Error - an incident or problem **for which the root cause** is known and for which a temporary workaround or a permanent alternative has been identified

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Vocabulary - 2

- OGC - Office of Government Commerce (OGC)
- BS 15000 - Specification for IT Service Management
- PD0005 - A Code of Practice for IT Service Management
- PRINCE2 – Projects in Controlled Environments Version 2 (PRINCE2)
- Customer – Senior managers who commission, pay for and own the IT Services
- User - people who use the services on a day-to-day basis

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Vocabulary - 3

- Definitive Copy – Master Library component

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Why ITIL?

- Organisations are increasingly dependent upon IT to satisfy their corporate aims and meet their business needs
  - This growing dependency leads to growing needs for quality IT services – quality that is matched to business needs and user requirements as they emerge
- The authors of ITIL have tried to introduce “Engineering” think and practices into the IT world

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Why ITIL? - 2

- ***IT Service Management*** is concerned with delivering and supporting IT services that are appropriate to the business requirements / objectives of the organisation
- IT service providers must continually strive to improve the quality of their service, while at the same time trying to reduce the costs or, at a minimum, maintain costs at the current level

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Why ITIL? - 3

- ITIL provides a comprehensive, consistent and coherent set of best practices for IT Service Management processes, promoting a quality approach to achieving business effectiveness and efficiency in the use of information systems
- ITIL processes are intended to be implemented so that they underpin, but do not dictate, the business processes of an organisation

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CMMI & Business Objectives

- Based on the CMMI Framework, CMMI Models are tailored to assist an organization in aligning the application of the model with its business objectives

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Business Objectives

- For a focus on Quality Management to be successful, it must be tied to the organization's business objectives:
  - What are the organization's highest priorities?
  - What business consequences have resulted from weak or ineffective focus on quality management functions?
  - What action is being taken to correct the cause?
  - How can a focus on Quality Management support the organization's business objectives

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Helping The Business

- Process improvement should be done to help the business—not for its own sake.

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ITIL Background

- Developed in the late 1980s, the IT Infrastructure Library (ITIL) has become the world-wide *de facto* standard in Service Management
- Starting as a guide for UK government, the framework has proved to be useful to organisations in all sectors
- ITIL has been adopted by many companies as the basis for Service Management, and for consultancy, education and software tools support

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ITIL Background - 2

- The IT Infrastructure Library documents industry best practice guidance
- ITIL is a framework that describes the goals, general activities, inputs and outputs of the various Service Management processes, which can be incorporated within IT organisations
- The CMMI is a framework that organizes CMMI components, including common elements of the current CMMI models, their appraisal methods and their training materials

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ITIL Background - 3

- In the past, many IT organisations were internally focused and concentrated on technical issues
- These days, businesses have high expectations of the quality of services
- This means that for IT organisations to live up to these expectations, they need to concentrate on service quality and a more customer-oriented approach
- It means doing these things at the right price
- ***In short, it means managing IT as a business***

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ITIL Background - 4

- ITIL focuses on both tactical and operational level
  - Tactical processes are centered on the relationships between the IT organisation and their Customers
  - Service Delivery is partially concerned with setting up agreements and monitoring the targets within these agreements. (SAM – ISM)
  - On the operational level, the Service Support processes can be viewed as responding to the changes needed in, and any failures in, the services laid down in these agreements (SAM – ISM)

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ITIL Background - 5

- On both the tactical and operational levels there is a strong relationship with quality systems such as ISO 9000 or CMMI and a total quality framework such as European Foundation for Quality Management (EFQM) or Baldridge and even project management systems such as PMI or Prince2
- ITIL supports these quality systems by providing defined processes and best practices for the management of IT Services but it must be remembered that there needs to be on-going review of the quality of processes aligned with business requirements.

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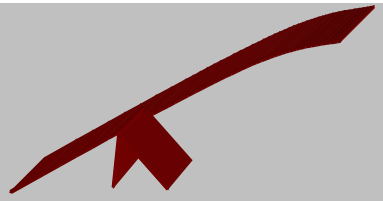

The IT Infrastructure Library

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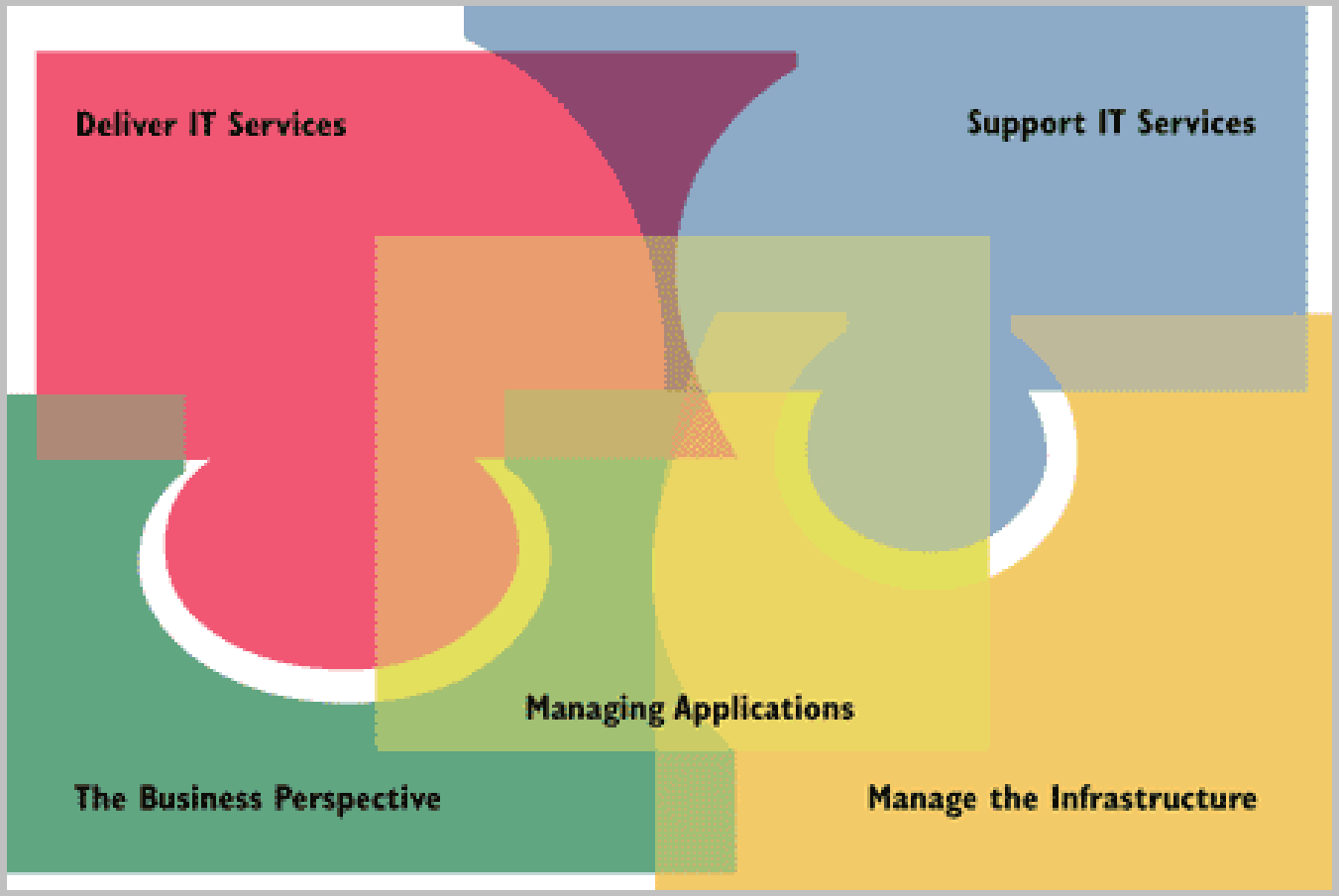
Jigsaw Diagram



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Jigsaw Diagram - 2

- The major elements of ITIL can be compared to overlapping jigsaw puzzle pieces (or perhaps better as tectonic plates), some of which have a precise fit, and some of which overlap or do not fit together accurately

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Business Perspective

- The Business Perspective covers a range of issues concerned with understanding and improving IT service provision, as an integral part of an overall business requirement for high quality IS management. These issues include:
  - Business Continuity Management
  - Partnerships and Outsourcing
  - Surviving change
  - Transformation of business practice through radical change

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Service Delivery

- Service Delivery looks at what service the business requires of the provider in order to provide adequate support to its business customers
- To provide the necessary support Service Delivery is broken down into the following topics:
  - Capacity Management
  - Financial Management for IT Services
  - Availability Management
  - Service Level Management
  - IT Service Continuity Management.

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Service Support

- Service Support is concerned with ensuring that the User has access to the appropriate services to support its business functions
- Issues discussed under Service Support are:
  - Service Desk
  - Incident Management
  - Problem Management
  - Configuration Management
  - Change Management
  - Release Management

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ICT Infrastructure Management

- ICT Infrastructure Management includes:
  - Network Service Management
  - Operations Management
  - Management of Local Processors
  - Computer Installation and Acceptance
  - Systems Management

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Applications Management

- Applications Management embraces the software development lifecycle expanding the issues touched upon in Software Lifecycle Support and Testing of IT Service
- Applications Management expands on the issues of business change with emphasis on clear requirement definition and implementation of the solution to meet business needs → CMMI Requirements Development and Technical Solution with Requirements Management

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Interrelationship of ITIL Processes

- All the processes described in ITIL relate to each other – Example – Life-cycle of an "Incident"
  - A User calls the Service Desk to report response difficulties with the on-line service
  - The ***Incident Management*** process deals with Incident
  - The ***Problem Management*** process investigates underlying cause and calls in ***Capacity Management*** to assist in this process
    - ***Service Level Management*** is alerted that the SLA has been breached
    - ***Request for Change*** (RFC) raised if appropriate
  - The ***Change Management*** process co-ordinates the ***Request for Change*** (RFC)
  - The ***IT Financial Management*** process assists with the business case cost justification for any upgrade

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Interrelationship of ITIL Processes - 2

- The ***IT Service Continuity*** process gets involved in the Change Management process to ensure recovery is possible onto current back-up configuration
- The ***Release Management*** process controls the implementation of the Change by rolling out replacement hardware and software. Release Management updates Configuration Management with details of new Releases and versions
- The ***Availability Management*** process is involved in considering the hardware upgrade to ensure that it can meet the required availability and reliability levels.
- The ***Configuration Management*** process ensures the Configuration Management Database (CMDB) information is updated throughout the process

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Customers and Users

- Customer - Generally senior managers (CEO, CTO, CFO, COO) who commission, pay for and own the IT Services
  - The primary point of contact for Customers is either the Service Level Manager or the Business Relationship Manager
- Users - Those people who use the services on a day-to-day basis
  - The primary point of contact for Users is the Service Desk
- Users and Customers have related but different needs
  - Users may demand high availability
  - Customers look for value for money at different levels of availability

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Summary

- ITIL is written mainly from an in-house service provider's perspective, but it is generally relevant to all other methods of service provision
- ITIL is applicable to those involved in out-sourced service provision or working in partnerships.

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Summary - 2

- Business managers can use ITIL in understanding and establishing best practice IT services and support
- Managers from supplier organisations should also find ITIL relevant when setting up agreements for the delivery and support of services

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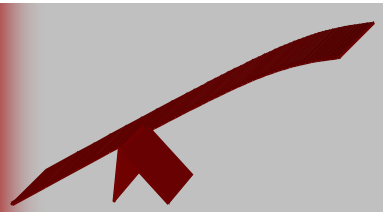

Overview of Service Support & Service Delivery Functions

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Service Delivery Functions

- Availability Management
- IT Services Continuity Management
- Capacity Management
- Financial Management
- Service Level Management

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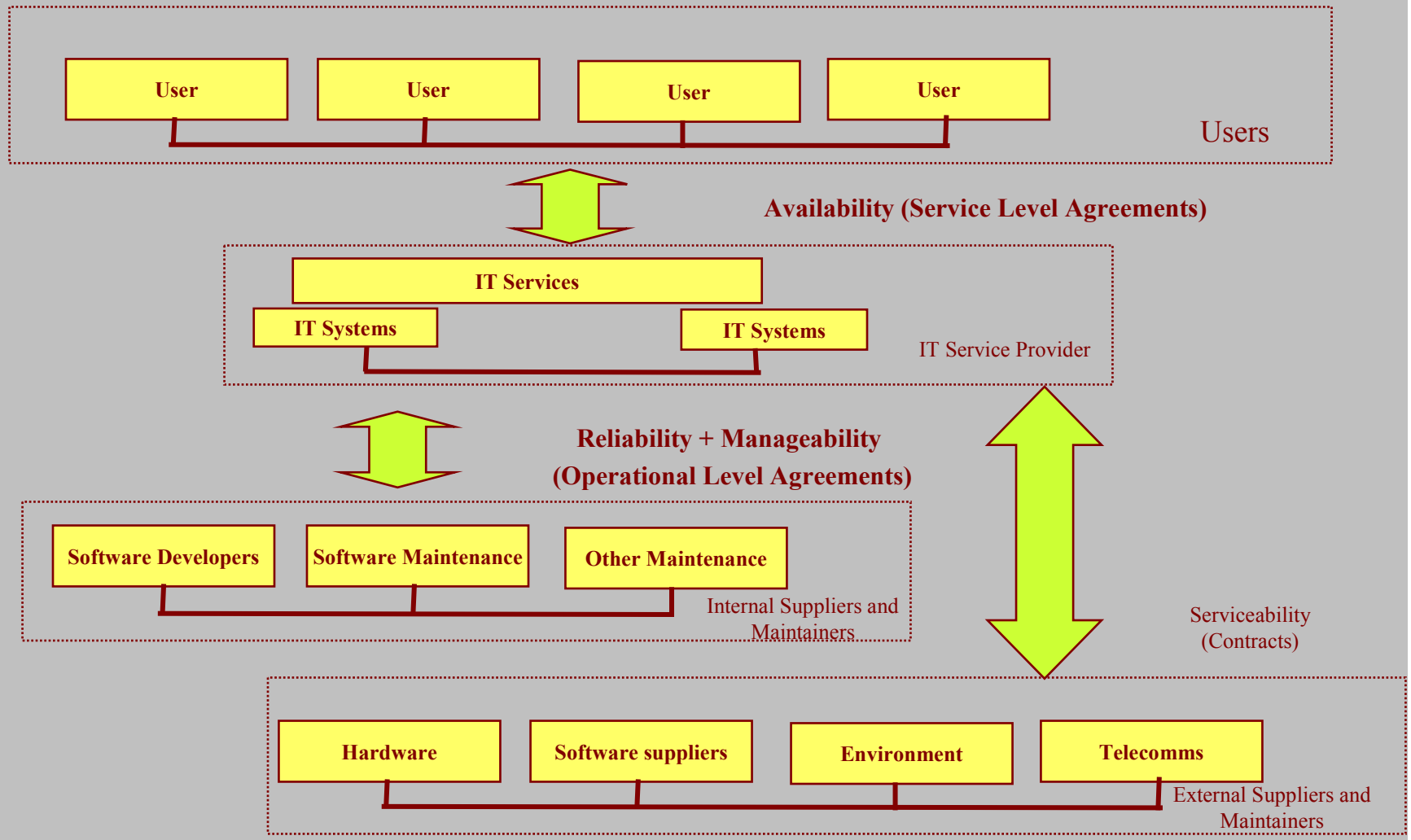
Availability Management

- Availability Management enables an organization to predict, plan for and manage the availability of services by ensuring that:
  - All services are supported by sufficient, reliable, and properly maintained configuration items (CM)
  - CI's not supported internally are supported through appropriate contractual agreements with third party suppliers (SAM – ISM)
  - Changes are proposed to prevent future loss of service availability (SAM – ISM)

Availability Management - 2

- Availability Management is defined by: (MA, TS)
  - Reliability
  - Maintainability : Maintenance you do yourself as an organization
  - Resilience – Level of Redundancy you establish
  - Serviceability – Maintenance done by someone else

The IT Infrastructure and IT support organization



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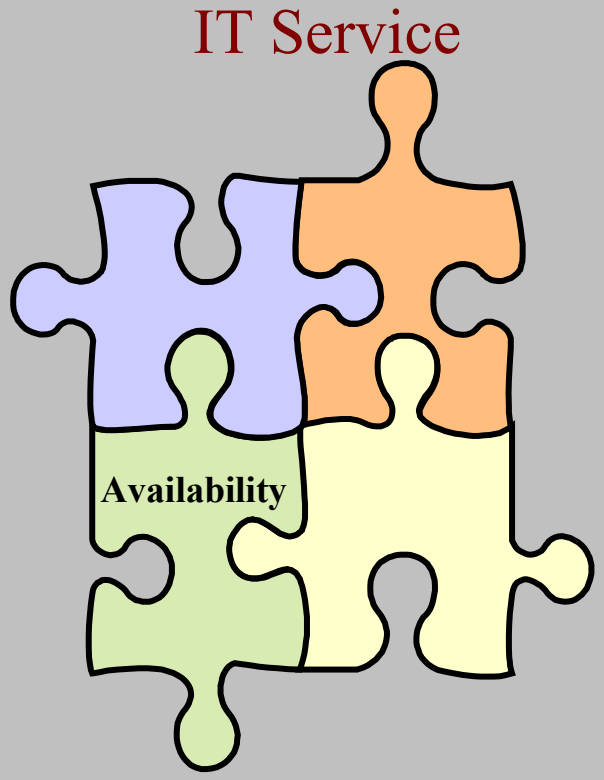
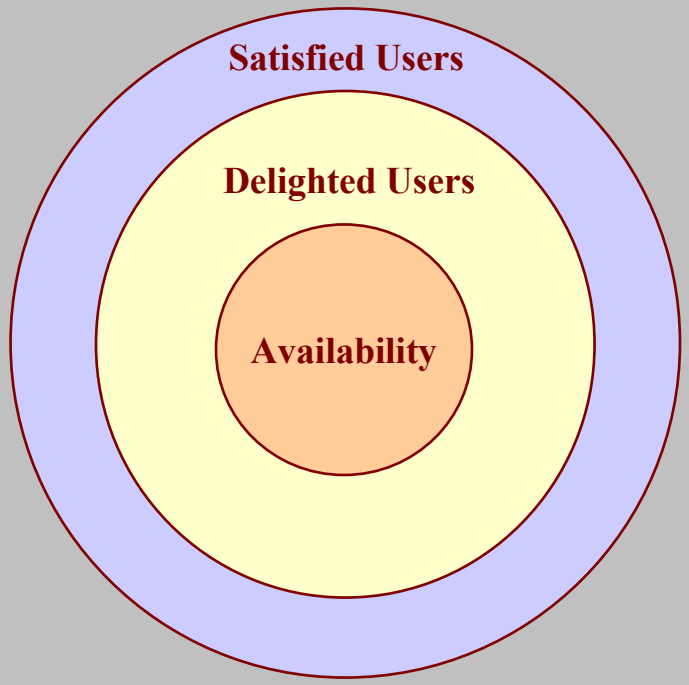
Availability is at the Core of Business and User Satisfaction



"A key component of Users' perception on the quality of IT Services"



"Recognize that Availability is at the core of User satisfaction"

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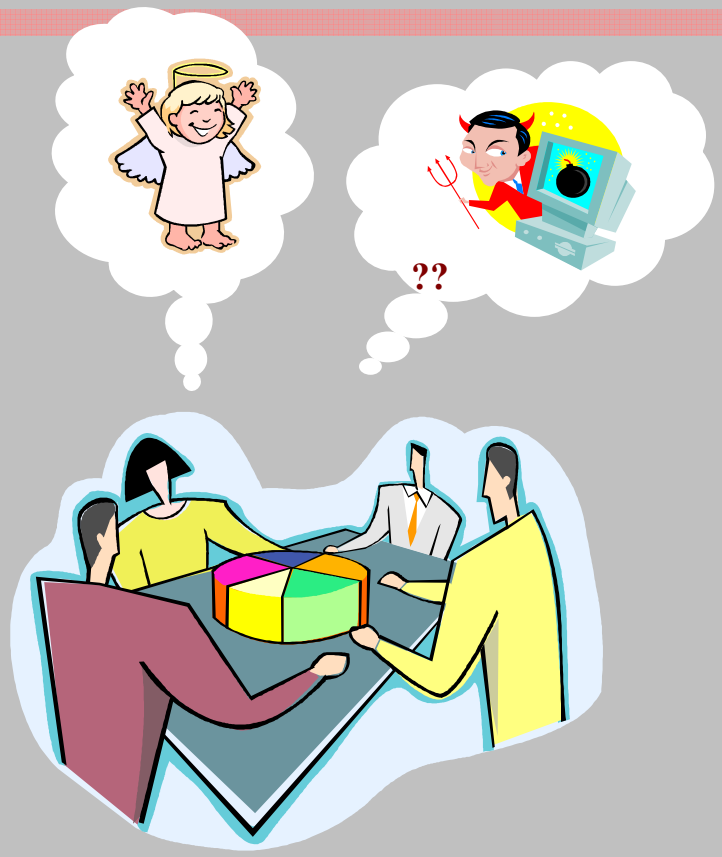
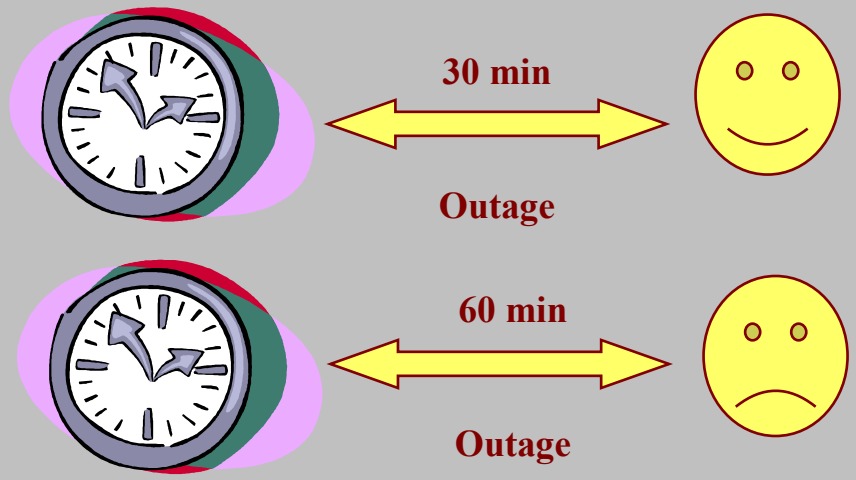
Business and User Satisfaction Levels Following an IT Failure



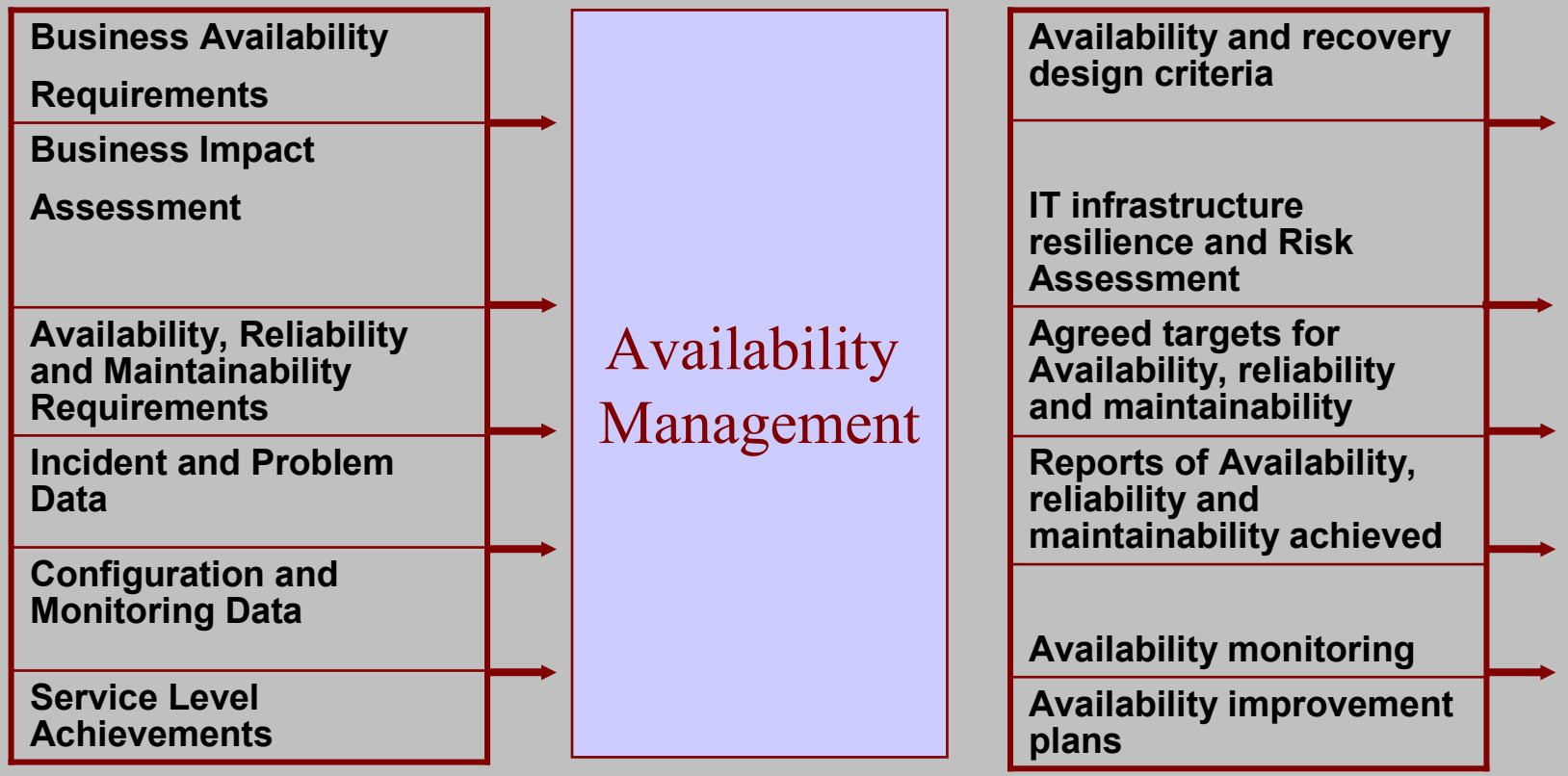
Business Satisfaction Report



"The business and User view of the IT support Organization"

"The business and User view of the IT support Organization"

8.3 The Availability Management process



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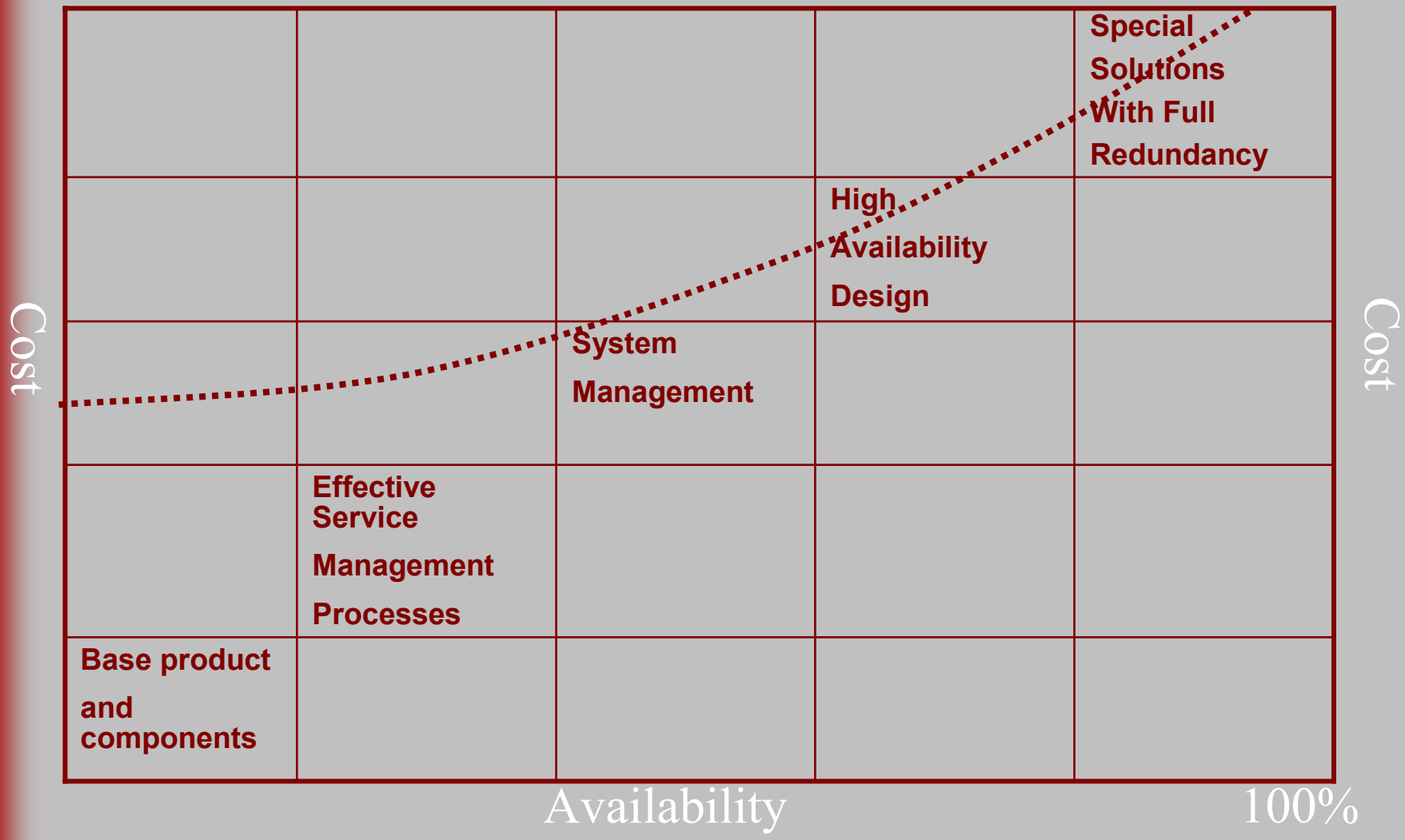
The Cost of (Un)Availability



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IT Services Continuity Management

- IT Services Continuity Management is established to mitigate the risk of the business suffering a major IT disaster (RSKM)
- IT Services Continuity must be planned to:
  - Increase business dependency on IT
  - Reduce cost and time of recovery
  - Reduce cost to customer relationship
  - Survive

IT Services Continuity Management - 2

- Conduct Risk Analysis to determine:
  - Value of assets
  - Threats
  - Vulnerabilities
- Conduct Risk Management to:
  - Develop countermeasures
  - Plan for potential disasters
  - Manage a disaster

IT Services Continuity Management - 3

- Establish Risk Mitigation Strategies (RSKM)
  - Do Nothing
  - Manual workarounds
  - Reciprocal arrangements
  - Gradual Recovery (cold standby)
  - Intermediate Recovery (warm standby)
  - Immediate Recovery (hot standby)

IT Services Continuity Management - 4

- Conduct Tests and Reviews
  - Initially followed by every 6-12 months after each disaster
  - Test under realistic conditions (TS, VER, VAL)
  - Move / protect any live services first
  - Review and change the plan (VER)
  - All changes made via the CAB – Change Advisory Board (CM)

Business Continuity Lifecycle

Stage 1 Initiation

Initiate BCM

Stage 2 Requirements and Strategy

Business Impact Analysis

Rick Assessment

Business Continuity Strategy

Stage 3 Implementation

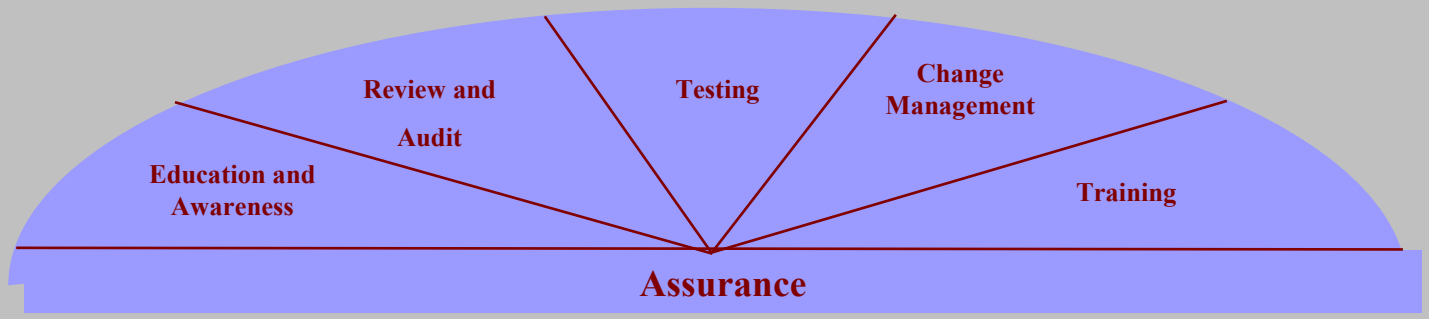
Organization and Implementation Planning

Implement Stand-by Arrangements | **Develop Recovery Plans** | **Implement Risk Reduction Measures**

Develop Procedures

Initiate Testing

Stage 4 Operational Management



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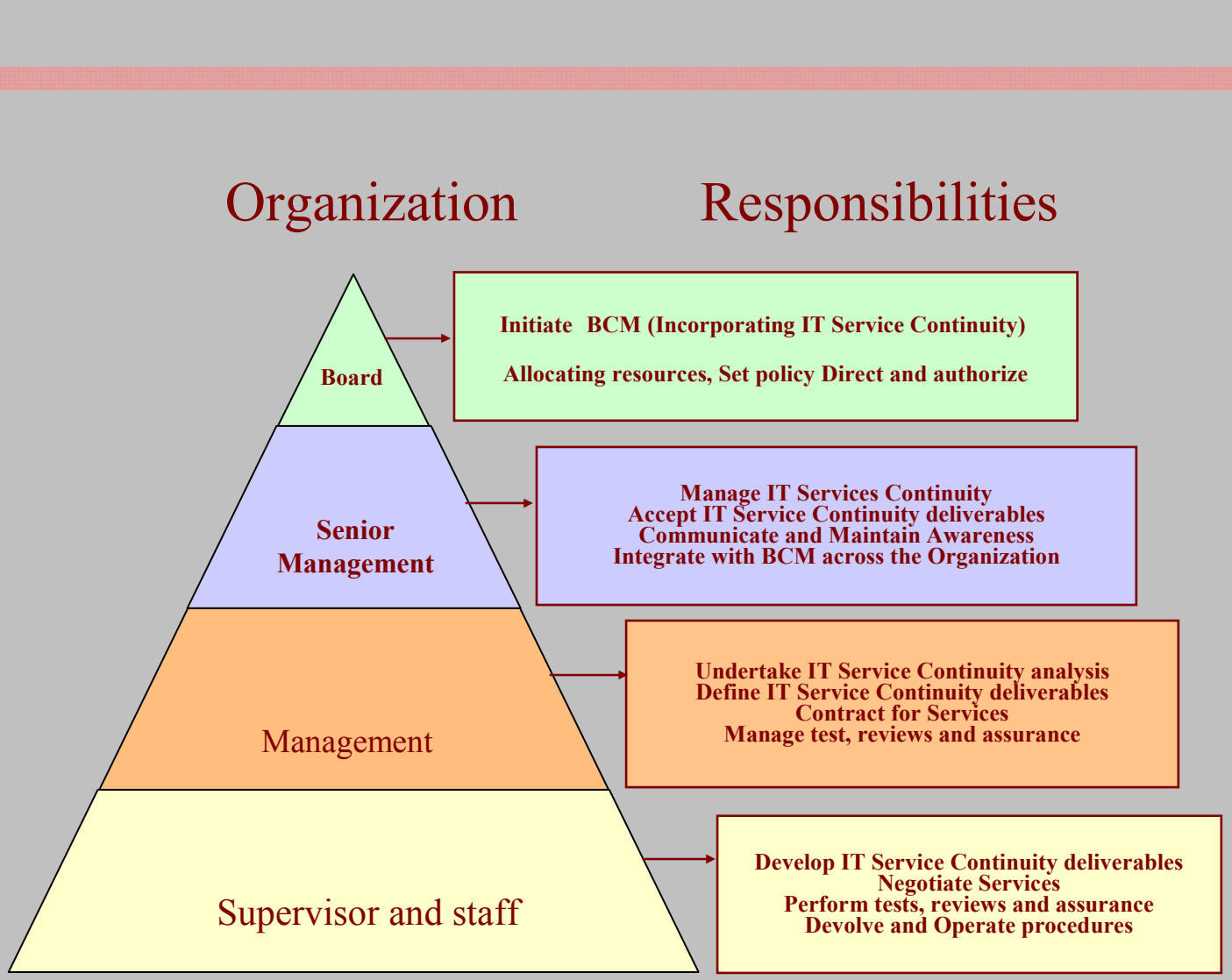
Responsibilities



Capacity Management

- Capacity Management assists the organization in determining the right, cost justifiable, capacity of IT resources such that the Service Levels linked to the business are achieved “at the right time” (Project Planning – SP 2.4 Plan for Project Resources)

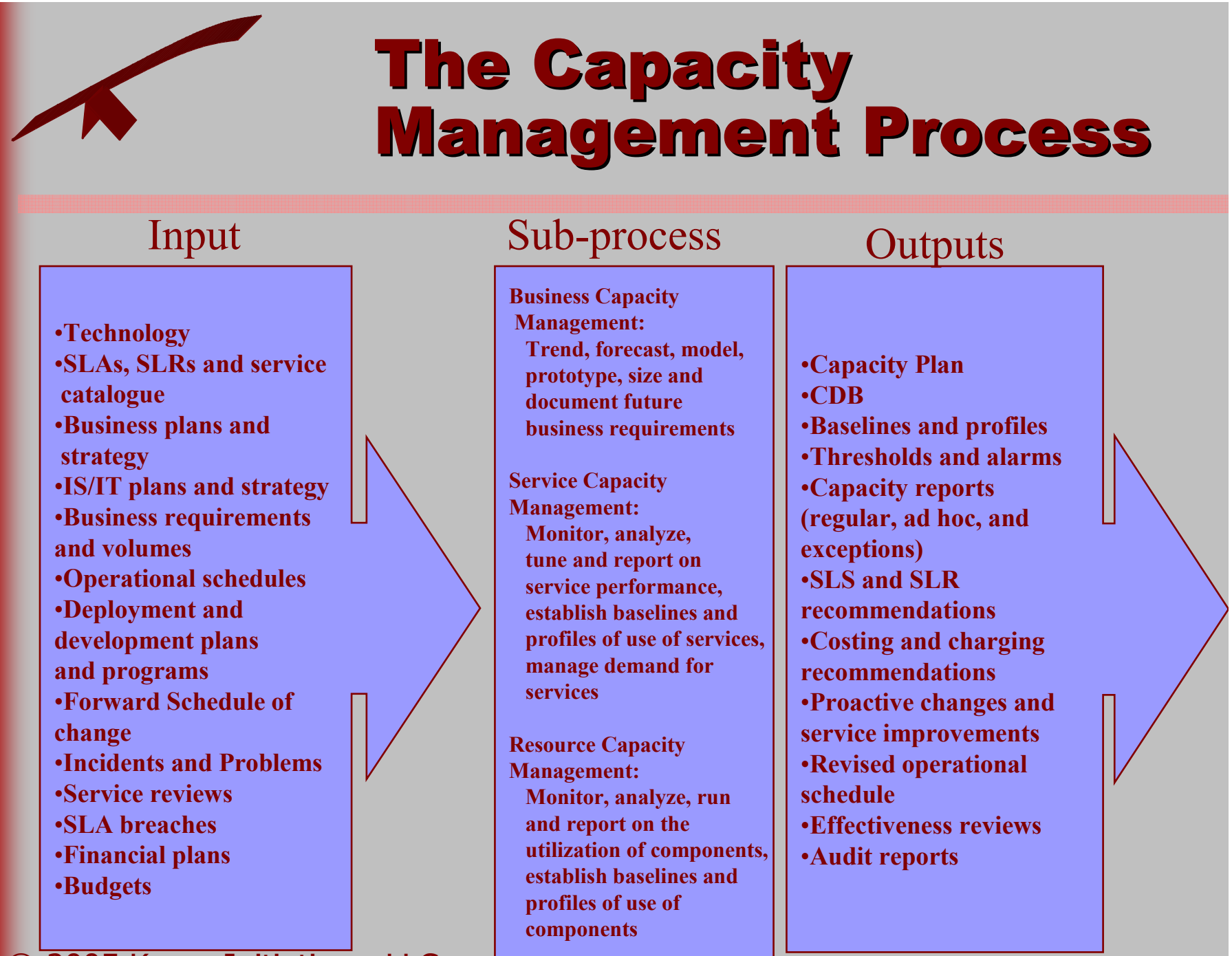
Capacity Management - 2

- Capacity Management is defined by:
  - Demand Management – Business Capacity in management
  - Workload Management – Service Capacity of Management
  - Resource Management – Resource Capacity Management
- Capacity Management must also take into consideration Performance Management
  - Internal and External Financial Data
  - Usage Data
  - SLM =Data / Response Times
  - Capacity Database (CDB) is populated by Performance Management Data

Capacity Management - 3

- Application sizing is required to estimate the resource requirements to support a proposed application change to ensure it meets its required service levels. (PP)
- Modeling is often used to support Capacity Management (PP – SP 1.4)
  - Trend Analysis
  - Simulation Modeling
  - Baseline Models
  - Used to answer “What If” questions

The Capacity Management Process



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Financial Management

- Financial Management is used to provide information about the costs of delivering IT services that support customer business needs
- Financial control of costs is a must!
- Cost factors include (PP) :
  - Equipment Costs
  - Organization Costs
  - Transfer Costs
  - Accommodation Costs
  - Software Costs

Financial Management - 2

- Different Types of Costs (PP)
  - Fixed – Unaffected by the level of usage
  - Variable – Varying according to the level of usage
  - Direct – Usage specific to one service
  - Indirect or Overhead – Usage not specific to one service
  - Capital – Not diminished by usage
  - Revenue or running – diminish with usage

Financial Management - 3

- Continuous Cost Awareness
  - Recover from customers the full costs of the IT services provided (RM)
  - Ensure that customers are aware of the costs they impose on IT (PP, RM, PMC)
  - Ensure that providers have an incentive to deliver agreed quality and quantity of services (ISM)

Financial Management - 4

- Main Financial Management Processes
  - Budgeting – The process of predicting and controlling the spending of money within the enterprise
    - Periodic negotiation cycle to set budgets (PP)
    - Day-to-day monitoring of the current budgets
  - IT Accounting – The set of processes that enable the IT organization to fully account the way its money is spent
  - Charging – The set of processes required to bill a customer for the services applied to them.

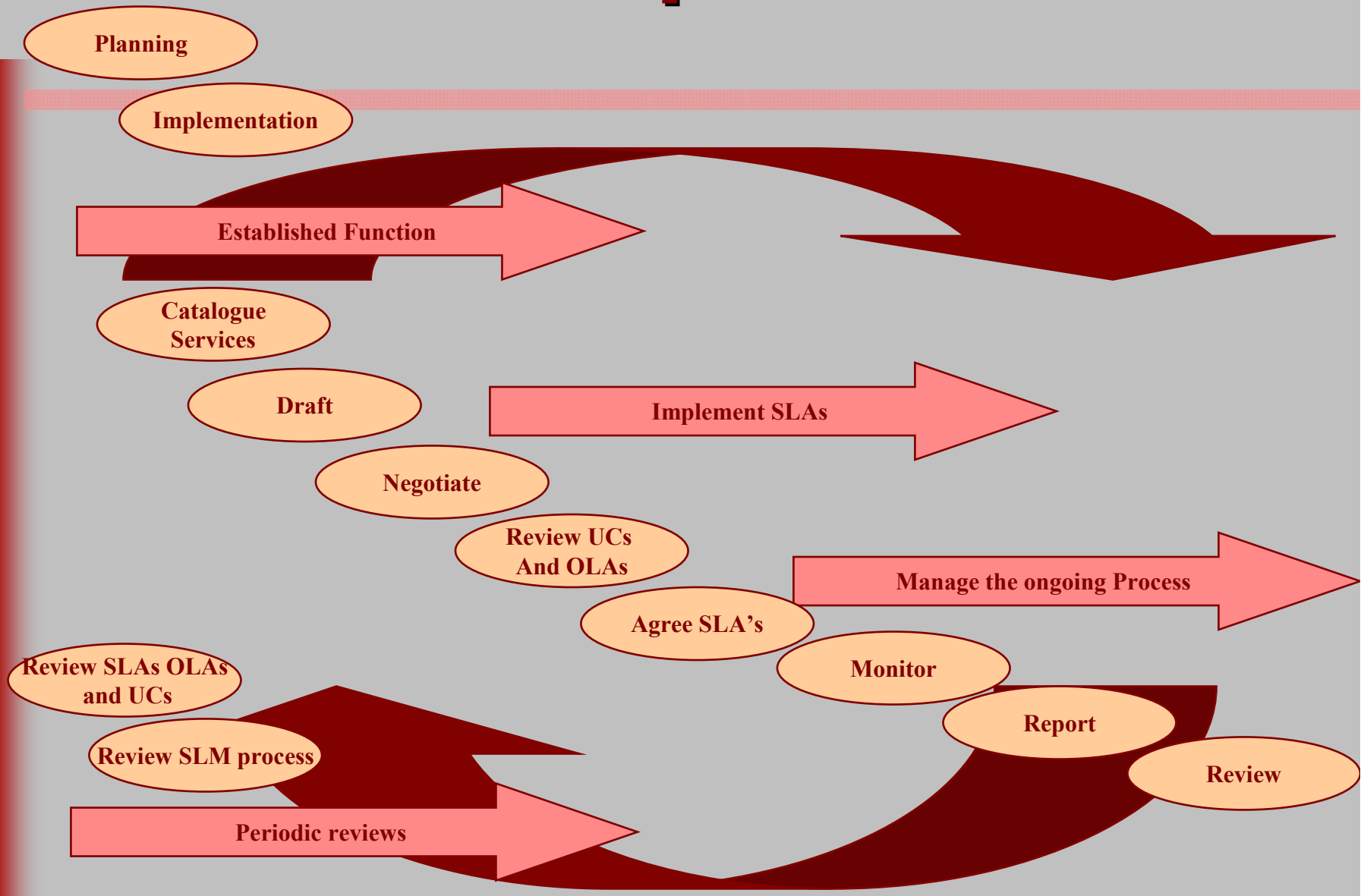
Service Level Management

- Service Level Management is designed to provide the balance between the Demand for IT services and the Supply of IT services by:
  - Knowing the requirements of the business
  - Knowing the capabilities of IT

Service Level Management - 2

- Service Level Management strives for:
  - Business-like relationship between customer and supplier (SAM – ISM)
  - Improved specification and understanding of service requirements (RD, REQM)
  - Greater flexibility and responsiveness in service provision
  - Balance customer demands and cost of services provision (REQM)
  - Quality Improvement (PPQA, VER)
  - Objective Conflict Resolution (RD, PP)

The SLM process



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Service Support Functions

- Service Desk
- Incident Management
- Problem Management
- Change Management
- Configuration Management
- Release Management

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Service Desk

- The Service Desk is the primary point of contact for all: (CM, REQM)
  - Calls
  - Questions
  - Requests
  - Complaints
  - Remarks
- Service Desk Main Functions
  - Restore the service as quickly as possible
  - Manage the incident life-cycle
  - Support business activities
  - Generate reports, communicate and promote issues

Service Desk - 2

- Service Desk Essentials
  - Serve as the single point of contact (CM, REQM)
  - Provide Customer Interface, Business Support, Incident Control and Management Information
  - Concentrate on incident life-cycle management
  - Determine Incident priority by business impact and urgency (REQM, CM)
  - Conduct assessment of priorities to determine the deployment or manpower and other resources (REQM)
  - Escalate issues to the proper next level as necessary (REQM, PPQA)

Incident Management

- Incident Management focuses on:
  - Restoring normal service as quickly as possible
  - Minimizing the adverse impact on business operations
  - Ensuring that the best possible levels of service quality and availability are maintained according to the SLAs (SAM – ISM)

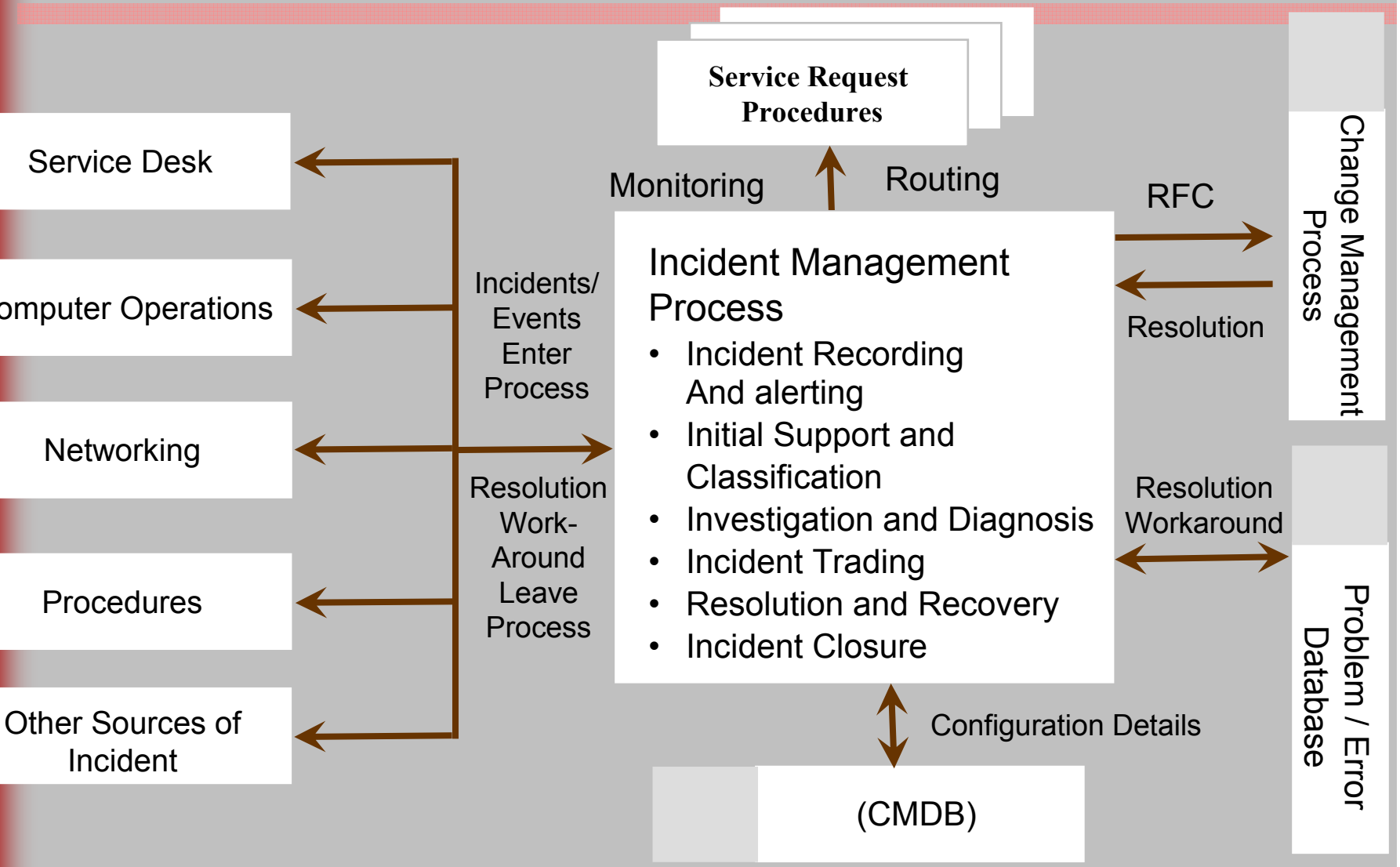
Incident Management - 2

- Incident Management Terms
  - Incident - any event which is not part of the standard operation of a service and which causes or may cause an interruption to or a reduction in the quality of that service
  - Work-Around – Intermediate method of avoiding an Incident or Problem
  - Service Request – Every Incident not being a failure in the IT infrastructure
  - Problem – The unknown root cause of one or more incidents (CAR)

Incident Management - 3

- Known Error – A condition that exists after the successful diagnosis of the root cause of a problem when it is confirmed that a Configuration Item is at fault (CAR)
- Priority – Impact on the business + Urgency / Effect upon business deadlines (PP)
- Category – Classification of a group of Incidents (Applications, Hardware, etc.)
- Escalation – Escalating the incident up the management chain (REQM, PPQA)

Scope of Incident Management



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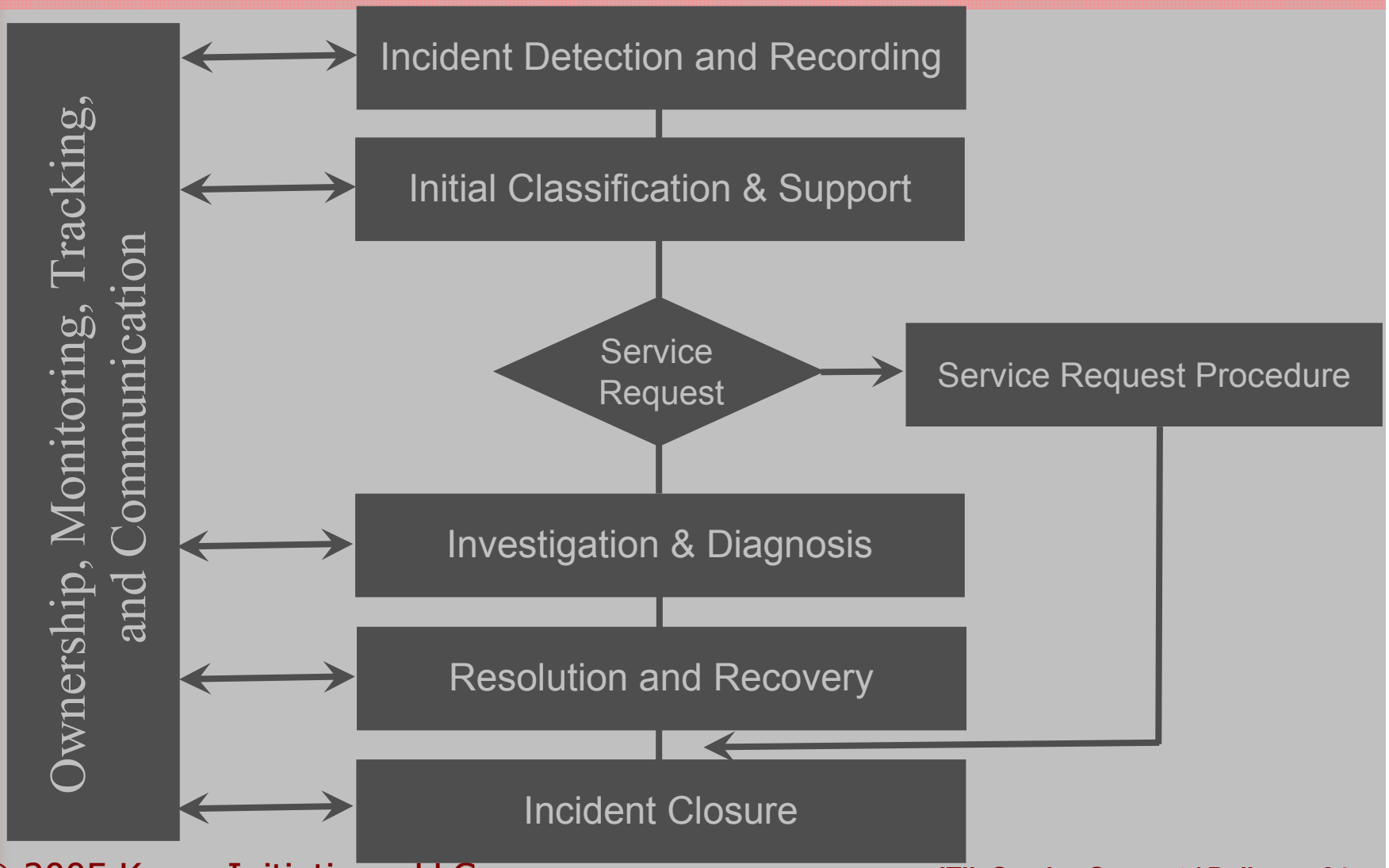
Incident Lifecycle



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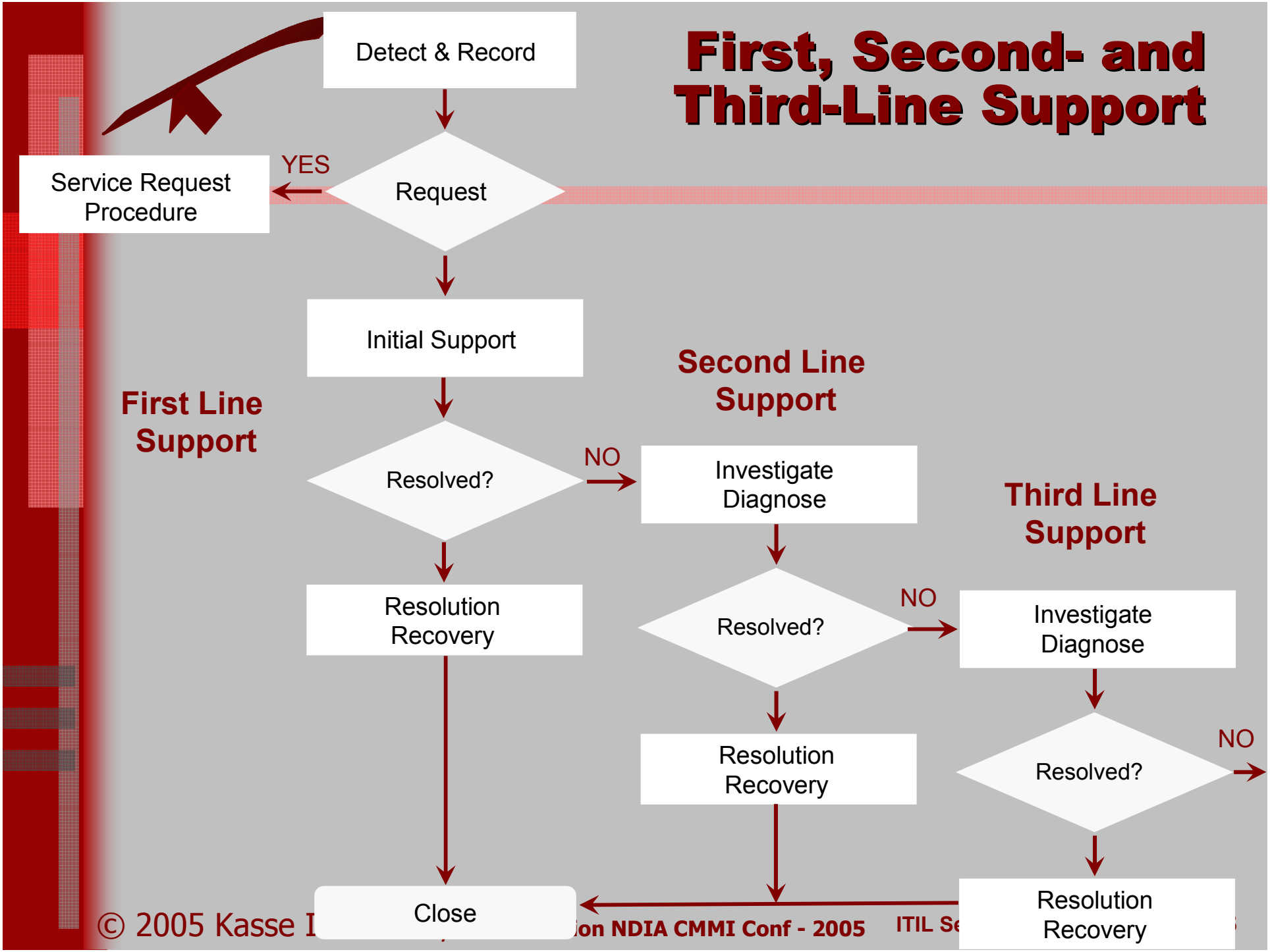
First, Second- and Third-Line Support



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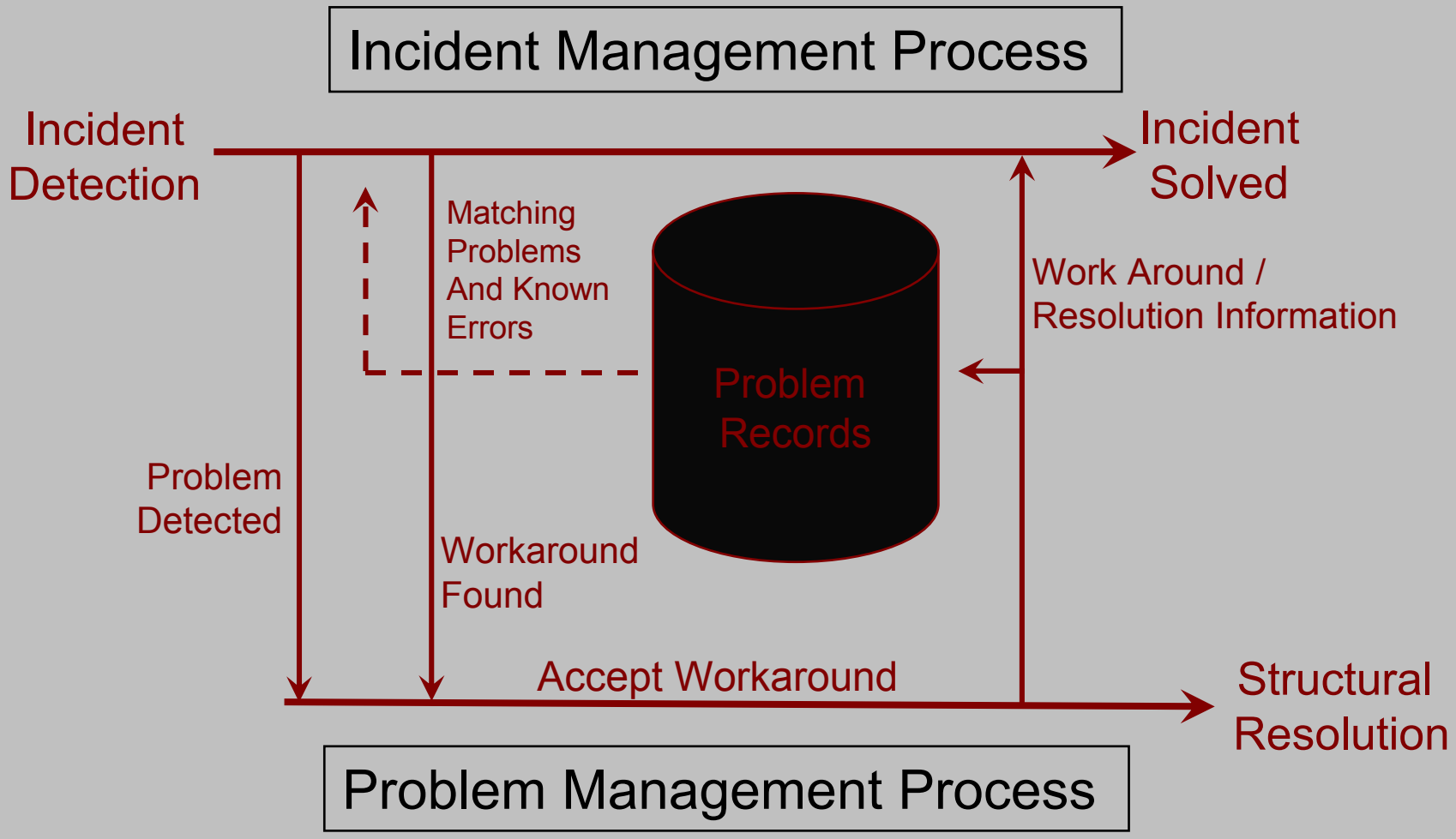
Handling Incident Work-Arounds and Resolutions



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Problem Management

- Problem Management stabilizes the IT Services through:
  - Minimizing the consequences of incidents
  - Removal of the root causes of incidents (CAR)
  - Prevention of incidents and problems (OID, OPD, OPF)
  - Prevent recurrence of Incidents related to errors (CM, OPD, OPF, OID)
- End goal is not to be the best in fixing incidents but to become proactive and stop the problems from occurring in the first place

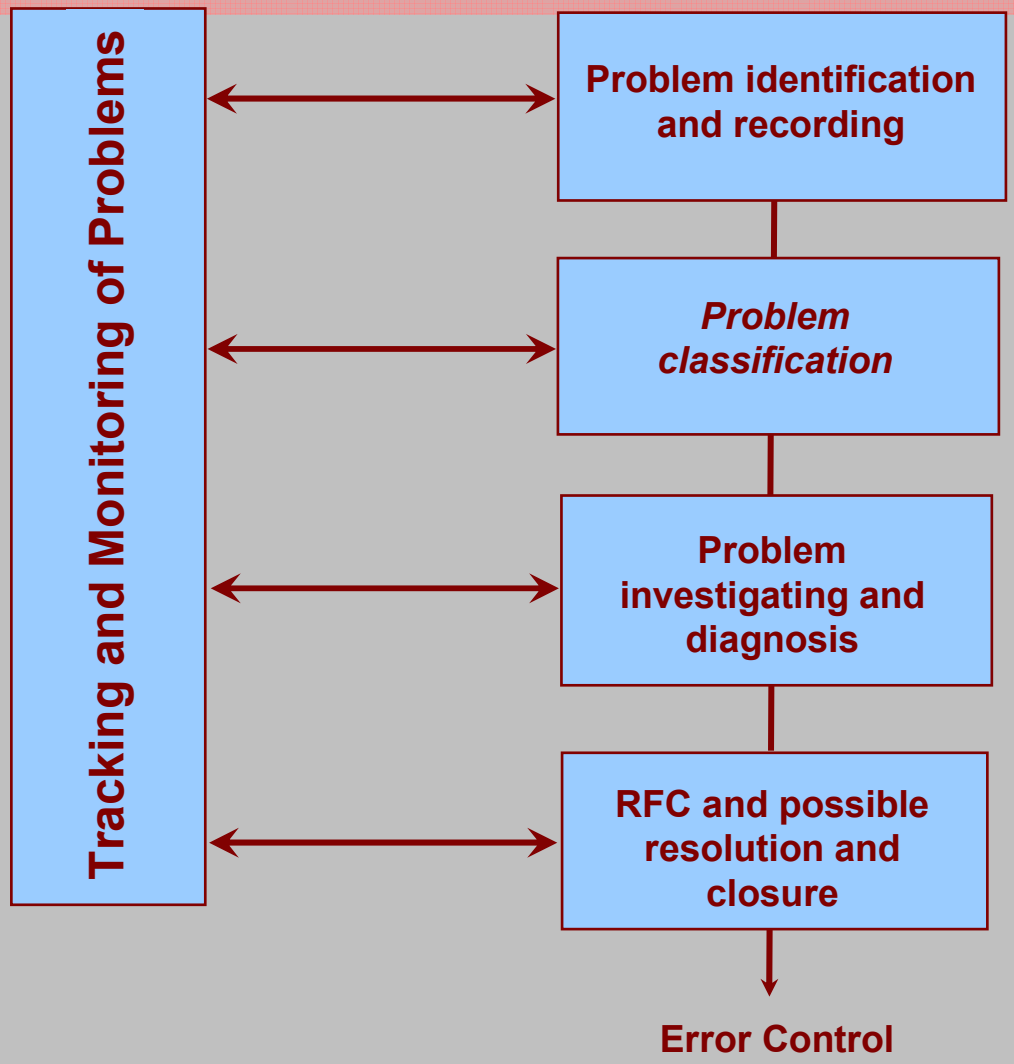
Problem Management - 2

- Inputs to Problem Management process
  - Incident details (CM)
  - Configuration details (CM)
  - Defined work-arounds
- Outputs from Problem Management process
  - Known errors
  - Requests for change
  - Updated Problem Records including work arounds and solutions

Problem Management - 3

- Known Errors resulting from development should be made known to the Helpdesk (GP 2.7 – Identify and Involve Relevant Stakeholders)
- Proactive Problem Management focuses on:
  - Trend Analysis
  - Targeting Support Action
  - Providing Information to the Organization

Problem Control



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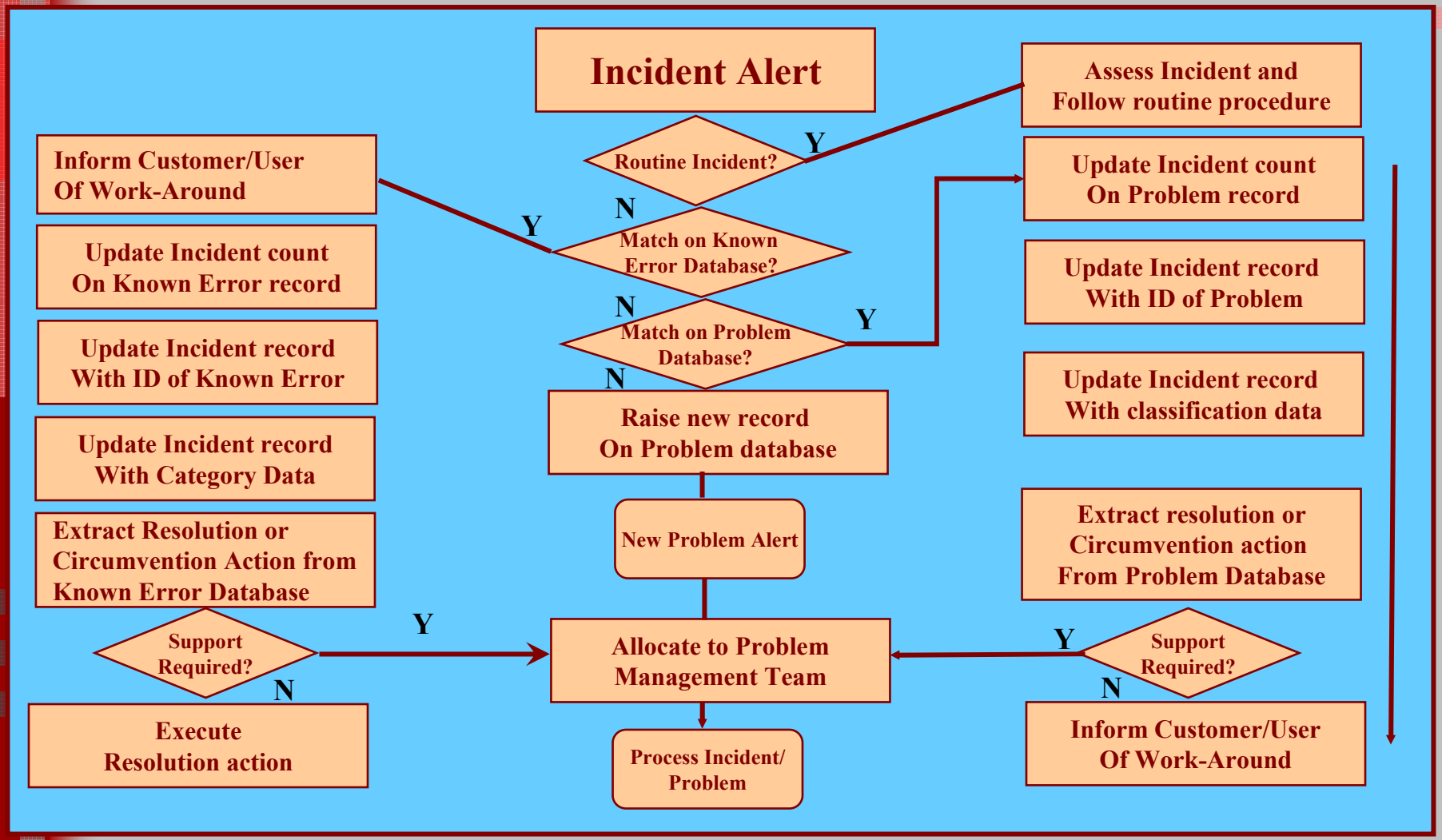
Incident-Matching Process Flow



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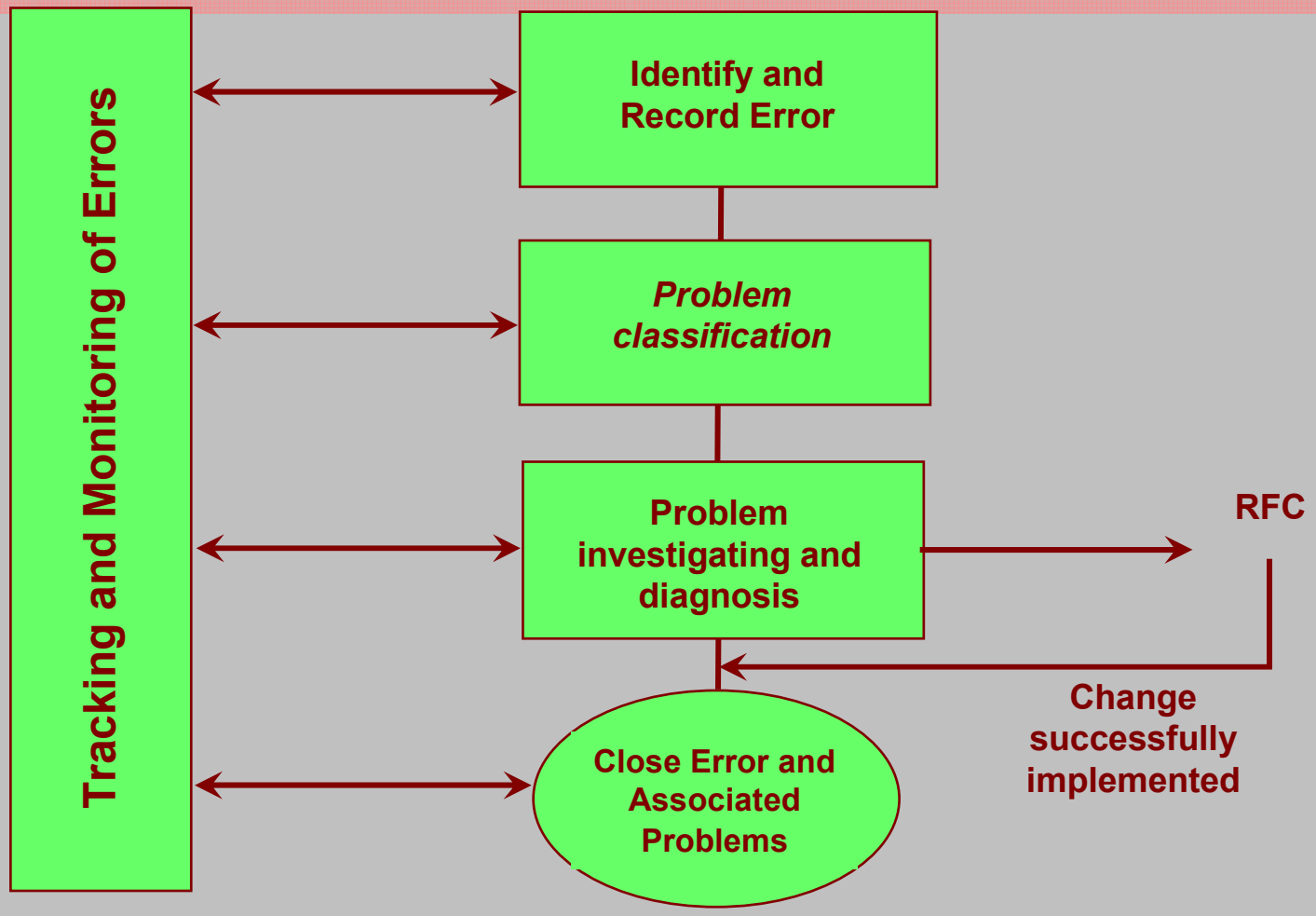
Error Control



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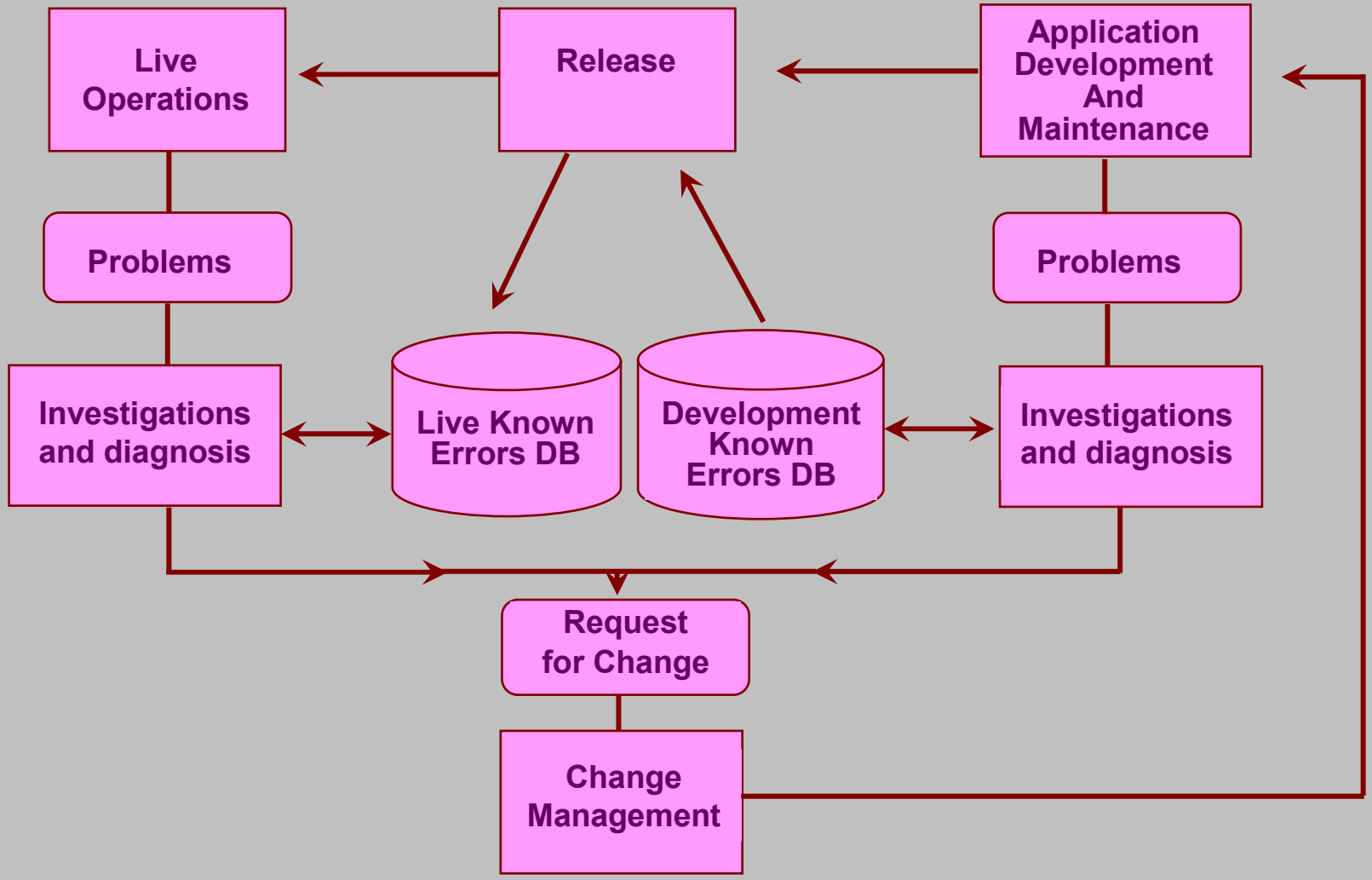
Error Cycle in the Live and Development Environments



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Change Management

- Change Management is implemented to implement approved changes efficiently, cost effectively and with minimal risk to the existing and to the new IT infrastructure
- Change Management tasks include:
  - Filtering Changes (REQM, CM)
  - Managing Change Process (CM)
  - Managing Changes (CM)
  - Chairing CAB (CM)
  - Review and Closure (CM)
  - Management Information (CM, GP 2.7)

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Change Management - 2

- Change Management Process (CM)
  - Request for a change
  - Registration and Classification
  - Monitoring and Planning
  - Approving
  - Build and Test
  - Authorize Implementation
  - Implementation
  - Evaluate

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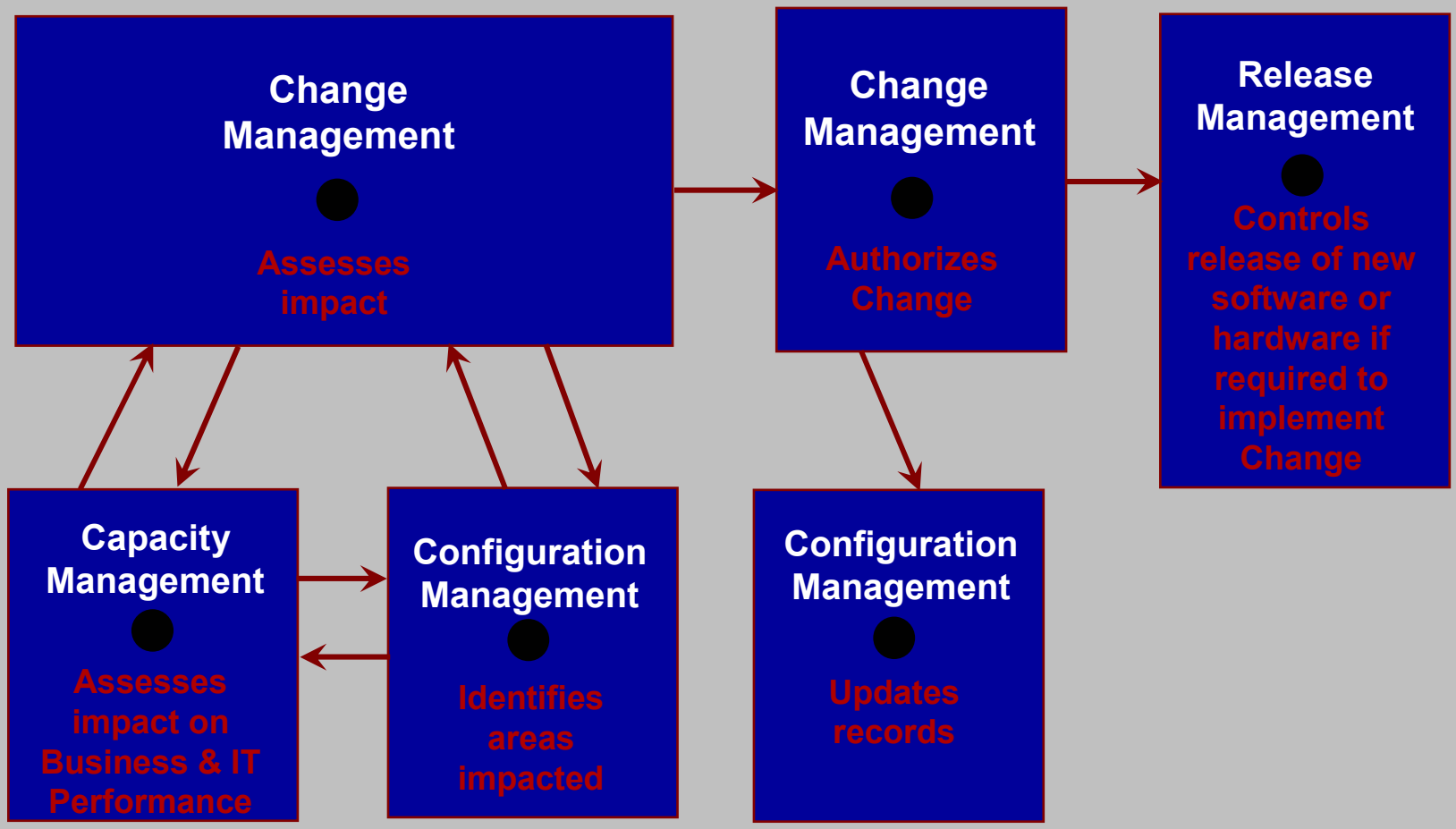
Change Management - 3

- Impact of a Change should be formulated according to incident classifications such as:
  - Category 1 – Little impact on current services
  - Category 2 – Clear impact on services
    - Request for Change (RFC) must be discussed in the Change Advisory Board
  - Category 3 – Significant impact on the services and the business
    - The RFC will have to be submitted to the board level Executive Committee

Change Management - 4

- Changes should be prioritized according to the business objectives and strategic planning
- A Change “Backout” plan must always be possible
- Change management always ends with a review of the change (CM)

Relationship between Capacity Management, Change Management, Configuration Management, and Release Management



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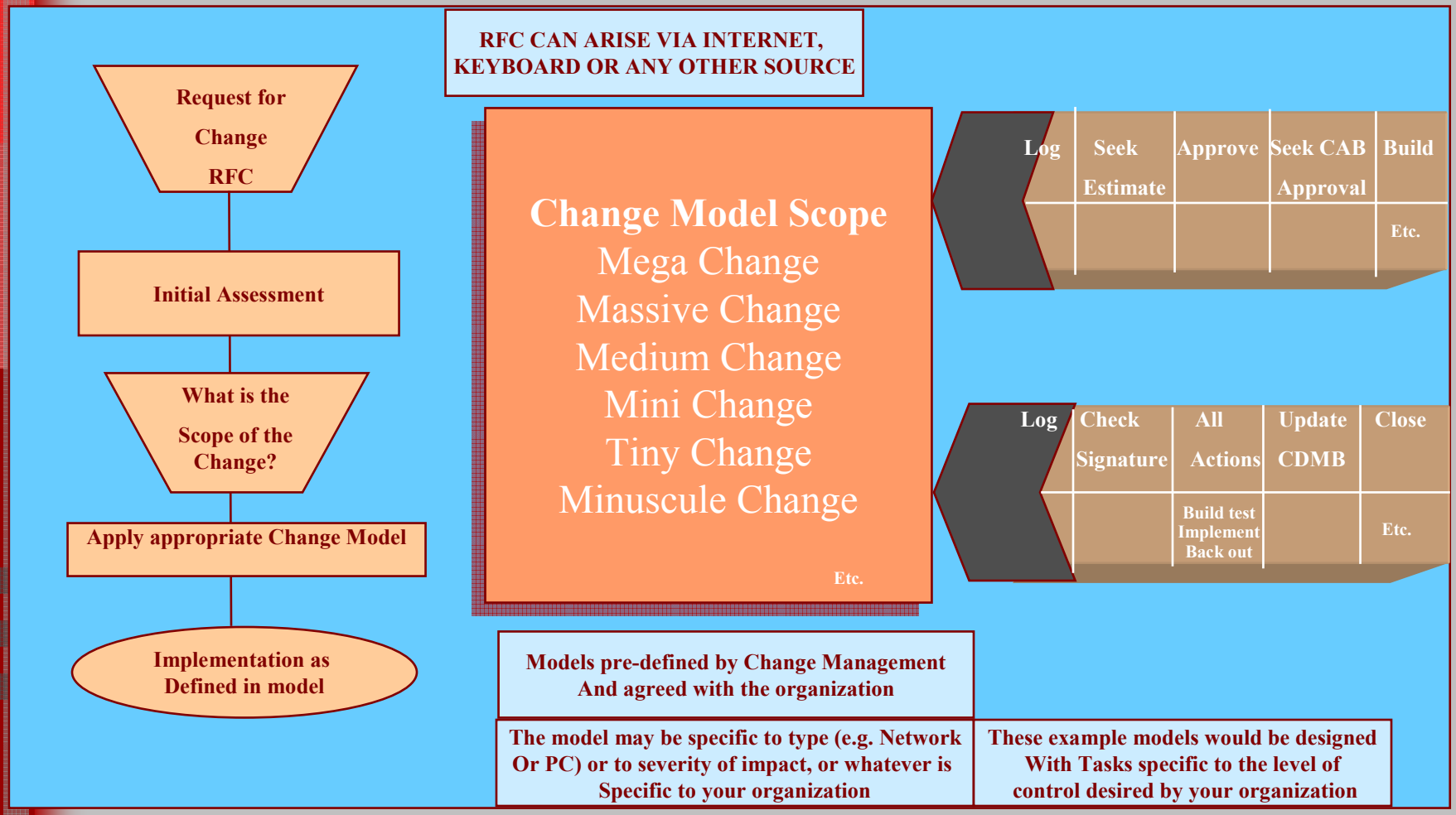
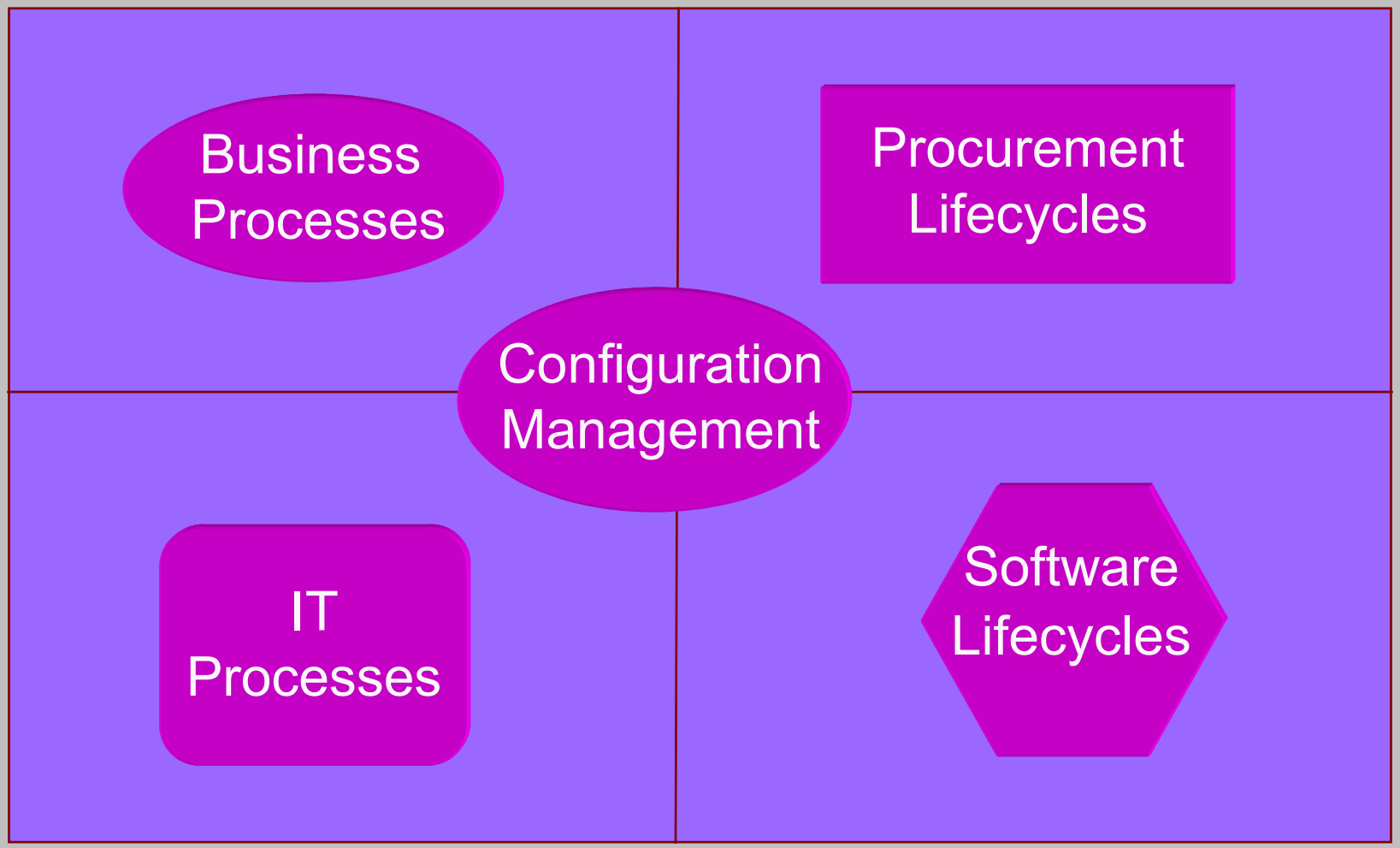
An Approach for Standard Change Management Procedures



Scope for Extending Change Management and Configuration Management Control



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Configuration Management

- Configuration Management (CM)
  - Provides information on the IT Infrastructure to all other processes and the IT Management
  - Enables control of the infrastructure by monitoring and maintaining information on:
    - Resources needed to deliver services
    - Configuration Item status and history
    - Configuration Item relationships

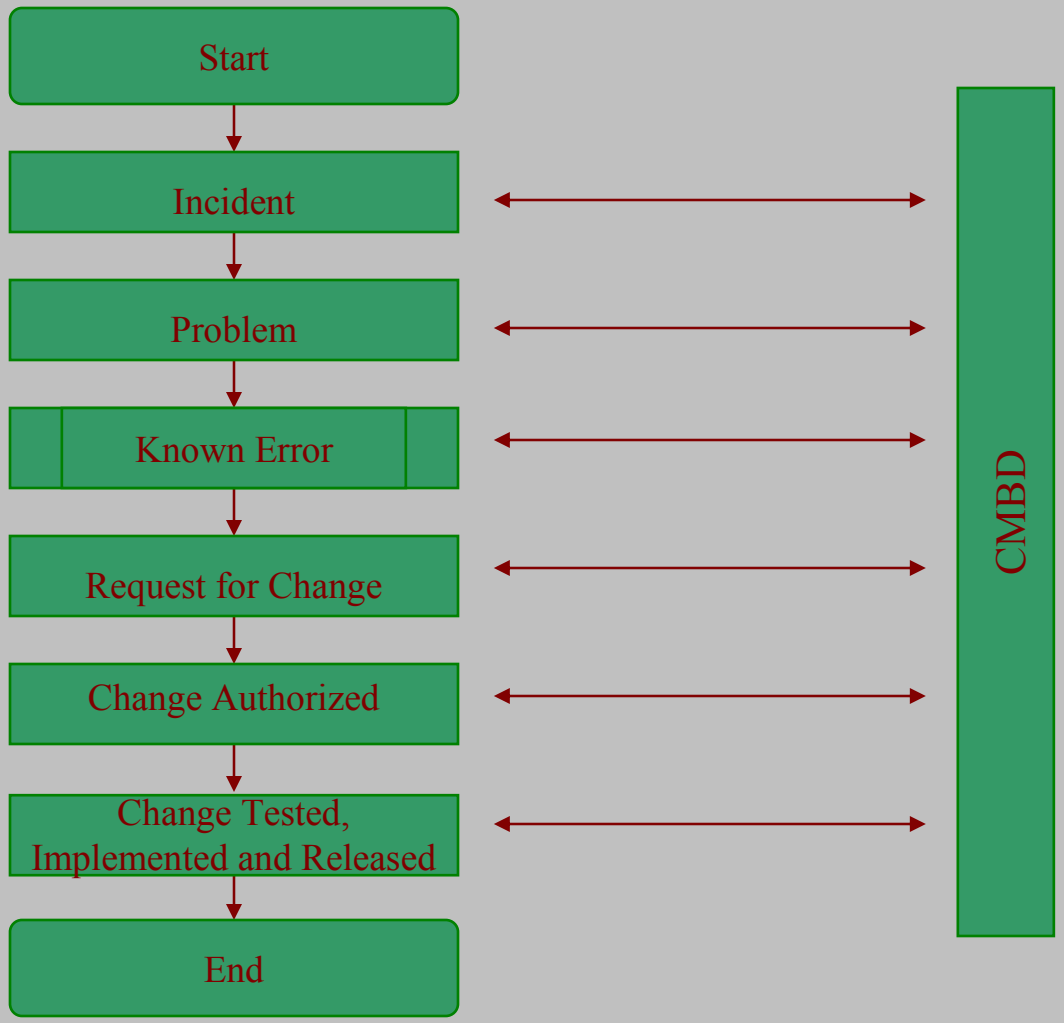
Configuration Management - 2

- Configuration Management Tasks
  - Identification and naming
  - Management Information
  - Verification (VER, PPQA)
  - Control
  - Status Accounting
- Configuration Management Database
  - Contains all relevant details of each Configuration Item
  - Contains details of the important relationships between CIs

Configuration Management - 3

- Configuration Item
  - Is needed to deliver a service
  - Is uniquely identifiable
  - Is subject to change
  - Can be managed
  - Has a category, relationships, attributes and a status
- Configuration Management support all other processes!

CMDB interfacing to Incident, Problem, Change and Release Management



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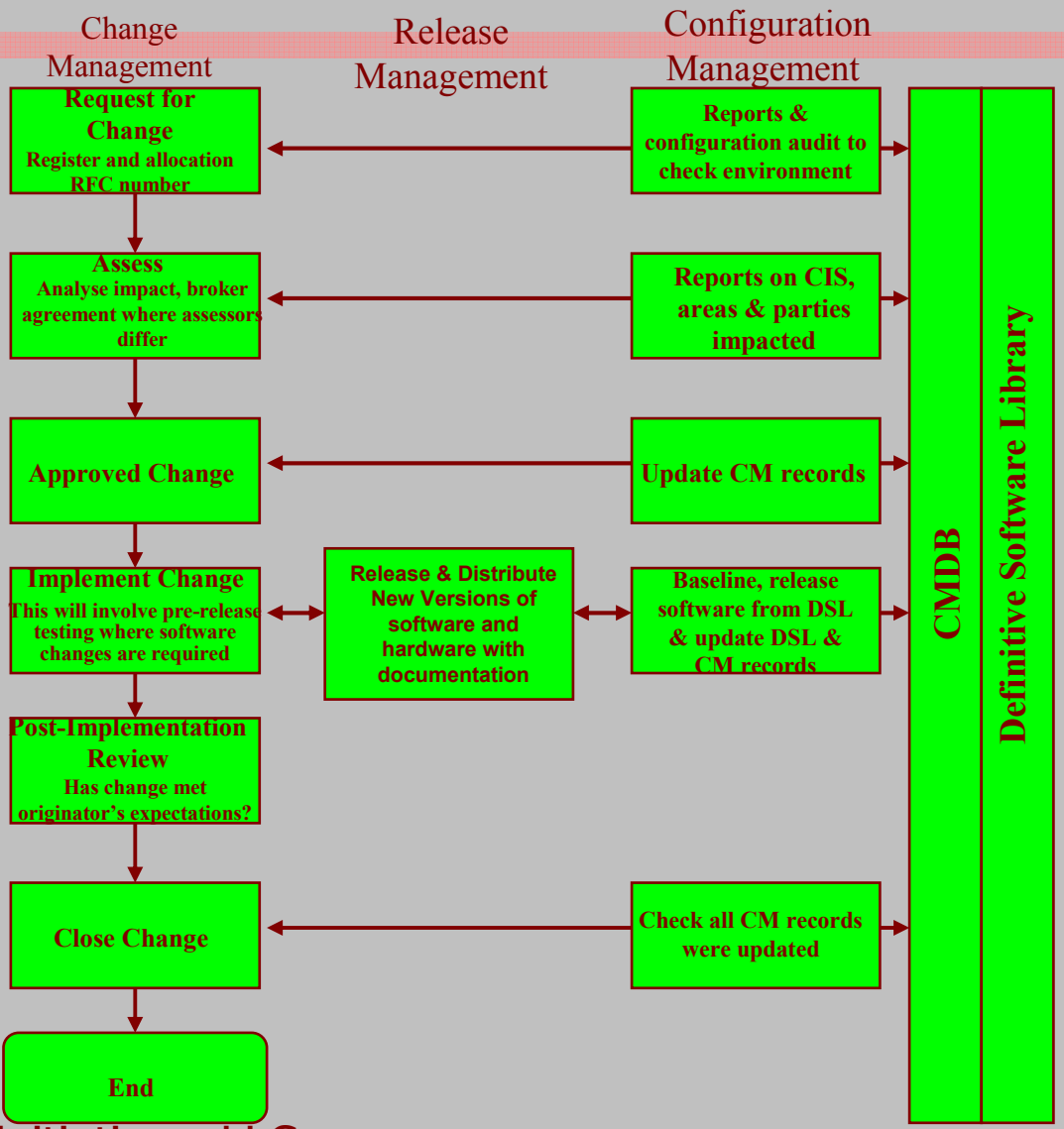
Relationship between Configuration, Change and Release Management



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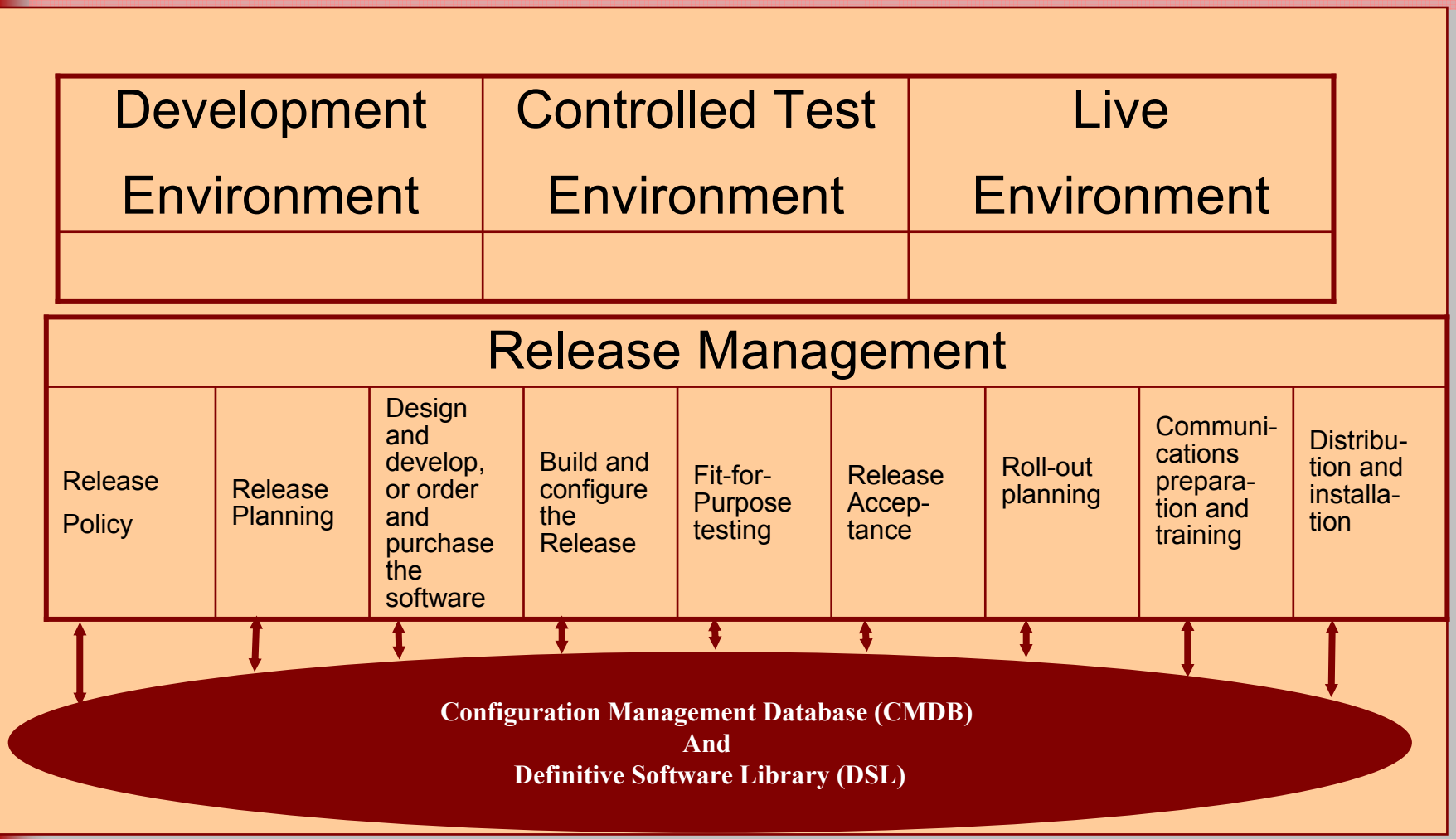
Release Management

- Release Management provides service support by:
  - Safeguarding all software and related items (CM)
  - Ensuring that only tested / correct version of authorized software and hardware are in use
  - Ensuring that the right software is in the right place at the right time
  - Ensuring that the right hardware is in the right place at the right time

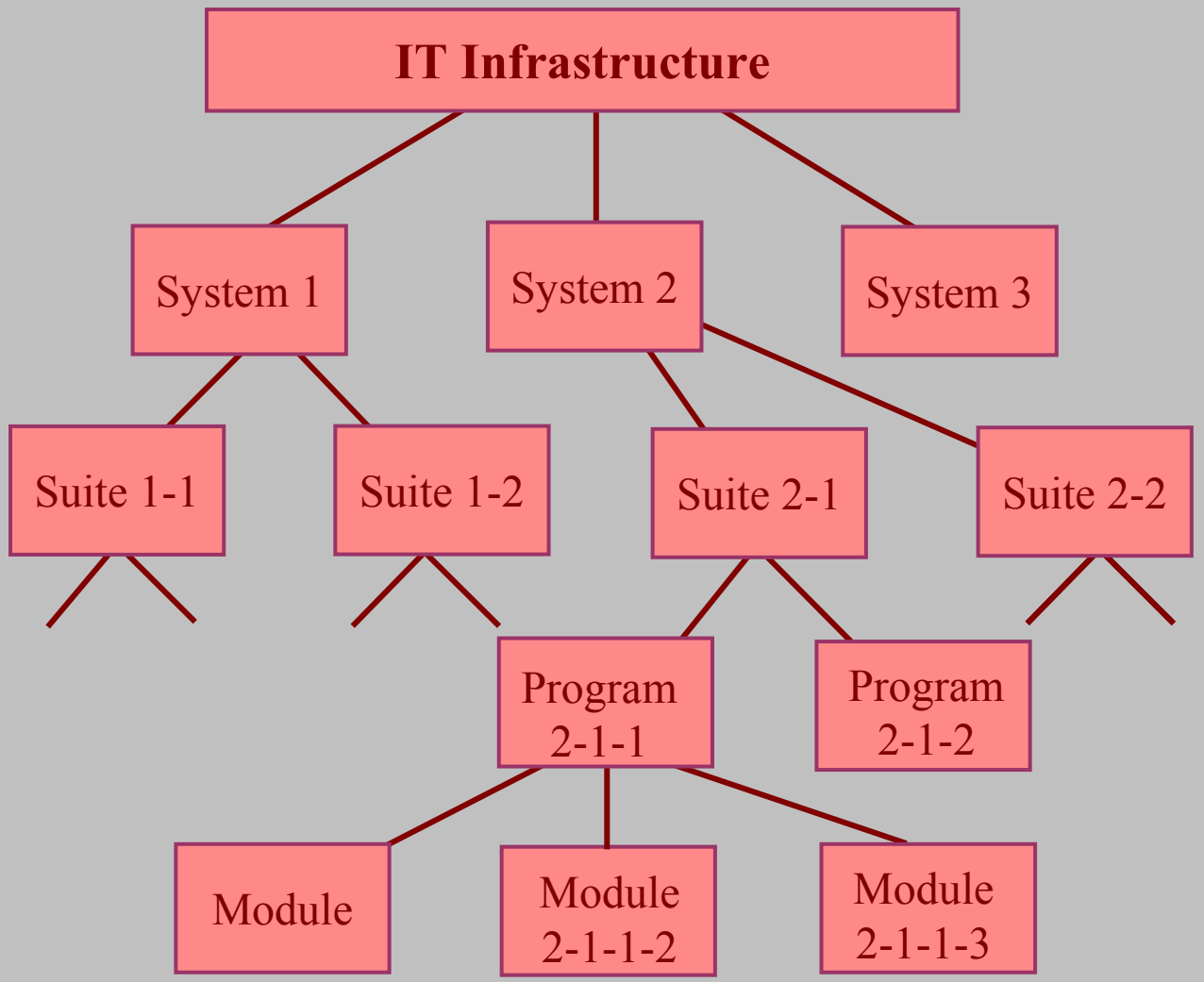
Release Management - 2

- Releases are done under the control of Change Management (CM)
- Release Management tasks include:
  - Define the release policies
  - Controlling the Software Library
  - Controlling the Hardware Storage
  - Distributing the Software and Associated CIs
  - Carrying out Software audits
  - Managing the software releases
  - Overseeing the build of the software releases

Major Activities in Release Management (VER – VAL)



Simplified Example of an IT Software Infrastructure



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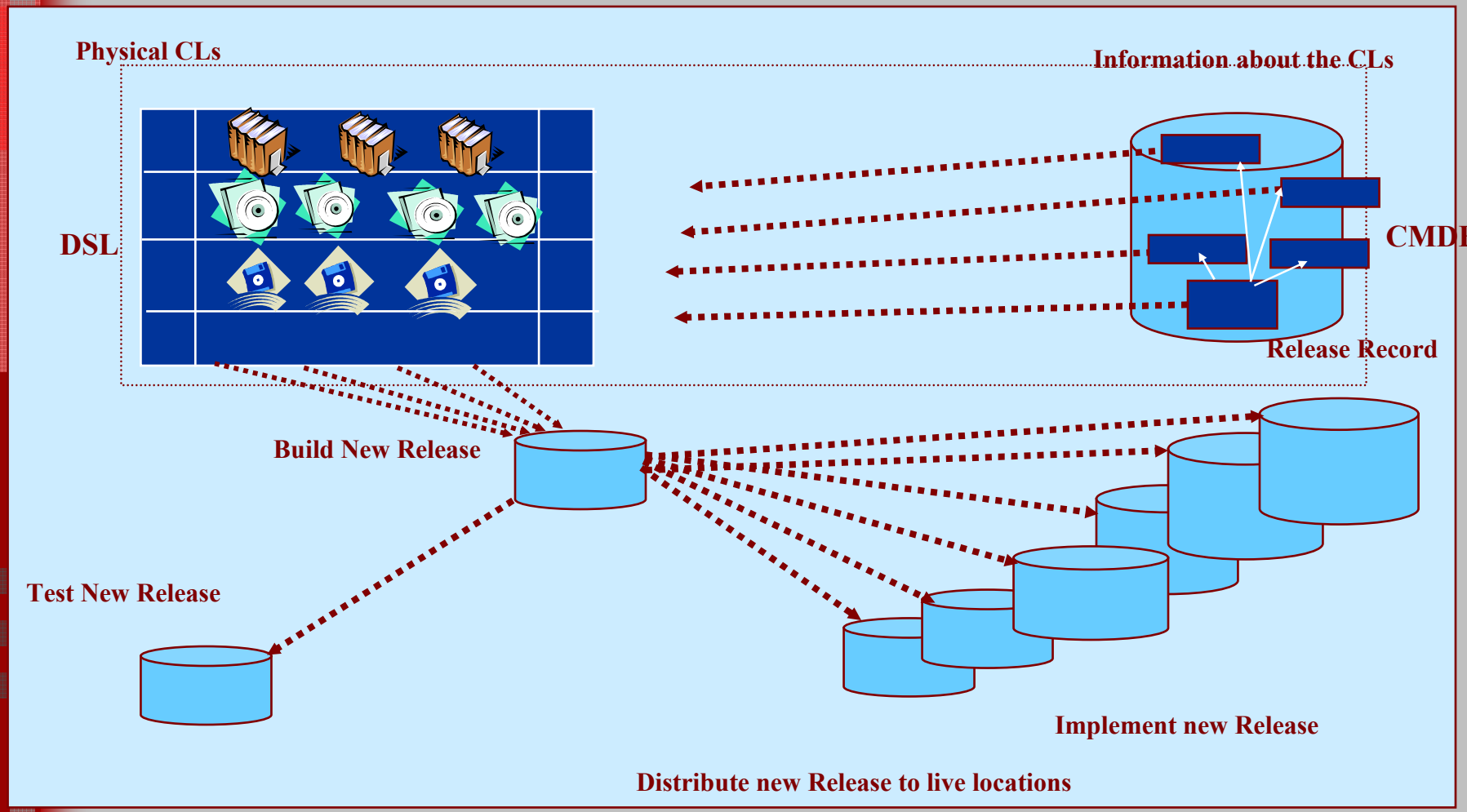
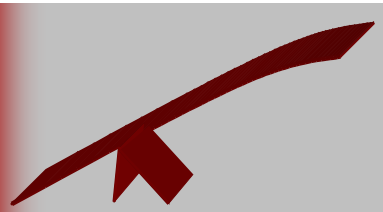
Definitive Software Library and CMDB relationship





Configuration Management & Change Management

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Configuration Management

- Purpose
- Establish and maintain the integrity of work products using configuration identification, configuration control, configuration status accounting, and configuration audits.

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Configuration Management Goals

- SG 1: Establish Baselines
  - Baselines of identified work products are established.
- SG 2: Track and Control Changes
  - Changes to the work products under configuration management are tracked and controlled.
- SG 3: Establish Integrity
  - Integrity of baselines is established and maintained.

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SP1.1-1 Identify Configuration Items

Identify the configuration items, components, and related work products that will be placed under configuration management

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Examples of Configuration Items

Examples of work products that may be identified to be placed under configuration control include:

- Requirements Specification
- Architecture Specification
- Interface Specifications
- Design Specifications
- Product Specifications
- Drawings
- Code Modules
- Project Plan
- Quality Plans
- Configuration Management Plan
- Risk Management Plan
- Test Plans
- Test Procedures
- Development Procedures
- Standards
- Product Technical Publications
- Compilers
- Operating Systems
- Linkers/Loaders
- Procedure Languages
- Shell Scripts
- Other related support tools
- Third Party Tools
- Data Dictionaries
- System Build Files
- Product Data Files
- Logical Data Structures
- User Interface files, data
- Installation / Configuration files

etc...

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SP1.2-1 Establish a Configuration Management System

Establish and maintain a configuration management and change management system for controlling work products

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Configuration Management System

- A configuration management system is established containing the baselines as they are developed
- A configuration management system includes the storage media, the procedures, and the tools for accessing the configuration system
- A change management system includes the storage media, the procedures, and tools for recording and accessing change requests – It is part of the CMS

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Configuration Management System - 2

- A well functioning configuration management system includes the following functions:
  - Managing multiple control levels of configuration management – (Organizational, Product Line, Project)
  - Creation and dissemination of configuration management status reports to projects
  - Preserving the contents of the configuration management system
    - backup and restoring of configuration management files
    - recovery from configuration management errors
    - archiving of configuration management files
    - disaster recovery

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SP1.3-1 Create or Release Baselines

Create or release baselines for internal use and for delivery to the customer

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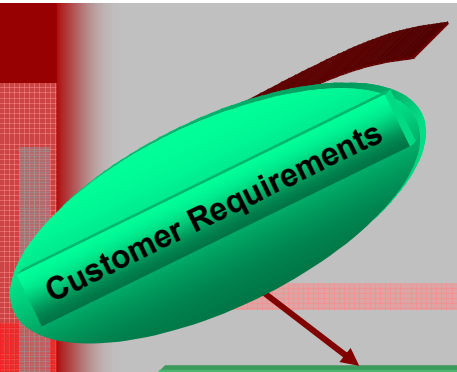
Baselining

- A baseline is an approved snapshot of the one or more configuration items at appropriate points in the development lifecycle
  - Record of a contract
  - Serves as the basis for further development
  - Can be changed only through an agreed upon change control procedure
- A baseline could be
  - A specification (i.e., requirements specification, design specification)
  - A product that has been formally reviewed and agreed upon
  - A partial system

Mapping of System and Developmental Baselines



Functional Baseline → System Requirements Specification Review
{Product or Product Component Requirements}

Allocated Baseline → Software Requirements Specification Review
Interface Requirements Specification Review
{Customer Requirements}

TRACEABILITY

Requirements Baseline	Software Requirements Specification Review Interface Requirements Specification Review {Org., Proj., or Other Outside Requirements}
Architectural Design Baseline	Architecture Specification Review
Detailed Design Baselines	Design Specification Review
Module Baselines	Code Walkthroughs or Inspections Module Testing from baseline
Integration & Test Baselines	Integration & Interface Testing from baseline
Systems Testing Baseline	Systems Testing & Functional Configuration Audit from baseline

Product Baseline → Physical Configuration Audit on System or Product and Deliverable customer documentation becomes Operational Baseline

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SP 2.1-1 Track Change Requests

- Change requests apply to not only new or changed requirements, but also system failures and defects in work products
- The change request process typically contains the following steps:
  - The change request is recorded
  - The impact the change will have on the work product, related work products, and schedule and cost is determined
  - The change request is reviewed and agreement is reached with those affected by the change request
  - The change request is tracked to closure

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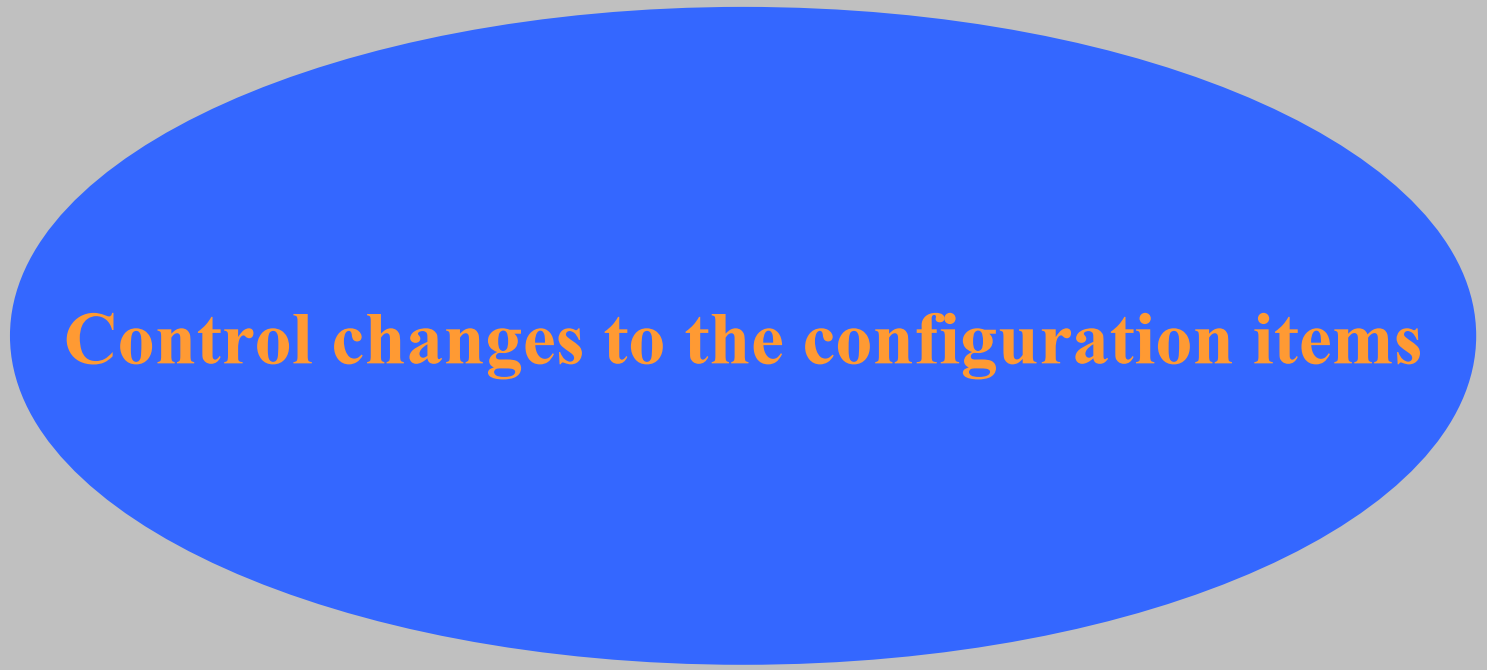
SP2.2-1 Control Configuration Items



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Change Control

- Change control involves:
  - Tracking each configuration item
  - Approving a new configuration
  - Updating the baseline
- Check-in, check-out procedures are used to maintain the correctness and integrity of the CMS
- Reviews and regression testing are performed to ensure that changes have not caused unintended effects on the baselines
- Authorization from the Configuration Control Board must be obtained before changed configuration items are re-entered into the CMS
- All changes and the reasons for the changes must be recorded in sufficient detail to provide change history and support configuration management status accounting

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SP3.1-1 Establish Configuration Management Records

Establish and maintain records describing configuration items

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Configuration Management Status Accounting

- Status reports on a given baseline and changes made to it are readily available
  - All relevant stakeholders, especially project leaders should have access to and knowledge of the configuration status of the configuration items
    - may involve a human being
    - may be provided by the Configuration Management tool
    - Periodically sent out to affected groups and individuals
  - Previous versions can be recovered
  - The difference between successive baselines is able to be clearly described
  - Current status and history of each configuration item are maintained and updated as necessary

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SP3.2-1 Perform Configuration Audits

Perform configuration audits to maintain integrity of the configuration baselines

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Configuration Auditing

- Configuration audit verifies that the product is built according to the requirements, standards, or contractual agreement
- Verifies that all product components have been produced, correctly identified and described, and that all change requests have been resolved

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Configuration Auditing - 2

- Baseline audits are conducted:
  - The integrity of the baselines is assessed
  - The completeness and correctness of the baseline library contents are verified
    - based on the requirements as stated in the plan and the approved requirements change requests
  - The product's functionality and performance are compared to the requirements
  - The documentation that is baselined for maintenance activities and for operational use is compared to the requirements

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“Service Support”

Change Management

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Module Objective

- Define the scope of the Service Support function of Change Management in the IT Infrastructure Library (ITIL)
- Provide an overview of the basic Change Management functions
- Show relationships between Change Management and
  - Incident Management
  - Problem Management
  - Configuration Management
  - Release Management
  - Capacity Management

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Goals of Change Management

- Changes arise as a result of Problems
- Changes also can come from proactively seeking business benefits such as reducing costs or improving services
- The goal of the Change Management process is to ensure that **standardised methods and procedures** are used for efficient and prompt handling of all Changes, in order to minimise the impact of Change-related Incidents upon service quality

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Goals of Change Management - 2

- To make an appropriate response to a Change request entails a considered approach to:
  - Assessment of risk and business continuity
  - Change impact
  - Resource requirements and change approval
- This considered approach is essential to maintain a proper balance between the need for change against the impact of the change

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Change Management and Configuration Management

- It is generally accepted that Change Management and *Configuration Management* are best planned and implemented concurrently
- Implementing Change and Configuration Management concurrently allows the organisation to weigh the risks of not implementing either process properly at the planning stages

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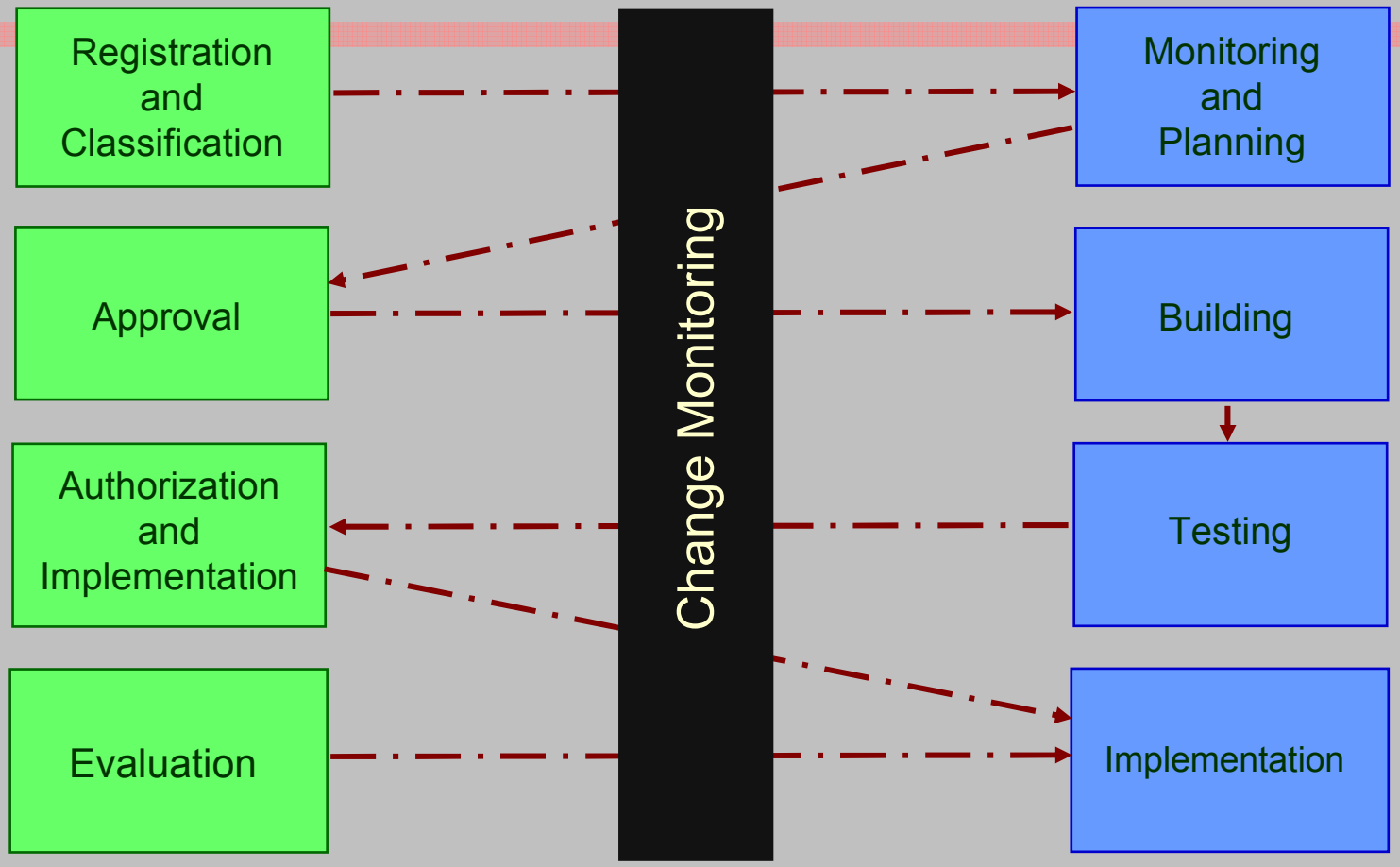
Change Management and Project Management



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Scope of Change Management

- Change Management is responsible for managing change processes involving:
  - Hardware
  - Communications equipment and software
  - System software
  - 'Live' applications software (In production)
  - All documentation and procedures associated with the running, support and maintenance of live systems

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Scope of Change Management - 2

- This means that changes to any components that are under the control of an applications development project – for example, applications software, documentation or procedures – do not come under ITIL Change Management!
  - These would be subject to ***project*** Change Management procedures
- The Change Management team will, however, be expected to liaise closely with Application Management project managers to ensure smooth implementation and consistency within the changing management environments

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Scope of Change Management - 3

- NOTE: Change Management makes the process happen, but the decision authority is the Change Advisory Board (CAB), which is made up for the most part of people from other functions within the organisation
- NOTE: It is Configuration Management who is responsible for ensuring that information regarding the possible implications of a proposed change is made available, and that these possible impacts are detected and presented appropriately

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Scope of Change Management - 4

- *Change Management* is not responsible for identifying components affected by *Change* or updating *Change Records* (the domain of *Configuration Management*),
- Change Management is not responsible for the *Release* of new of changed components (the domain of Release Management).

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Scope of Change Management - 5

- **An Incident is not a Change!**
- A *Problem* may not lead to a Change
- A Change in infrastructure management terms **is the result of Problem fixing where there is '*a state different from a previously defined condition*'**
- The *Change Management* process should ensure that any Change plans include plans for back-out in the event of serious unforeseen problems

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Change Management

- The basic concepts of **Change Management** are principally process-related and managerial
- **Incident Management** is primarily technical, with a strong emphasis on the mechanical nature of some of the processes

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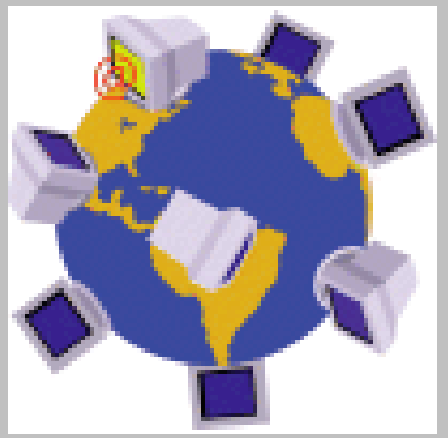
Request for Change

- RFCs can be concerned with any part of the infrastructure or with any service or activity:
  - Hardware
  - Software
  - Documentation
  - Telecommunications facilities
  - Engineering cover
  - Training courses
  - IT infrastructure management procedures
  - Tactical plans
  - Environmental infrastructure



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Change Review

- Change Management must review all implemented Changes after a predefined period has elapsed
- The purpose of such reviews is to establish that:
  - The change has had the desired effect and met its objectives
  - Users and Customers are content with the results, or to identify any shortcomings
  - There have been no unexpected or undesirable side-effects to functionality, availability, capacity/performance, security, maintainability etc.
  - The resources used to implement the change were as planned
  - The implementation plan worked correctly (so include comments from the implementers)
  - The change was implemented on time and to cost
  - The backout-plan functioned correctly, if needed

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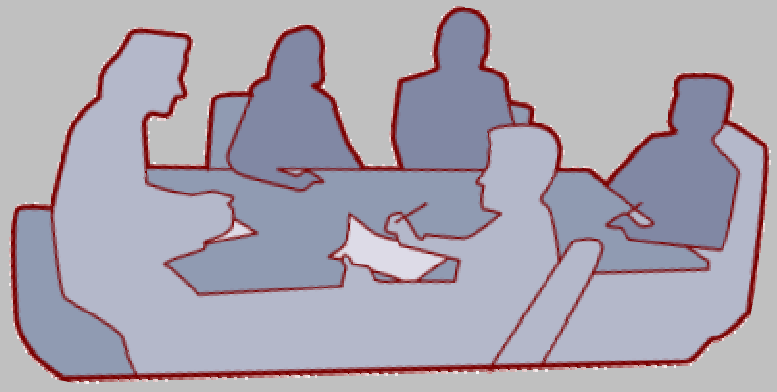
Change Advisory Board (CAB)

- The Change Advisory Board (CAB) is a body that exists to approve changes and to assist Change Management in the assessment and prioritisation of changes
- Its members should be chosen who are capable of ensuring that all changes are adequately assessed from both a business and a technical viewpoint
  - The CAB needs to include people with a clear understanding of the Customer business needs and the User community, as well as the technical development and support functions



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Change Advisory Board (CAB) - 2

- Suggested CAB membership includes:
  - Change Manager
  - Customer(s) affected by the Change
  - User manager(s)
  - User group representative(s)
  - Applications developers/maintainers (where appropriate)
  - Experts/technical consultants
  - Representatives of all major areas within the Service Management process
  - Senior Users, or their representatives.
  - Services staff (as required)
  - Office services staff (where Changes may affect accommodation and vice versa)
  - Contractor's or third parties' representatives (as required – for instance in outsourcing situations)

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Impact and Resource Assessment

- When conducting the impact and resource assessment for RFCs referred to them, Change Management, CAB, CAB/Executive Committee or any others who are involved in this process, should consider the following items:
  - Impact that the change will make upon the Customer's business operation
  - Effect upon the infrastructure and Customer service, as defined in the SLA, and upon the capacity and performance, reliability and resilience, contingency plans, and security
  - Impact on other services that run on the same infrastructure (or on software development projects)

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Outsourcing and Change Management

- When outsourcing is under consideration, the receiver of services needs to take into account the following issues concerning the Change Management process:
  - Who is responsible for managing day-to-day changes arising from RFCs, from whatever sources
  - What control do I have over the service provider so that I am not being made to pay for unreasonable changes?
  - How do I know that changes are not approved piecemeal, with a consequent impact on service and service cost?
  - Who is responsible for ensuring that major business changes are properly costed, approved, planned, controlled and implemented?
  - Who is responsible for the integrity of systems and services following changes?
  - Has security of systems been properly considered?
  - Who should sit on the CAB?

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Outsourcing and Change Management - 2

- The Buyer is responsible to ensure that service providers (outsourced or in house) provide the change management function and processes that match the needs of your organisation
- Ensure that you coordinate the Change Management, Incident Management, Release Management and *Configuration Management processes* across all of the organisations involved in service support, delivery and management

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“Service Support”

Configuration Management

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Goals of Configuration Management

- The goals of Configuration Management are to:
  - Account for all the IT assets and *configuration*s within the organisation and its services
  - Provide accurate information on configurations and their documentation to support all the other Service Management processes
  - Provide a sound basis for Incident Management, Problem Management, Change Management and Release Management
  - Verify the *configuration* records against the infrastructure and correct any exceptions

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Configuration Management Objectives

- Detailed objectives for Configuration Management should include:
  - Providing everyone working in Service Management and support with correct and accurate information on the present configurations with their physical and functional specifications
  - Defining and documenting the procedures and working practices to be followed
  - Identifying, labelling and recording the names and versions of the CIs that make up the IT services, infrastructure and their relationships (RD)
  - Controlling and storing definitive, authorised and trusted (CMMI – Masters) copies of specifications, documentation and software

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Configuration Management Objectives - 2

- Reporting the current status and history of all items on the IT infrastructure
- Ensuring that all Changes to CIs are recorded as soon as practicable
- Tracking and reconciling the actual state of the IT infrastructure against the authorised configuration records and data
- Educating and training the organisation in the control processes
- Reporting metrics on CIs, Changes and Releases
- Auditing and reporting exceptions to infrastructure standards and Configuration Management procedures

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Scope of Configuration Management

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Scope of Configuration Management

- Configuration Management covers the identification, recording, and reporting of IT components, including their versions, constituent components and relationships (CMMI – Identification, Baselining, Status Accounting)
- Items that should be under the control of Configuration Management include hardware, software and associated documentation

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Scope of Configuration Management - 2

- The Basic activities of Configuration Management (ITIL) are as follows:
  - **Planning** - Planning and defining the purpose, scope, objectives, policies and procedures, and the organisational and technical context, for Configuration Management
  - **Identification** - Selecting and identifying the configuration structures for all the infrastructure's CIs, including their 'owner', their interrelationships and configuration documentation
    - It includes allocating identifiers and version numbers for CIs, labelling each item, and entering it on the *Configuration management database* (CMDB).

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Scope of Configuration Management - 3

- **Control** - Ensuring that only authorised and identifiable CIs are accepted and recorded, from receipt to disposal
  - It ensures that no CI is added, modified, replaced or removed without appropriate controlling documentation, e.g. an approved Change request, and an updated specification
- **Status Accounting** - The reporting of all current and historical data concerned with each CI throughout its *life cycle*. This enables Changes to CIs and their records to be traceable
  - e.g. tracking the status of a CI as it changes from one state to another for instance ‘under development’, ‘being tested’, ‘live’, or ‘withdrawn’
- **Verification and Audit** - A series of reviews and audits that verify the physical existence of CIs and check that they are correctly recorded in the Configuration Management System (CMMI – CMS)

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Scope of Configuration Management - 4

- Configuration Management is responsible for incorporating new and updated product deliverables by interfacing directly with:
  - Systems development
  - Testing
  - Change Management
  - Release Management

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Configuration Identification

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Configuration Identification

- Configuration Identification is the selection, identification and labelling of the configuration structures and CIs, including their respective 'owner' and the relationships between them
- CIs may be hardware, software or documentation and include:
  - Services
  - Servers
  - Environment
  - Equipment
  - Network components
  - Desktops
  - Mobile units
  - Applications
  - Licences
  - Telecommunication services
  - Facilities

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Configuration Identification - 2

- Configuration identification includes allocating identifiers for CIs
- Other records and data associated with a CI include:
  - Incidents
  - Known errors
  - Problems
  - Corporate data about employees
  - Suppliers
  - Locations
  - Business units
  - Procedures

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Summary

- Businesses require quality IT services provided economically
- To be efficient and effective, all organisations need to control their IT infrastructure and services
- Configuration Management provides a logical model of the infrastructure or a service

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Configuration Management & Change Management ITIL - CMMI

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CM – ITIL-CMMI

CM-SG1 Establish Baselines

- The goal of the Change Management process is to ensure that standardised methods and procedures are used for efficient and prompt handling of all Changes, in order to minimise the impact of Change-related Incidents upon service quality
- This means that changes to any components that are under the control of an applications development project – for example, applications software, documentation or procedures – do not come under ITIL Change Management!

CM – ITIL-CMMI

- Configuration Management provides a logical model of the infrastructure or a service by identifying, controlling, maintaining and verifying the versions of Configuration items (CIs) in existence
- It is generally accepted that Change Management and Configuration Management are best planned and implemented concurrently

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ITIL Process Maturity Self-Assessment & Action Plan

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DEFINITIONS OF MATURITY LEVELS

LEVEL	MATURITY	DESCRIPTION
0	**ABSENCE**	***"There is absolutely no evidence of any activities supporting the process"***
1	**INITIATION**	***"There are ad-hoc activities present, but we are not aware of how they relate to each other within a single process"*** • No dedicated resources or real commitment
2	**AWARENESS**	***"We are aware of the process but some activities are still incomplete or inconsistent; there is no overall measuring or control"*** • Process driven by tool rather than defined separate from tool

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DEFINITIONS OF MATURITY LEVELS

LEVEL	MATURITY	DESCRIPTION
3	**CONTROL**	***"The process is well defined, understood and implemented"*** • Tasks, responsibilities and authorizations are well defined and communicated • Targets for quality are set and results are measured
4	**INTEGRATION**	***"Inputs from this process come from other well controlled*** ***Processes; outputs from this process go to other well controlled processes"*** • Quality and performance metrics transferred between processes
5	**OPTIMIZATION**	***"This process drives quality improvements and new business opportunities beyond the process"*** • Evidence of innovation • Quality management & continuous improvement activities embedded

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The Look and Feel of a Successful CMMI Implementation

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Welcome

WelKom

Huan Yín

Bienvenido

Bienvenue

Wilkommen

ΚΑΛΟΣ ΟΡΙΣΑΤΕ

Bienvenuto

Välkommen

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Agenda

- Engineering Systems Think
- Business Results
- Roles and Responsibilities
- Project Management
- Risk Management
- Quality Management
- Supplier Management
- Recursive Nature of Requirements Engineering
- Alternative Solutions
- Components to Products

Agenda - 2

- Improving Processes At The Organizational Level
- The Knowledge and Skills Base
- Integrated Teams
- Reducing Variation
- Establishing a Measurement Program
- Improving Beyond Stability
- Repeatable, Effective, and Long Lasting
- Process Improvement Means Change
- Constagedeous Approach to Process Improvement
- Summary

Engineering Systems Think

Laws of Engineering Systems Thinking

- Systems Thinking is a discipline for seeing the whole
- In all of the project's phases/stages, and along the system's life, the systems engineer has to take into account:
  - The customer's organization vision, goals, and tasks
  - The customer's requirements and preferences
  - The problem to be solved by the system and the customer's needs
- The whole has to be seen as well as the interaction between the system's elements
  - Iterative or recursive thinking must replace the traditional linear thinking

Laws of Engineering Systems Thinking - 2

- The solution is not always an engineering one – remember to always take into account
  - Business and economic costs
  - Reuse or utilization of products and infrastructure already developed
  - Organizational, managerial, political, and personal considerations
- The end user must be considered as a major part of the system
  - At each stage the human element must be considered

Business Results

Support for the Organization's Business Objectives

Business Objectives

- For a focus on Process Improvement to be successful, it must be tied to the organization's business objectives for example:
  - Improve predictability of development cycle length, delivery time and costs
  - Find and fix each problem once
  - Reduce system errors that are discovered by customers
  - Increased control of suppliers
  - Increase quality of products
  - Always work with the correct version of a module or life-cycle work product

Support for Senior Management's Vision

Vision

- Where does senior management think the organization will be in the next year, and in the next two to five years?
- What products will be in the mainstream?
- Who will the competitors be?
- Will there be collaborators or strategic alliance partners?
- What technology changes are expected and/or will be required to support the vision?

Vision - 2

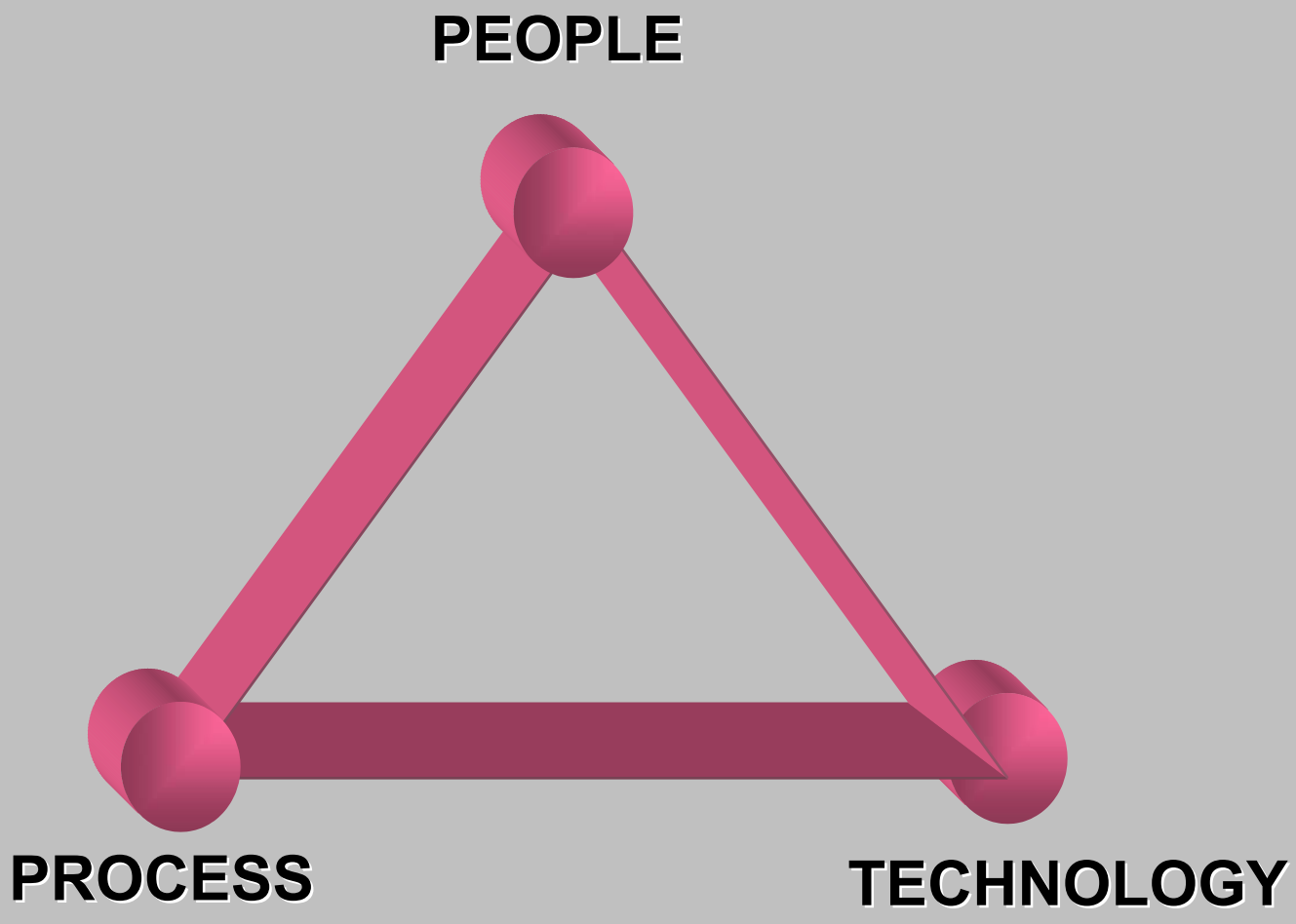
- What does the organizational structure have to be to support this vision?
- Who will the organization's suppliers be?
- What must the organizational culture be to support this vision?
- How will a Process Improvement Initiative support this vision?

Support for Project Leaders to Manage and Control Better

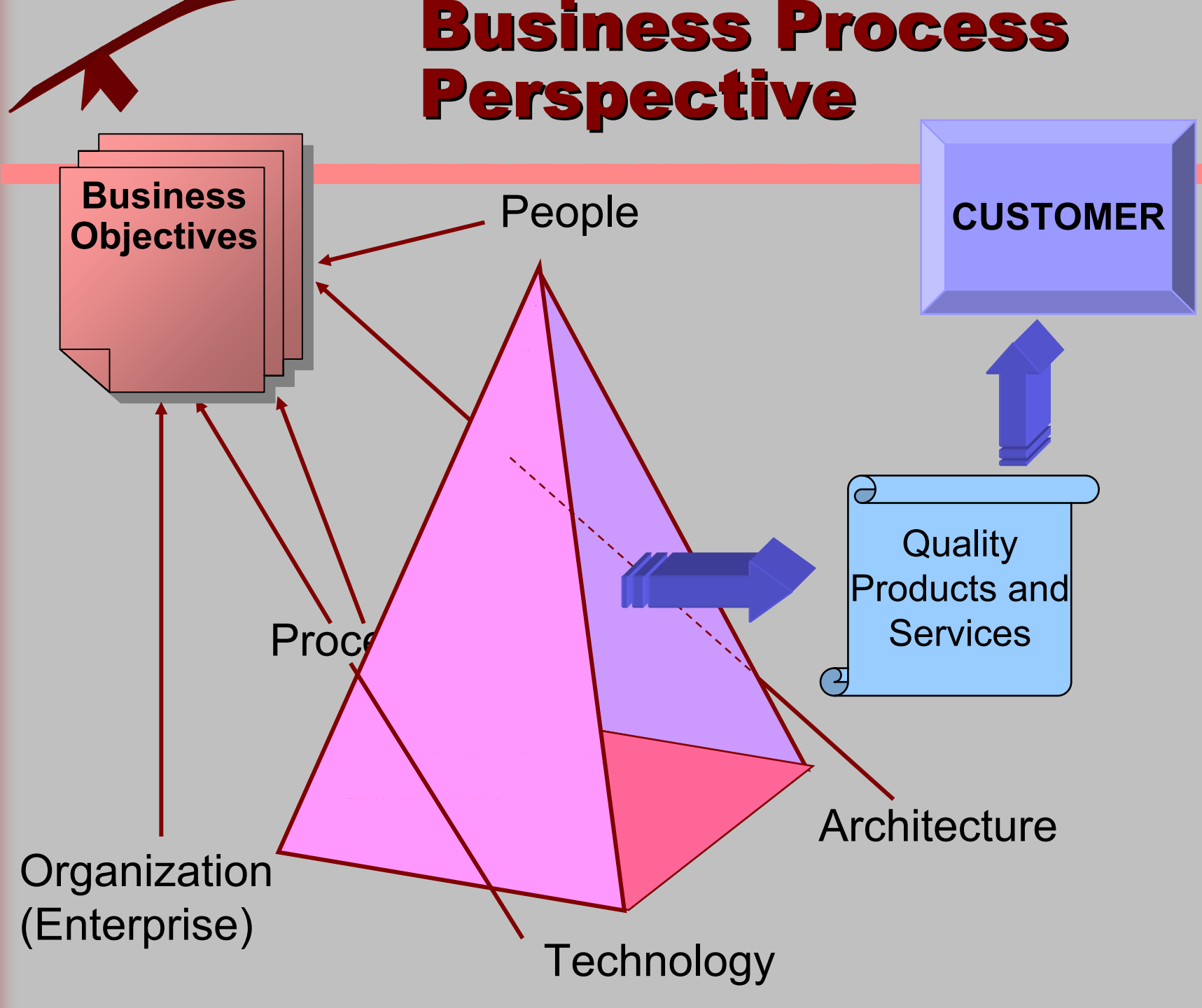
Process Improvement: What Value to Project Leaders?

- What measurable value will the quality management initiative bring to the project leaders who bear the line responsibility for product delivery?
  - More accurate schedules?
  - Higher productivity of developers?
  - Better quality products?
  - Traceable requirements?
  - Controlled configuration items?
  - Reviews focused on critical components?
  - Better control of suppliers?
  - Reduction in potential risks?

Process in Perspective



Business Process Perspective



Process and Business

Process and Business

- Process defines how a business does business
  - Software Engineering processes
  - Hardware Engineering processes
  - Systems Engineering processes
  - Manufacturing processes
  - Financial processes
  - Human Resources processes
  - Legal processes
  - ……..
- Process helps to establish the business culture and then sets guidelines and expectations

Process As A Methodology

- Process can be viewed as a methodology that is applied from elicitation of requirements to design through delivery
- Process helps the developers and maintainers to build in and retain the quality of the products and services and ensures profitability for the business
- There are no shortcuts – there are no other alternative methods that a business can adopt that embraces a “cradle to grave” philosophy to ensure quality and profitability with ***control*** every step of the way

Roles and Responsibilities

Senior Management Must Lead the Charge

- Since there are inherent costs to implementing process, Senior Management must demonstrate their belief in it through their communications, daily decision making, and financial commitment.
- Senior Management's resolve must not waiver when deadlines beg for shortcuts to get the product out the door

Senior Management

- Establish Policies – behavior expectation setting documents
- Allocate or reallocate resources
- Establish Authority and Responsibility
- Authorize Training
- Approve Organizational Commitments
- Have Senior Management Oversight into the processes used on projects and resulting product quality
- Provide Visible Management Support

Senior Management - 2

- Provide Visible Management Support
  - Ensuring effective bi-directional communication from Senior Management through developer
  - Developing or overseeing the development of management and technical policies
  - Establishing a Software Engineering Process Group (SEPG) if one does not exist along with the SEPG Chairman role
  - Setting up a Software Quality Assurance Group (SQA) Program at the organizational and project level
  - Ensuring that the Software Configuration Management function is established and operating on all projects

Middle Managers

- Provide the corporate bridge between the programs and projects and the senior management team
- Exercise risk management decision making based on data
- Guide the process improvement steering committee
- Serve as a “process owner”
  - The Middle Manager as “Process Owner” must participate in the periodic Senior Management Oversight Meeting and report the progress on his process focus area.

Project Manager

- Today's Project Manager is expected to be:
  - Better educated
  - Open, friendly, and people-oriented
  - A better listener
  - Quality conscious
  - Receptive to new ideas
  - More participative
  - A Facilitator
  - Skilled at group process and group dynamics
  - Encouraging to others to participate in plans and decisions
  - Skilled on how to coach, inspire, and motivate the project team
  - Able to span boundaries
  - Able to provide and apply integrative management techniques to unique, complex organizational ventures characterized by interdependent efforts, a variety of specialists, over multiple sites, multiple languages and multiple cultures

Project Manager - 2

- The Project Manager accepts responsibility for:
  - Working with the customer, the organization's Senior Management Team and outside groups such as regulatory agencies to determine which product components or subsystems should be treated as "critical"
  - Ensuring that Peer Reviews and Unit Tests are planned on the life-cycle work products that are identified from the product lifecycle chosen for the project
  - Ensuring that "developmental configuration management" is carried out on the project

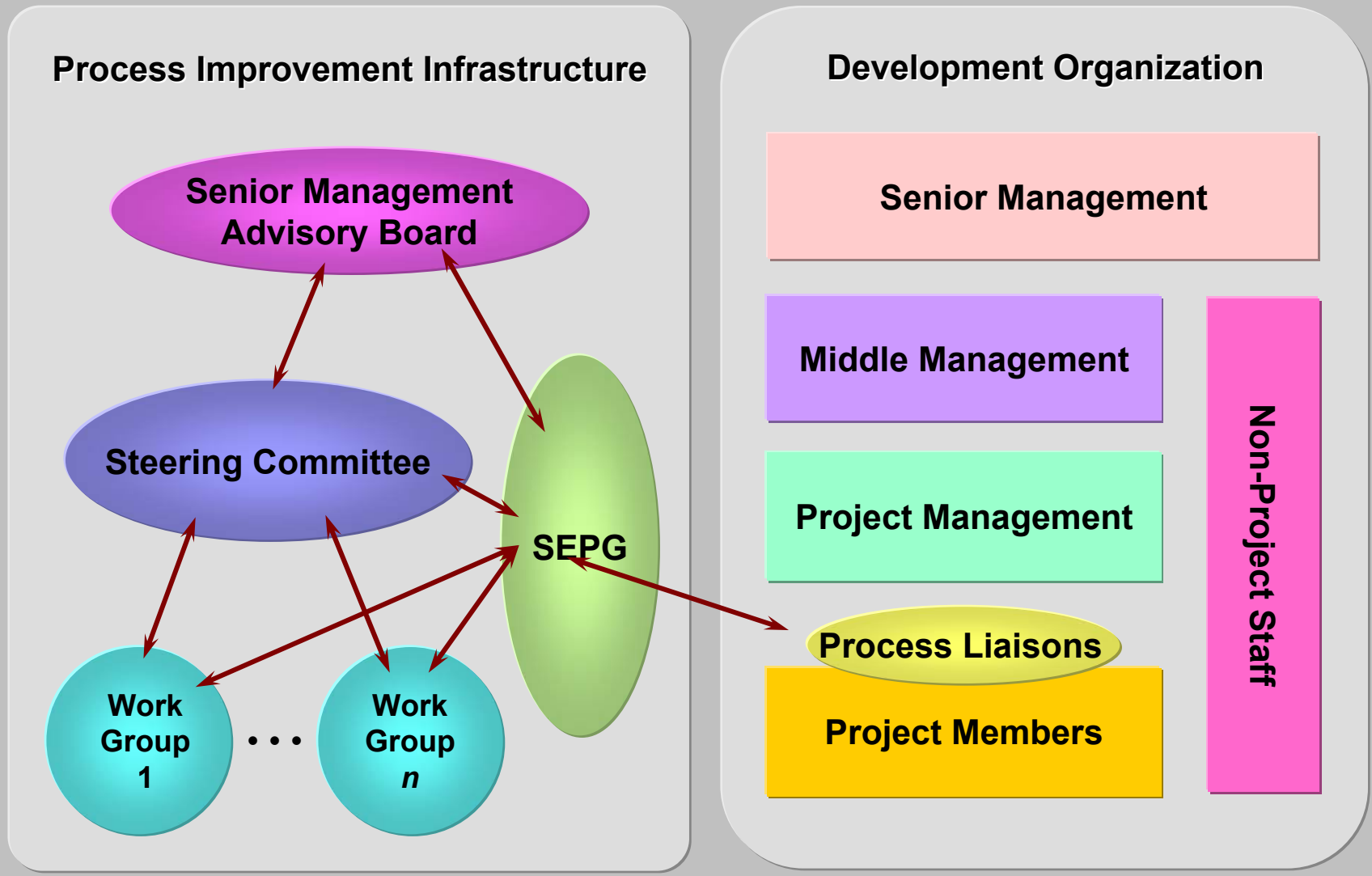
Project Manager - 3

- Reviewing and responding to Non-Compliance reports that are the result of “objective evaluations” carried out on the processes, procedures, standards, guidelines, templates and checklists that have been identified to be followed in the Project’s Quality Plan
- Supporting the “Escalation Procedure” that a Quality Engineer may follow if the project does not respond to the non-compliance reports in a timely fashion

Project Manager - 4

- Project Managers must manage their suppliers and are responsible for their involvement with:
  - Supplier Selection Criteria
  - Developing the requirements to a sufficient level to determine which requirements would or should be designed and implemented by a supplier
  - Developing the project plan to a sufficient level to determine if the Supplier's estimations are in line with project expectations
  - Helping to develop the Request for Proposal (RFP)
  - Helping to select the supplier based on the supplier selection criteria
  - Leading the "orientation meeting" with the Supplier's team to ensure complete understanding of what is expected and who is responsible for what part of the development
  - Managing the Supplier through specialized project management activities that keep track of Supplier's progress and performance
  - Ensuring that the Supplier's capability level is maintained through periodic review

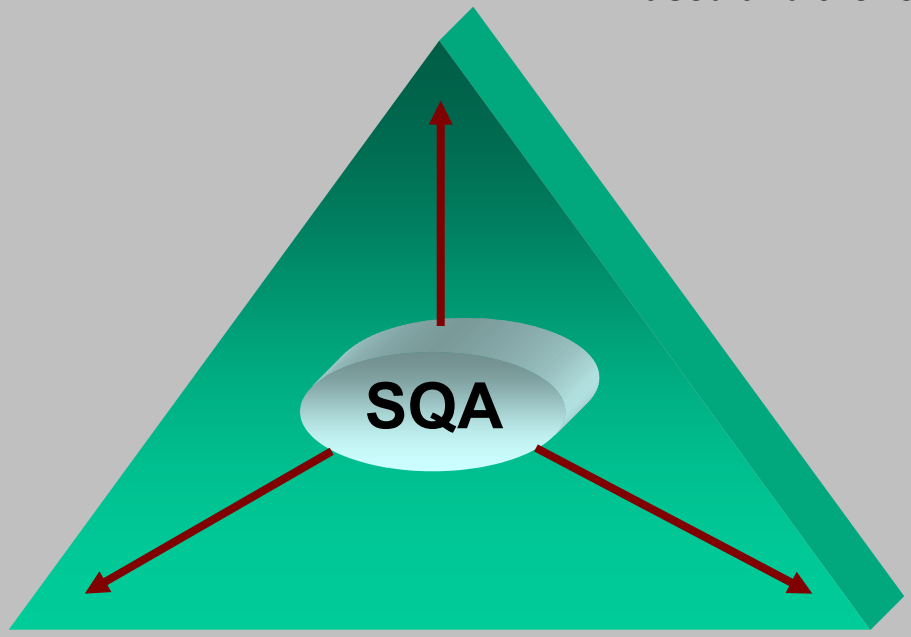
Process Group: Sample Improvement Infrastructure



SQA - Agent for Process Improvement

Management

Provides visibility into the effectiveness and efficiency of the processes being used and the resulting product quality



Developers

Provides feedback to the individual projects on the efficiency and effectiveness of the processes that they are following so they can be improved at the project level

SEPG

Provides feedback to the SEPG on the organizational processes they have facilitated in developing so they can be improved at the organizational level

CM Roles and Responsibilities

- Configuration Management Group
  - Configuration Management Manager
  - Configuration Management Engineer
  - Configuration Management System Manager
  - Test Library Manager
  - Release Library Manager
- Project Manager
- Project Team
- Project CM Specialist
- Configuration Control Board
  - Organizational Level
  - Project Level

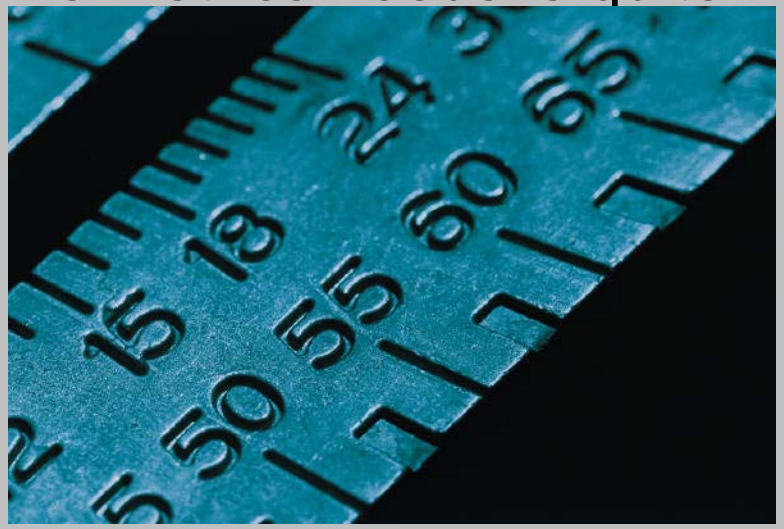
Mapping of System and Developmental Baselines

Integration & Systems Testing

- Integration ensures the product components match the interface descriptions and “fit together”
  - Interfaces are tested to ensure that Systems Testing can be conducted against a complete system or subsystem
- Systems Testing is the first time at which the entire system can be tested against the Systems Specification
- Systems Testing measures and determines what the systems capabilities are
- Systems test plan covers types of testing to be performed, test strategies, test coverage approaches, methods and approach for tracing requirements to test cases, and reliability metrics

Measurement Team

- Most organizations have at least one person who has an interest in and an ability to understand metrics and measurements
- Few organizations have a designated Measurement Group
- While it may not seem worthwhile for an organization to form a separate Measurement Group, having a measurement expert or two supporting the organization's metrics needs is quite valuable



Systems Engineering

- Systems Engineering provides a “cradle to grave” view of the evolving system
- Systems engineers help to define the total technical and managerial effort required to transform the set of customer needs, expectations, and constraints into a life-cycle balanced solution

Project Management

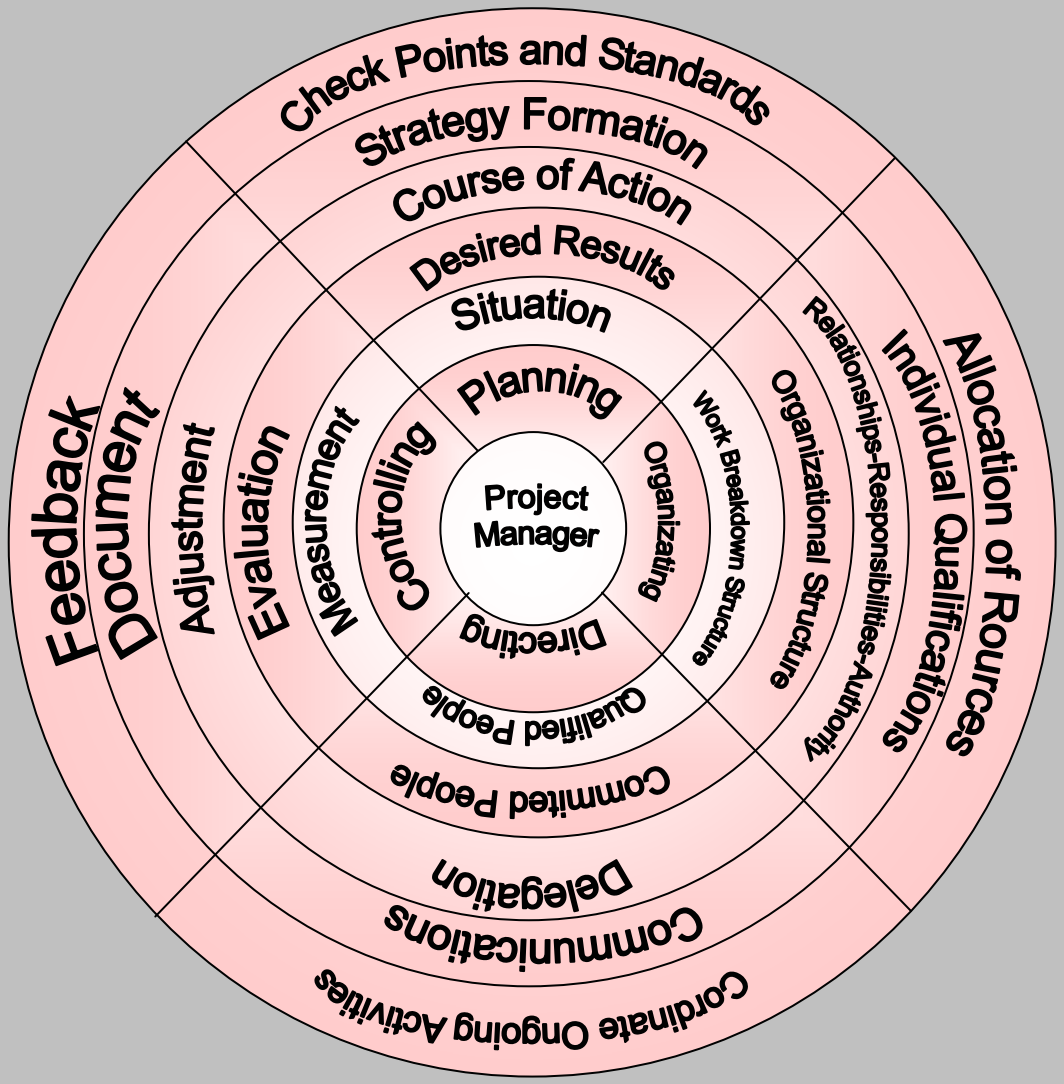
Project Management

- Project Management is a set of tools, techniques and knowledge that, when applied, helps produce better results for a project
- Project Management provides a process that can help answer basic questions:
  - What are you going to produce?
  - What is it the customer wants and needs?
  - Who is going to do the work?
  - How long will it take?
  - How much will it cost?
  - What might go wrong?
  - How can you avoid potential problems?

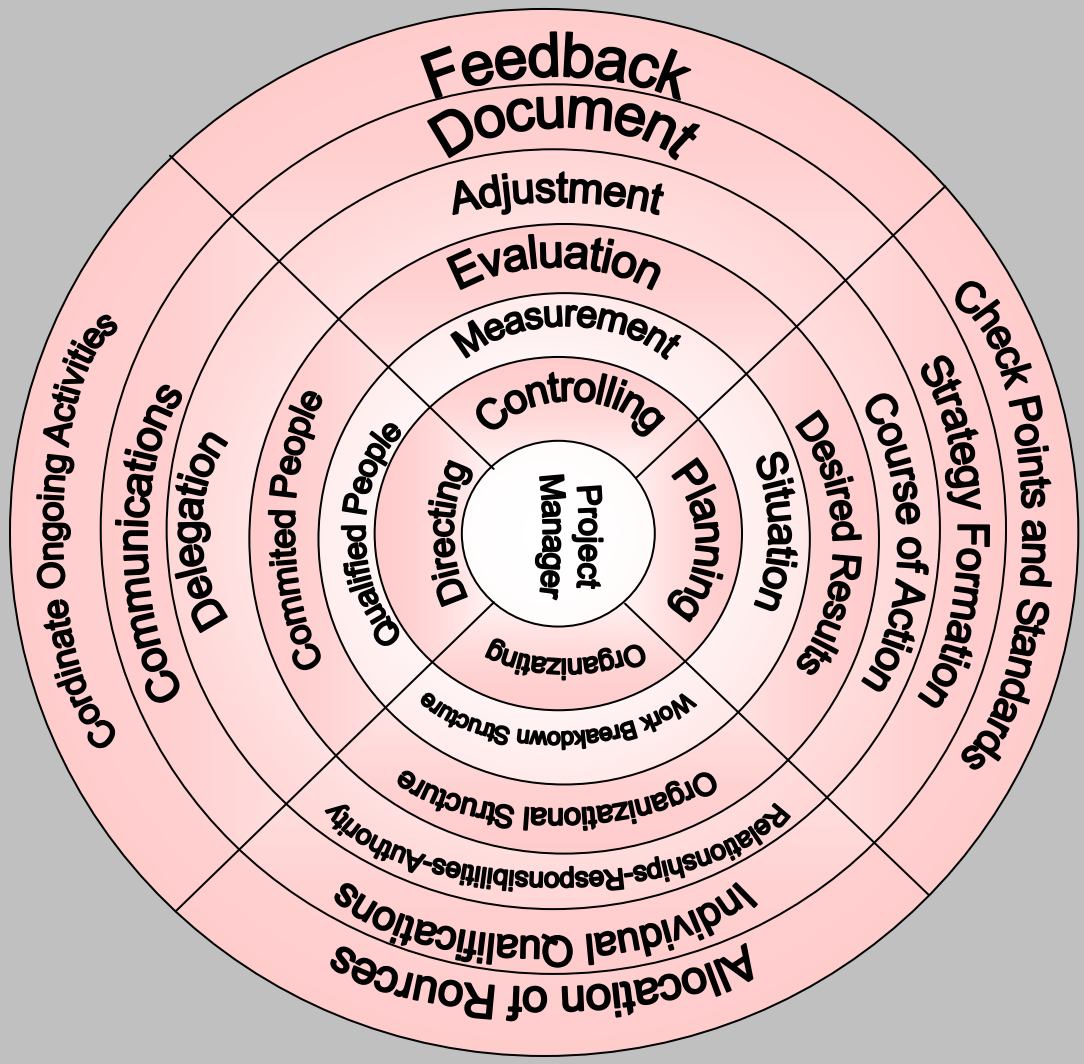
Project Management - 2

- Project Management functions include:
  - Define scope of project
  - Work Breakdown Structure
  - Estimation
  - Risk Management
  - Stakeholder Involvement
  - Commitment Process
  - Planning including integrating all support plans that affect the project
  - Supplier Management
  - Monitoring and Control

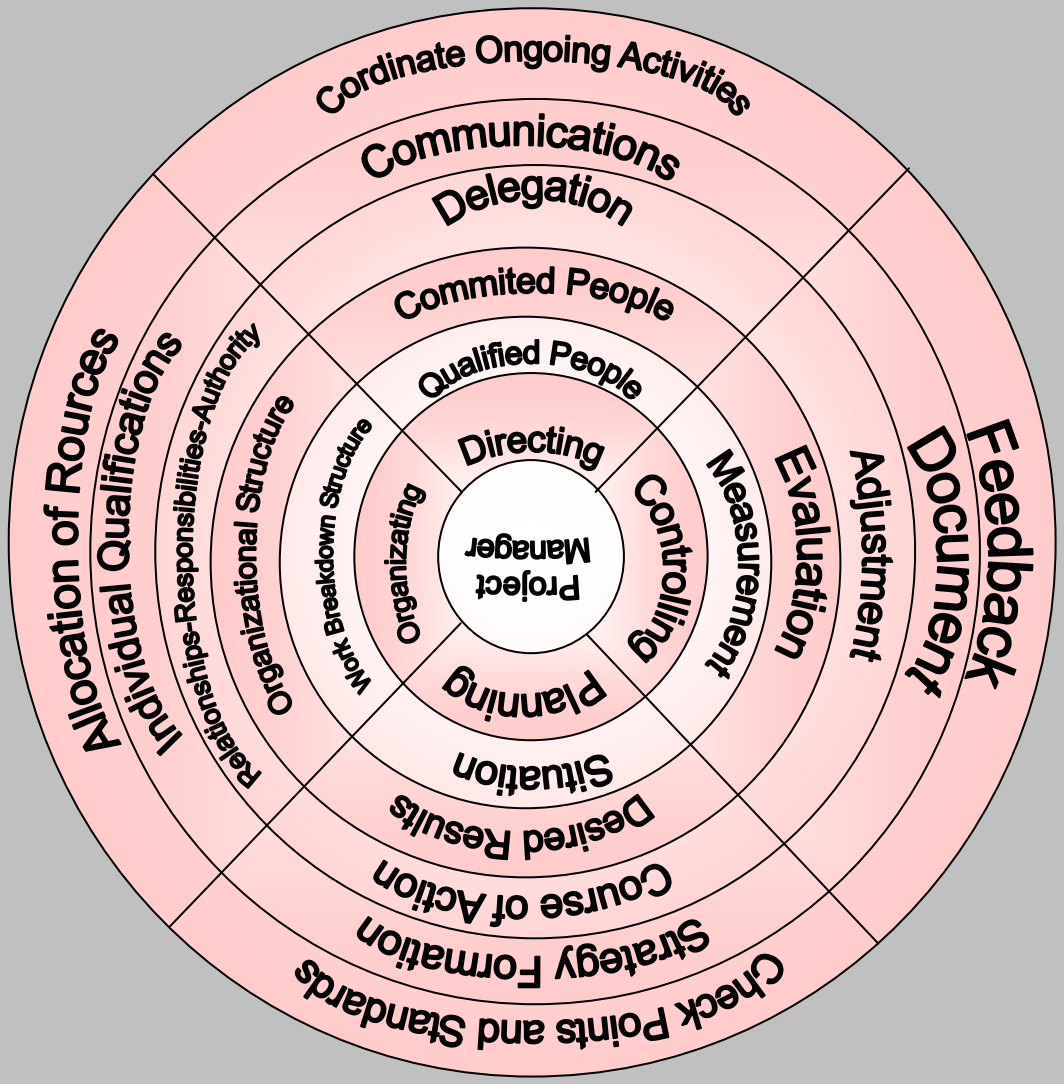
Project Management Functions



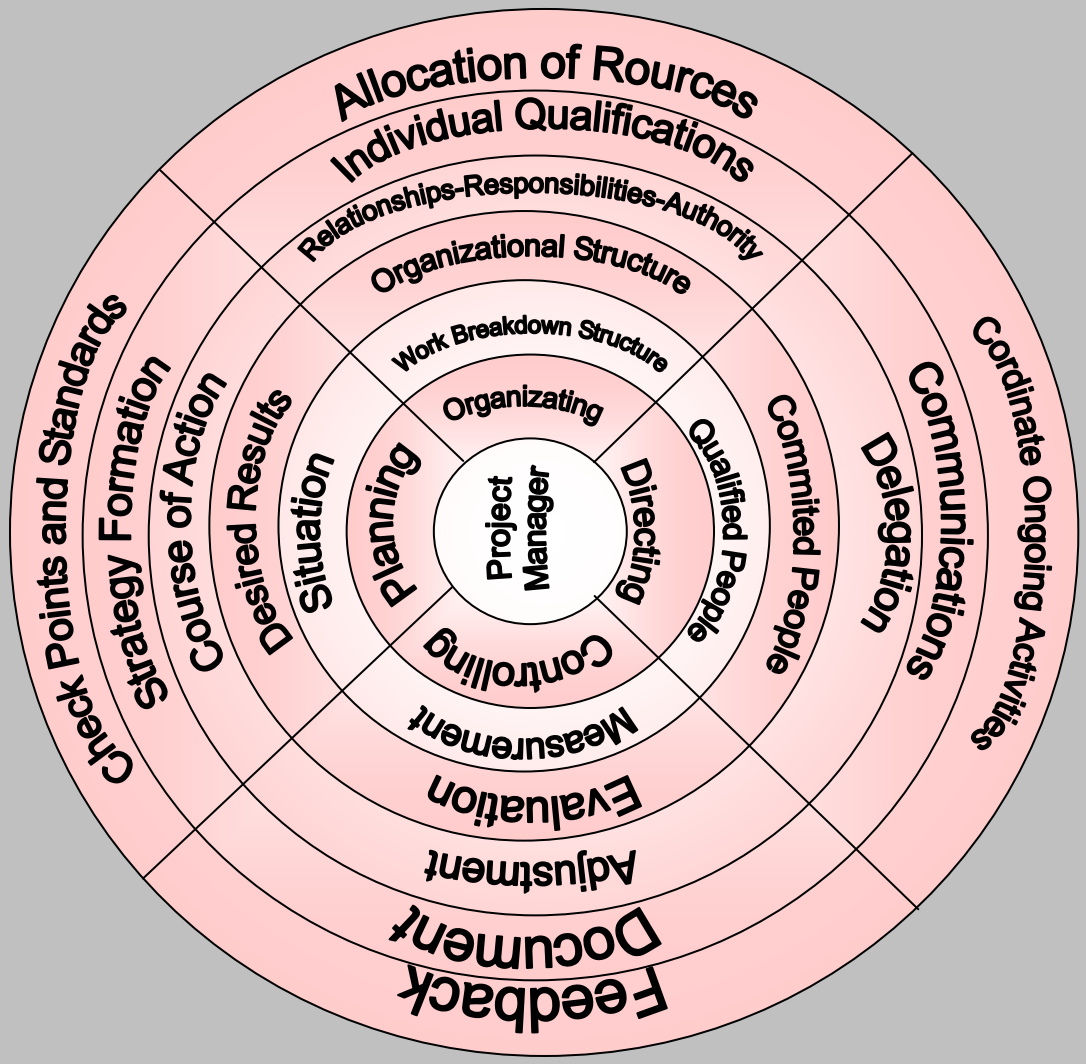
Project Management Functions - 2



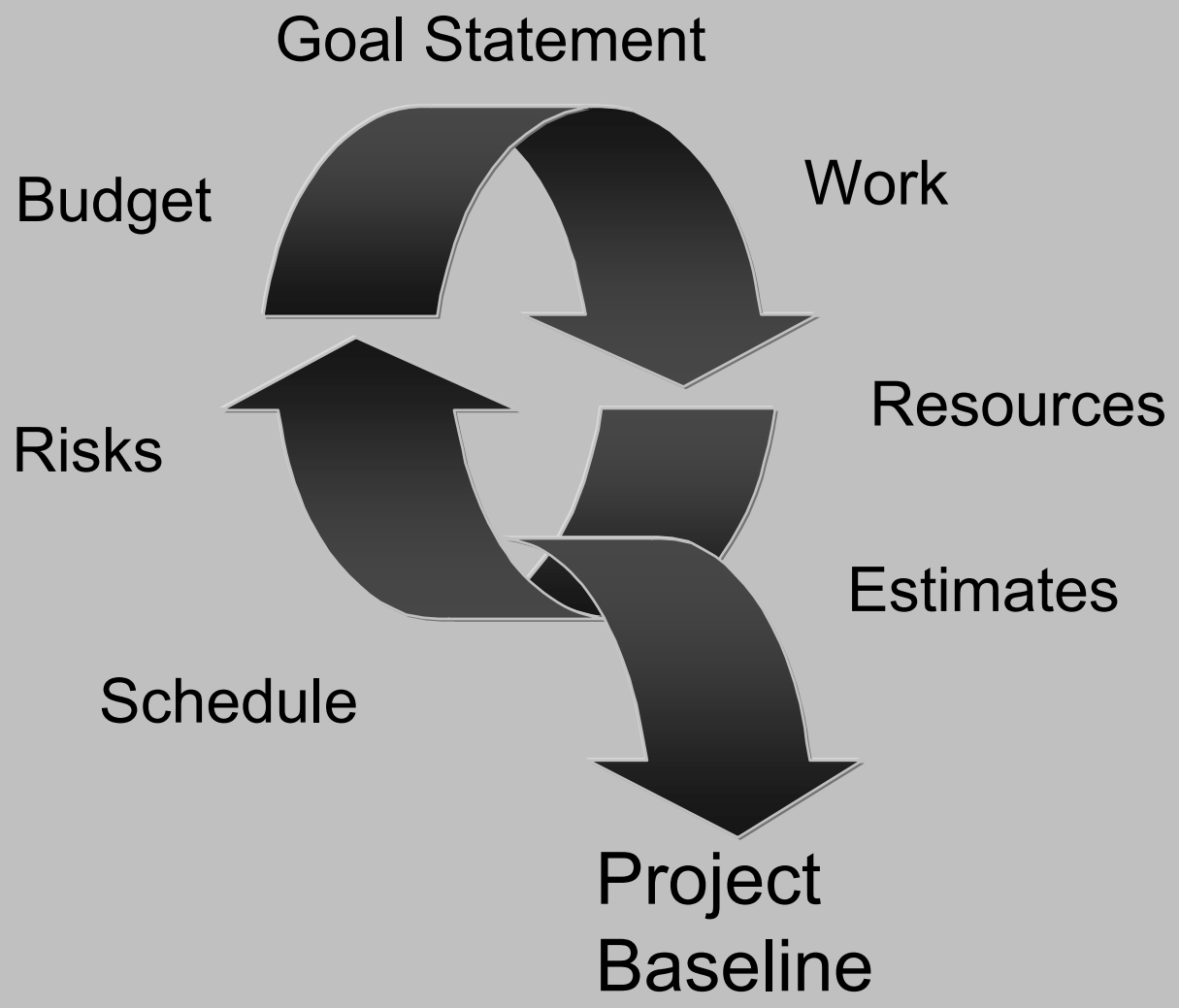
Project Management Functions - 3



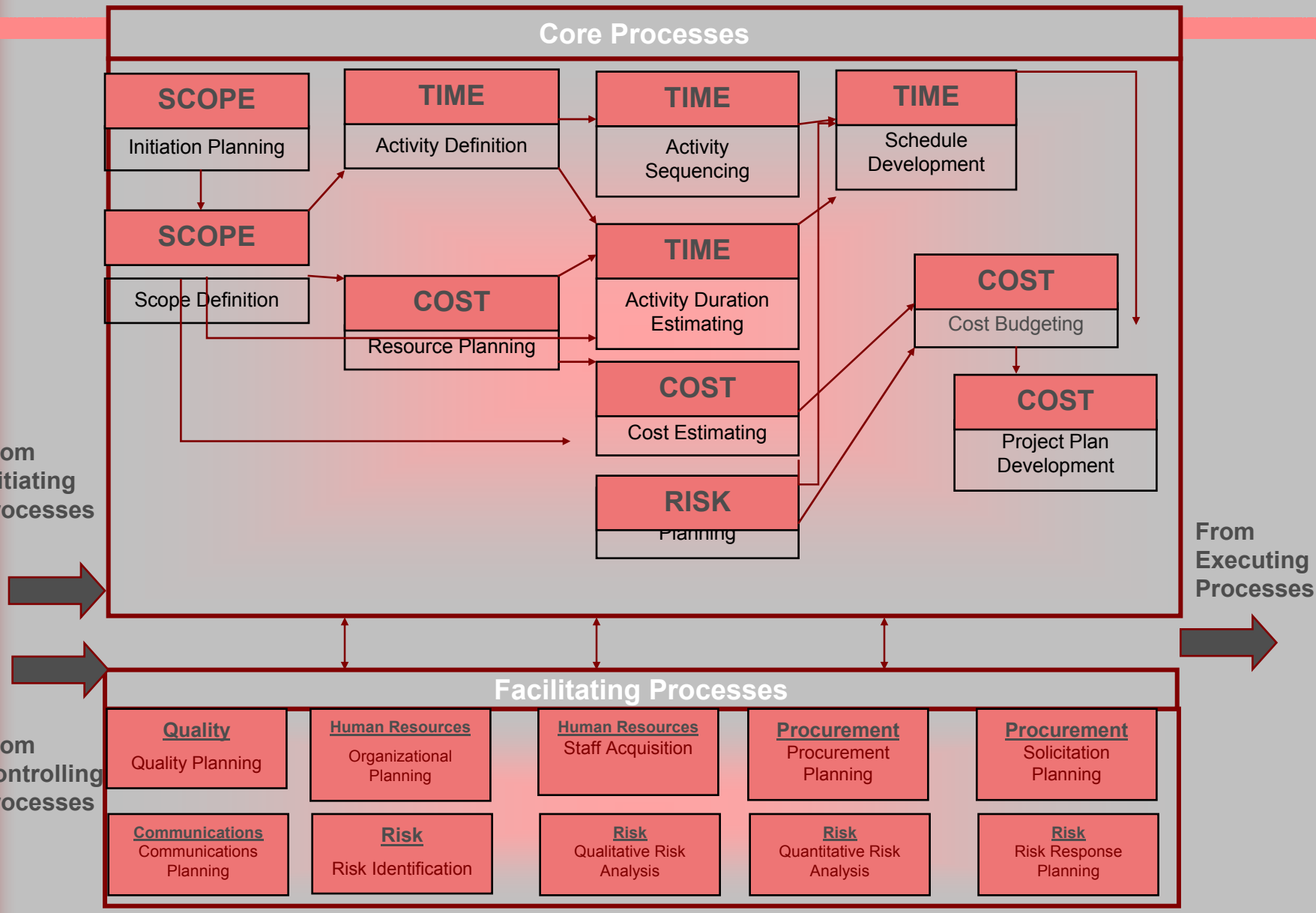
Project Management Functions - 4



Iterative Nature of Planning

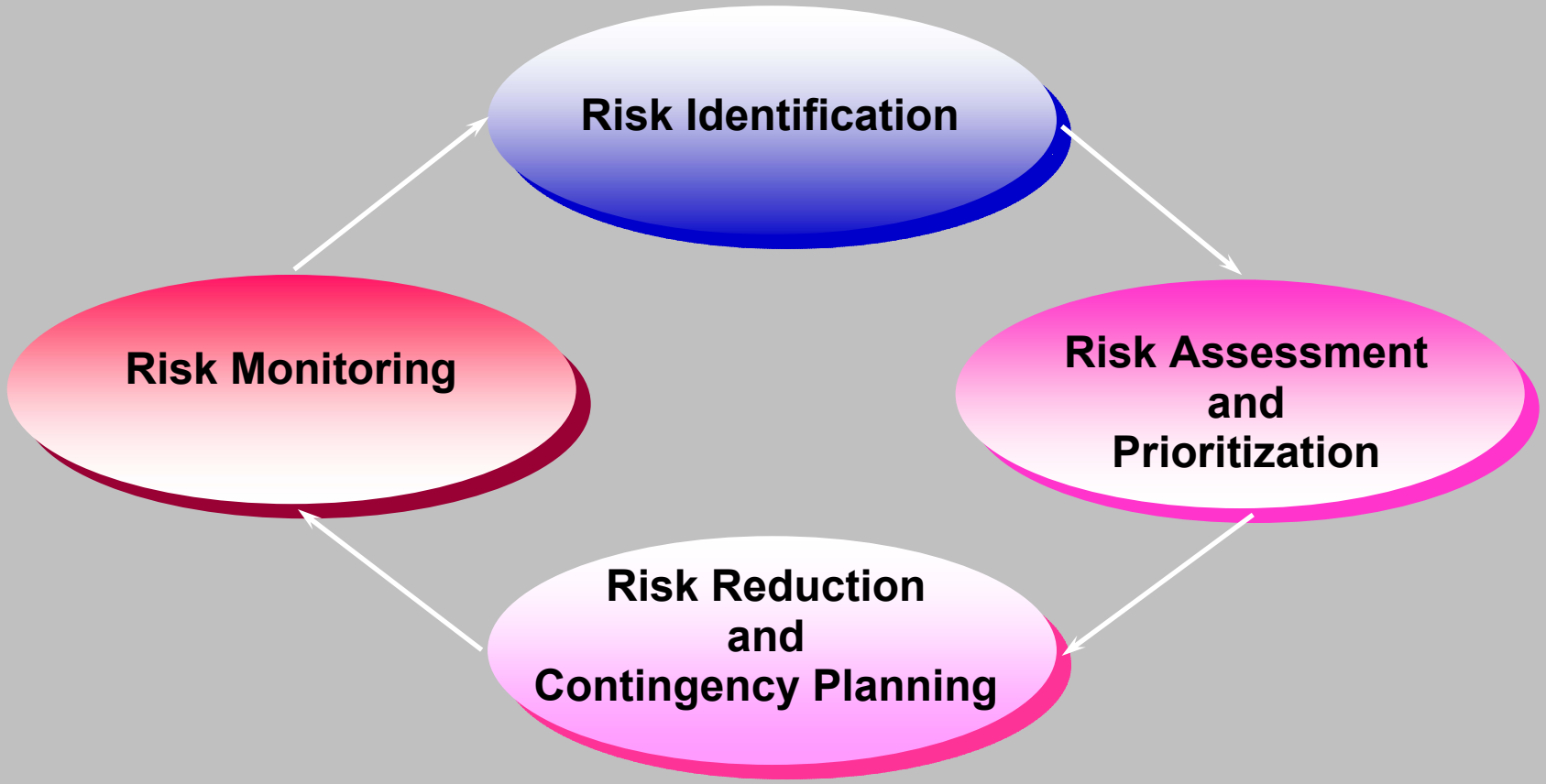


Relationships among the Planning Processes

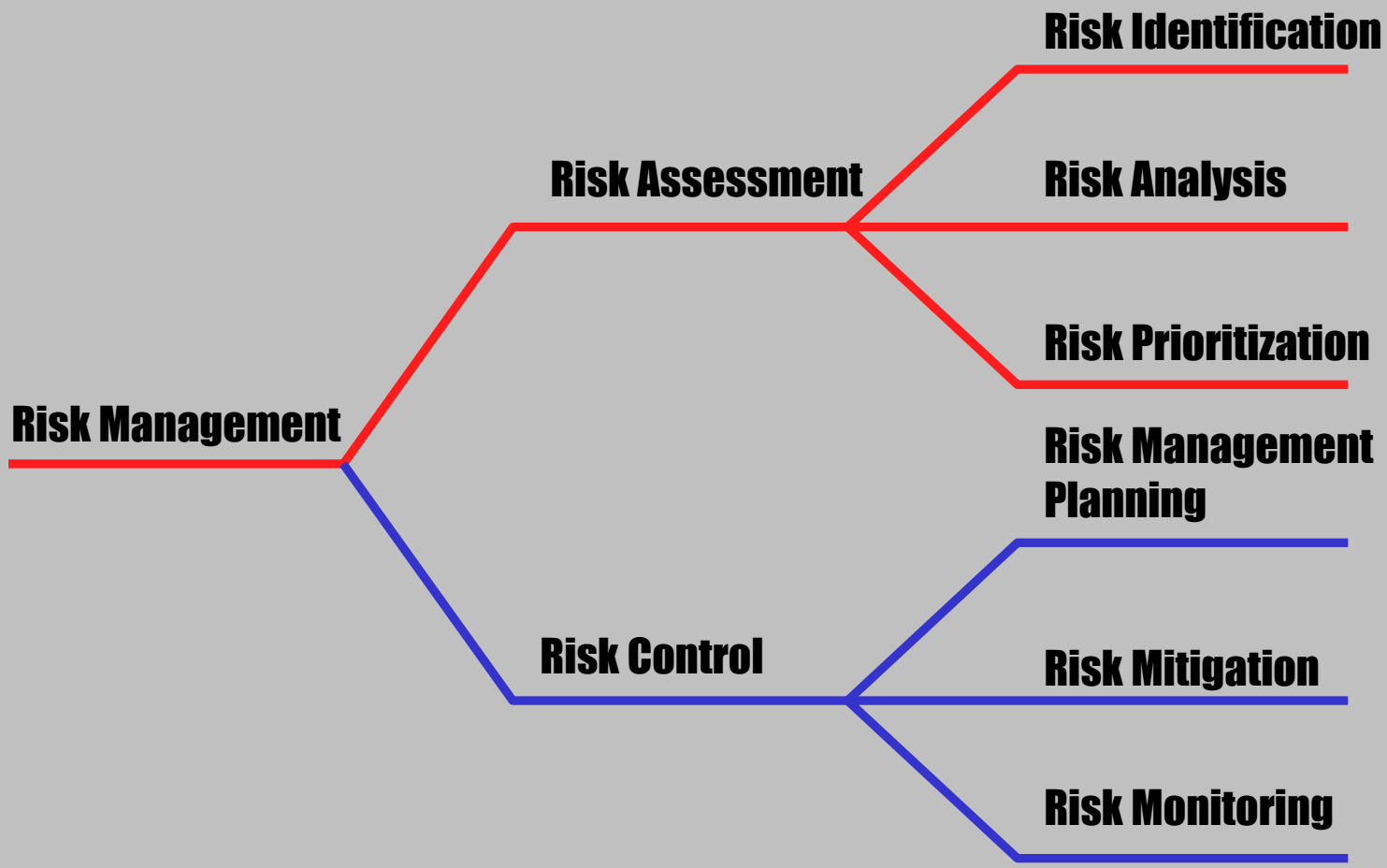


Risk Management

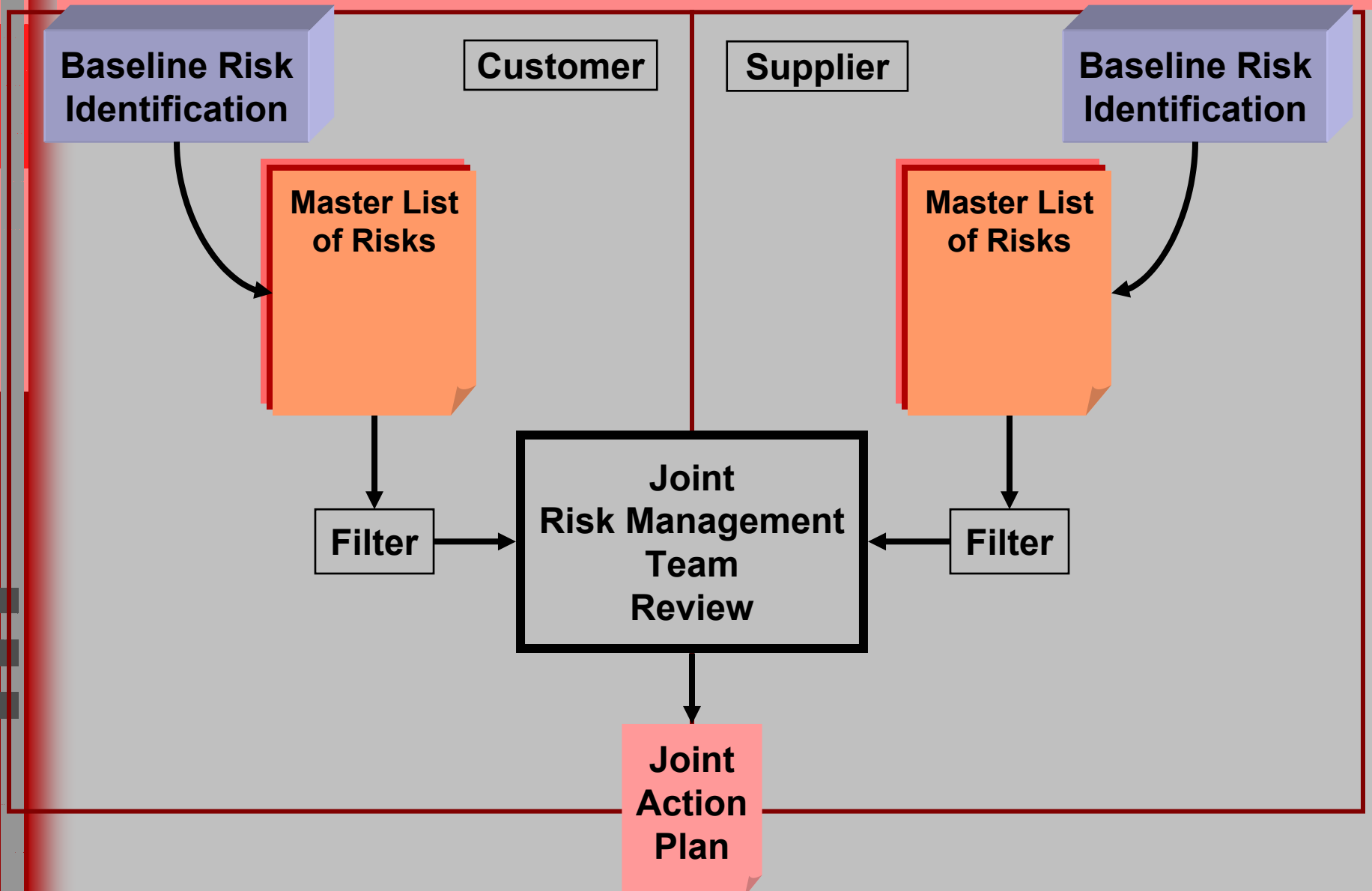
Risk Management Cycle



Elements of Risk Management



Baseline Risk Identification Outcome

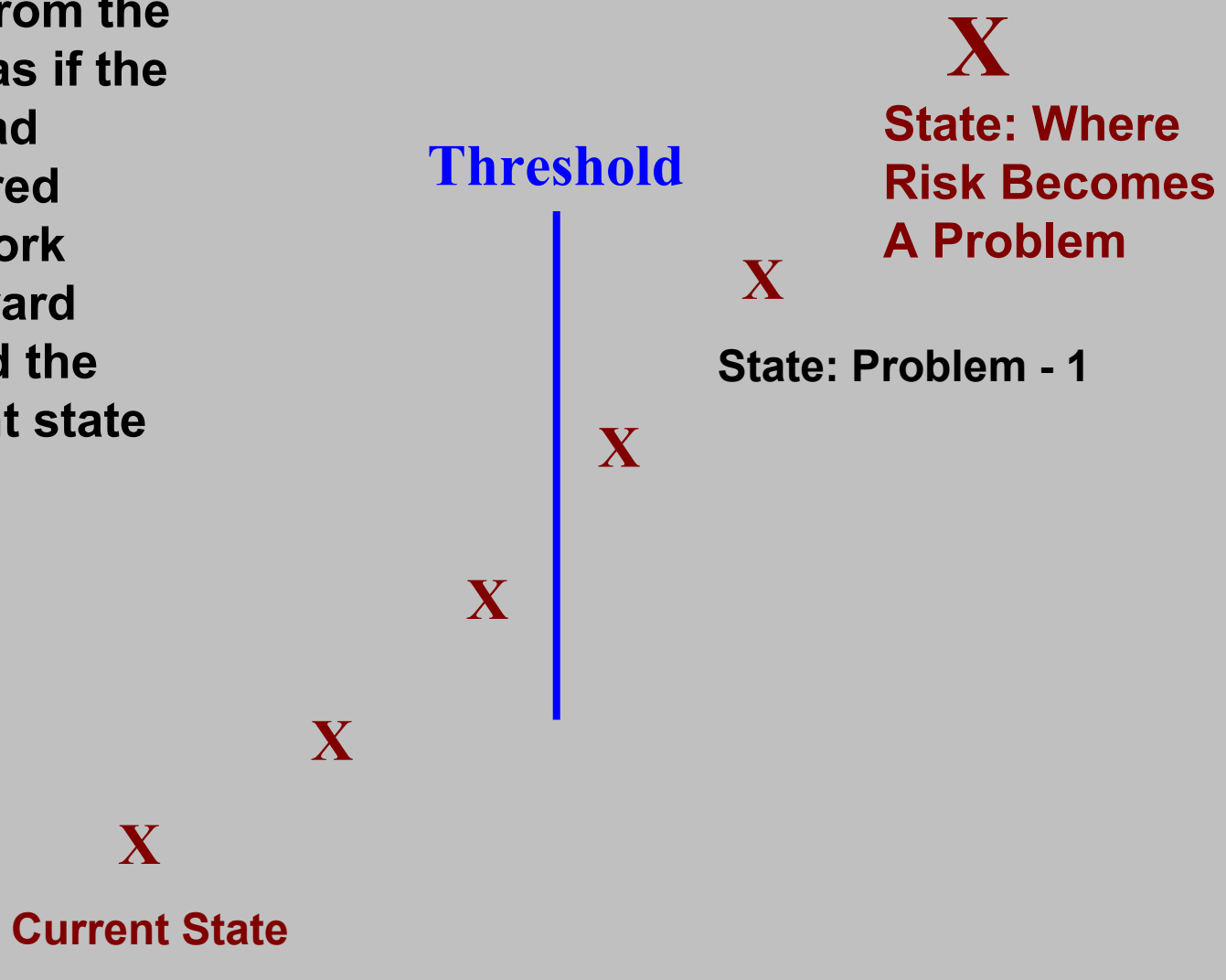


Developing Risk Scenarios

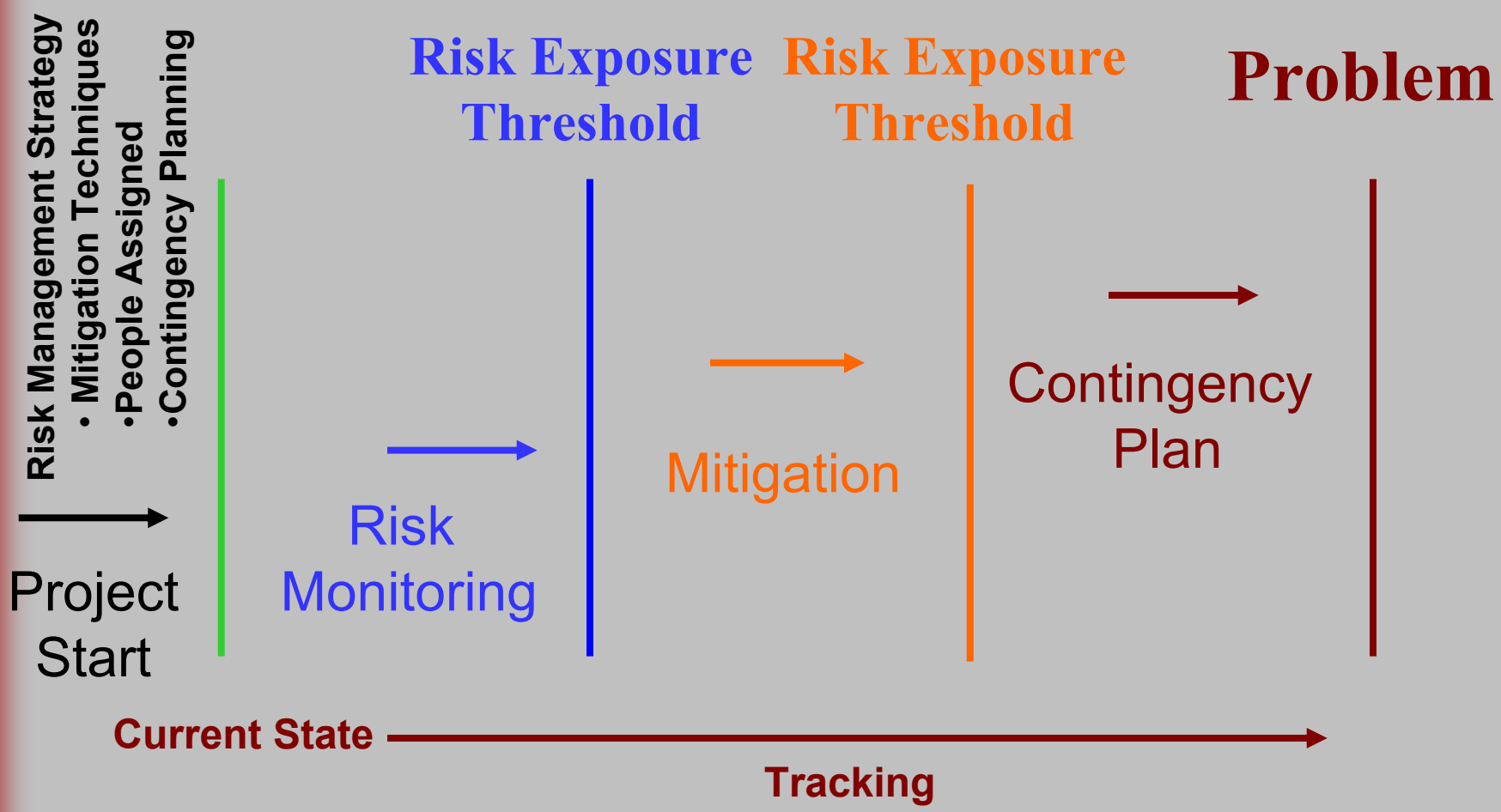
- For every high severity risk a **scenario** should be developed
- One procedure for developing such a scenario involves:
  - Thinking about the risk as if it had occurred
  - Stating the scenario as if the problem had happened
  - Listing the events and conditions that would precede the risk occurrence

Risk Scenario Example

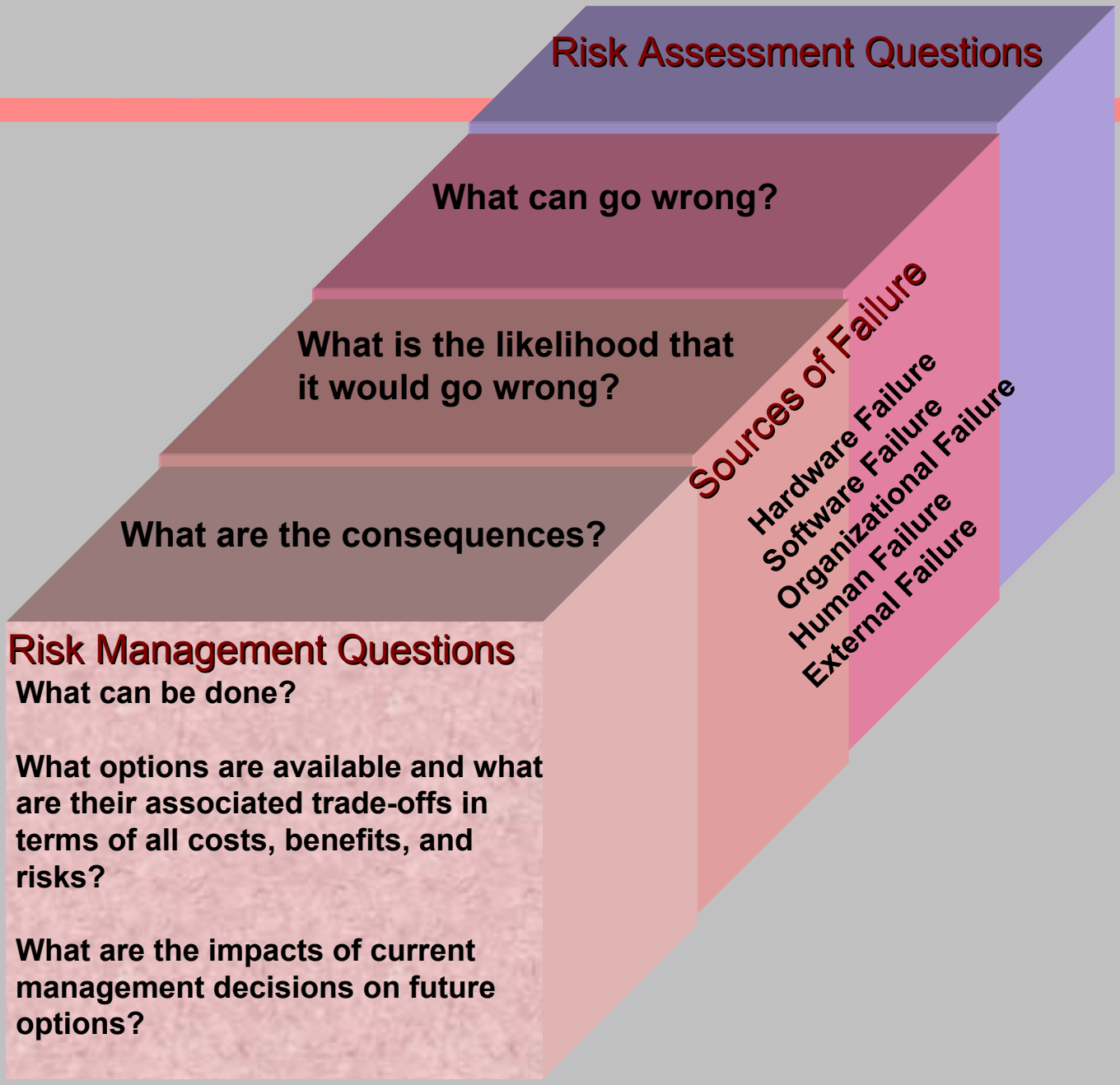
Start from the point as if the risk had occurred and work backward toward the current state



Establishing Risk Thresholds



Total Risk Management



Quality Management

Quality Management

- Quality Management consists of:
  - Setting Quality Goals that support business objectives
  - Establishing and enforcing a Quality Policy
  - **Planning** for quality
  - Developing Processes
  - Establishing the use of Standards and Procedures
  - Conducting Objective Evaluations Audits with respect to **product** quality
  - Conducting Objective Evaluations Audits with respect to **process** quality

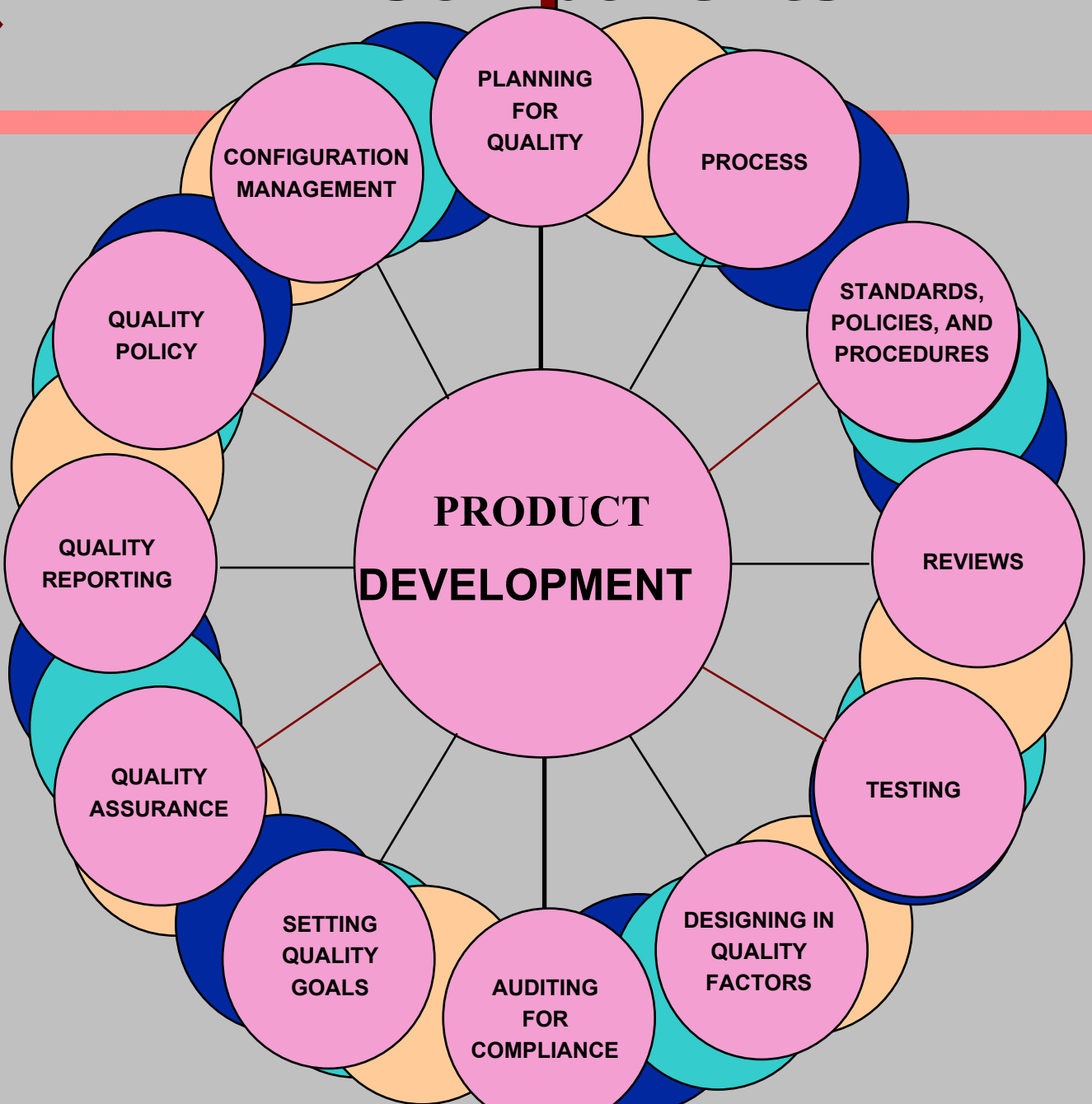
Quality Management - 2

- Performing multiple levels of Testing
- Conducting **Peer Reviews** throughout the product lifecycle
- Designing in **Quality Factors** (e.g.,maintainability, reliability)
- Providing visibility into the process and product quality for management (Reporting)
- Getting non-compliance issues resolved before the product is delivered to the customer
- Configuration Management
- **Measurement**

Quality Management - 3

- These quality functions may be performed by:
  - Project Leaders and project staff
  - Quality Manager or Quality Representative
  - Organizational level QA Group
  - Systems Engineering
  - Independent Test
  - Documentation
  - Customer
- and others…….

Quality Management Components



The CM Functions

- Identification
- Baselining
- Change Control
  - Organizational Change Control Board
  - Developmental Change Control Board
- Status Accounting
- Configuration Auditing
- Configuration Management System
- Interface Control
- Supplier Control

The CM Functions - 2

What is the system configuration?	**Identification**	The system consists of the following baseline documents and products:...
How are changes to the configuration controlled?	**Control**	The steps to process changes are...
What changes have been made to the system?	**Status Accounting**	The system configuration and related changes at this line are the combination of the following baselines, changes, pending changes:...
Does the system satisfy the requirements?	**Auditing**	The system as currently built differs from the baselines and approved changes as follows:...

End-to-End Quality

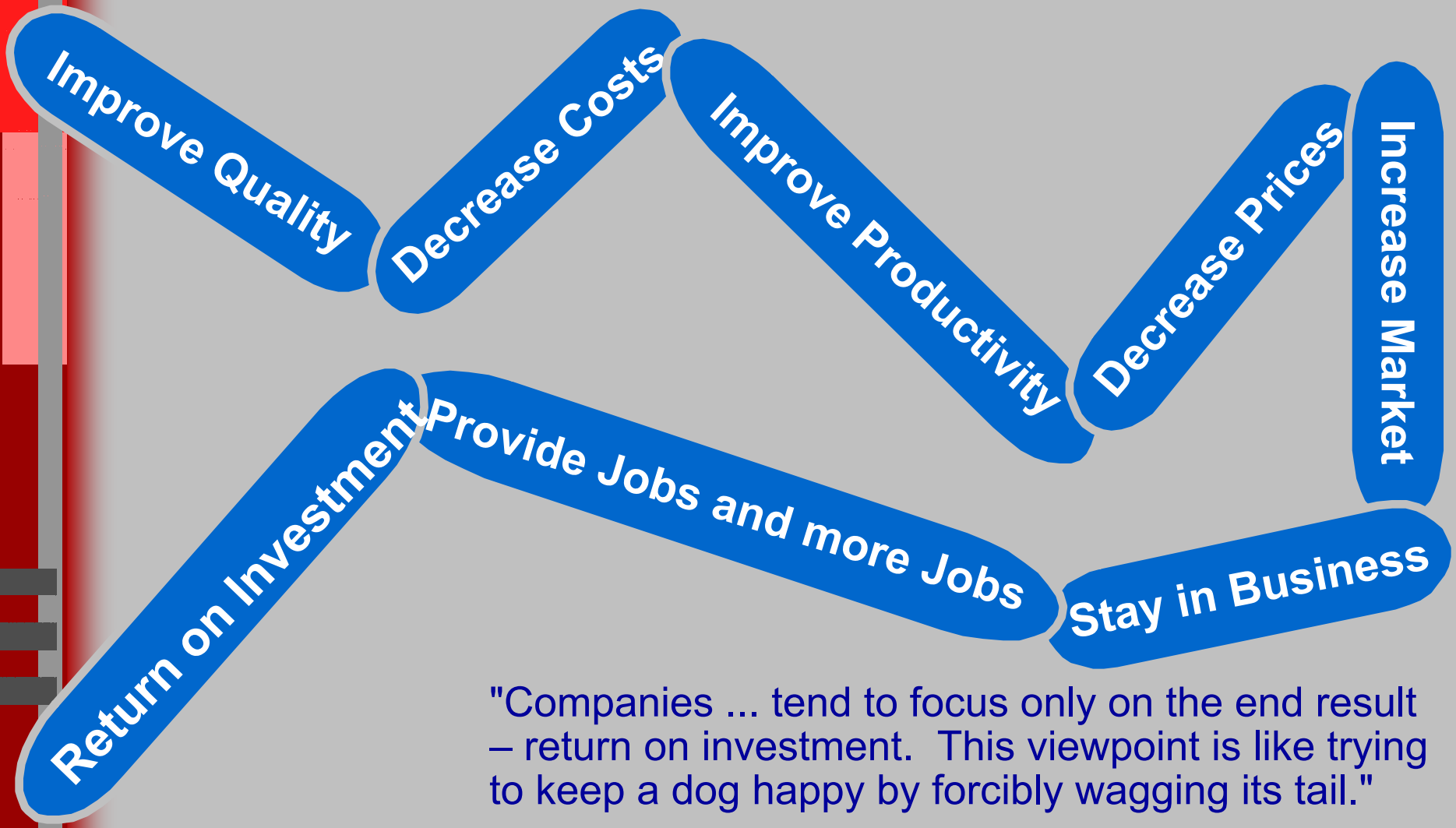
What Business Are You in?

- What Business Are You in?
- How does each department contribute to this business success?
- How do these departments interact with each other to maximize company profit and achieve business goals?
- What business processes exist in each department to optimize its product quality and minimize interface conflicts?

What Business Are You in? - 2

- What standards and models are you using to accomplish daily tasks?
- What personal processes are being used for each person to optimize his/her performance?
- Does each person understand his/her role in supporting the Organization's business quality goals?

The Deming Quality Chain



"Companies ... tend to focus only on the end result – return on investment. This viewpoint is like trying to keep a dog happy by forcibly wagging its tail."

Supplier Management

Terminology

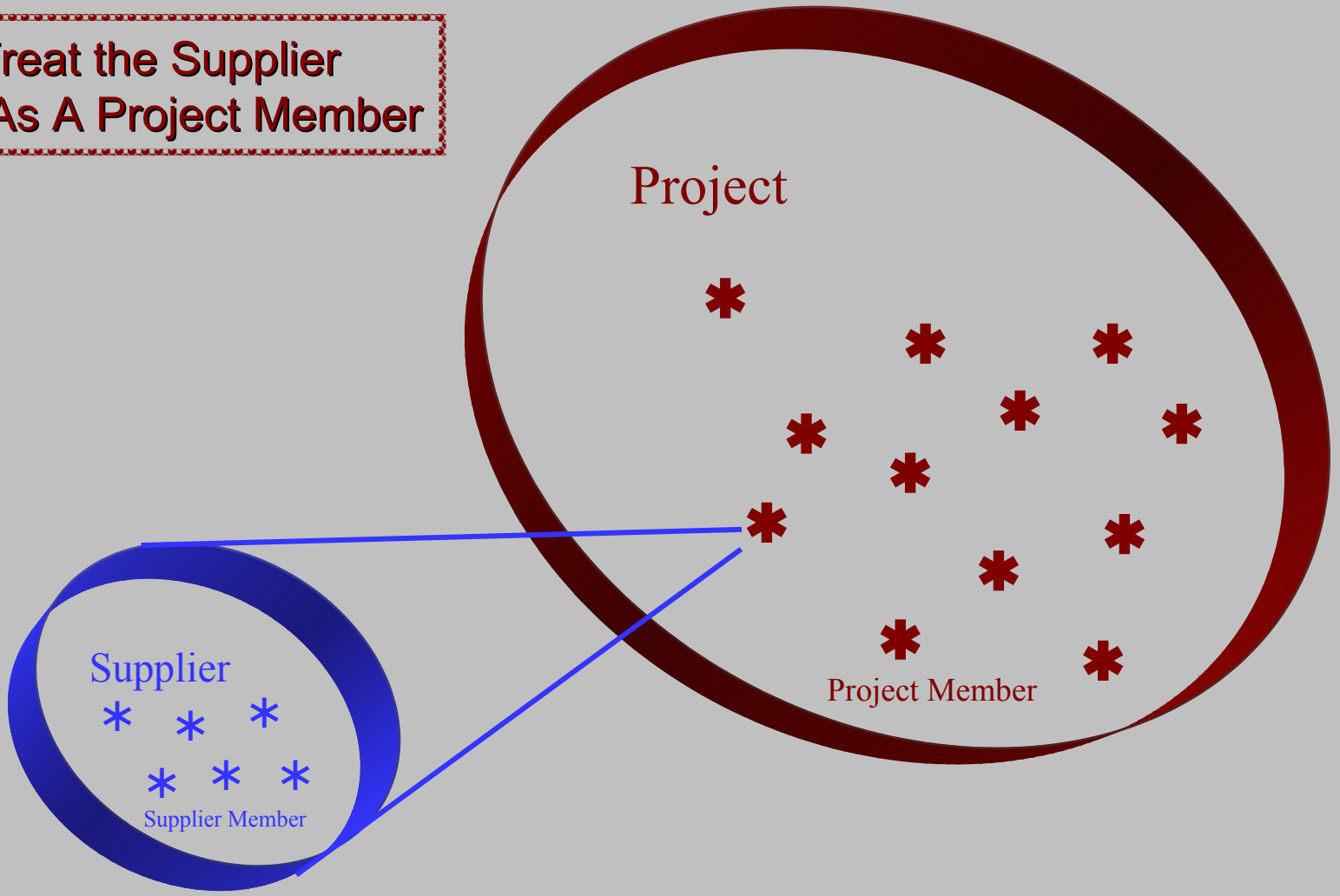
- Buyer: the project or organization that is setting up an agreement with a entity outside of the project's or organization's boundaries to develop a product or product component for delivery
  - Outside of the project's boundaries indicates the Buyer normally has no control over the supplier's resources

Terminology - 2

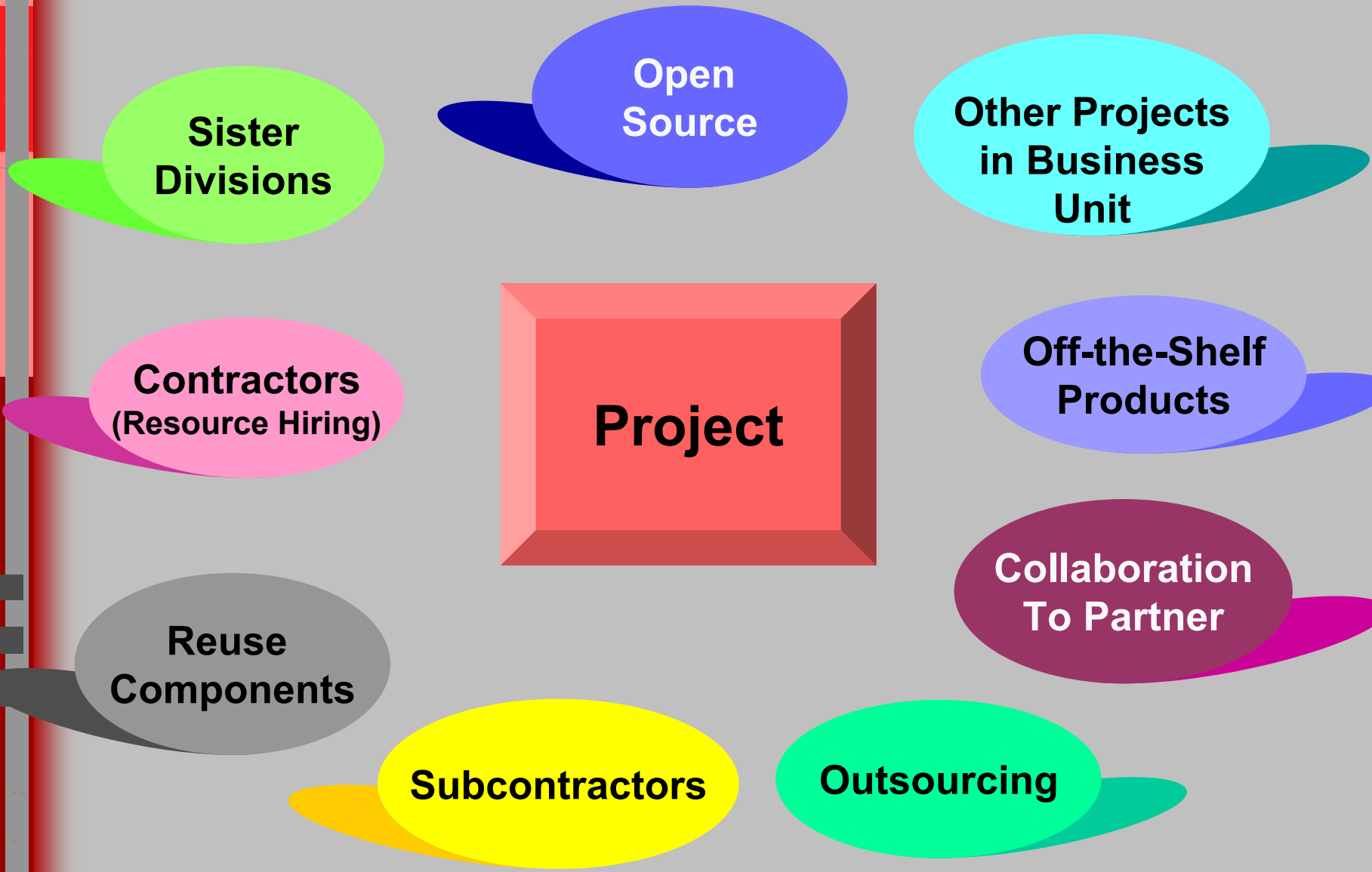
- Supplier: a project inside or outside of the Buyer's business unit or organization that agrees to do the necessary product or product component development according to the requirements of the Buyer and deliver within specified constraints such as cost, schedule, quality, and performance

Terminology - 3

Treat the Supplier
As A Project Member



Supplier Management Overview

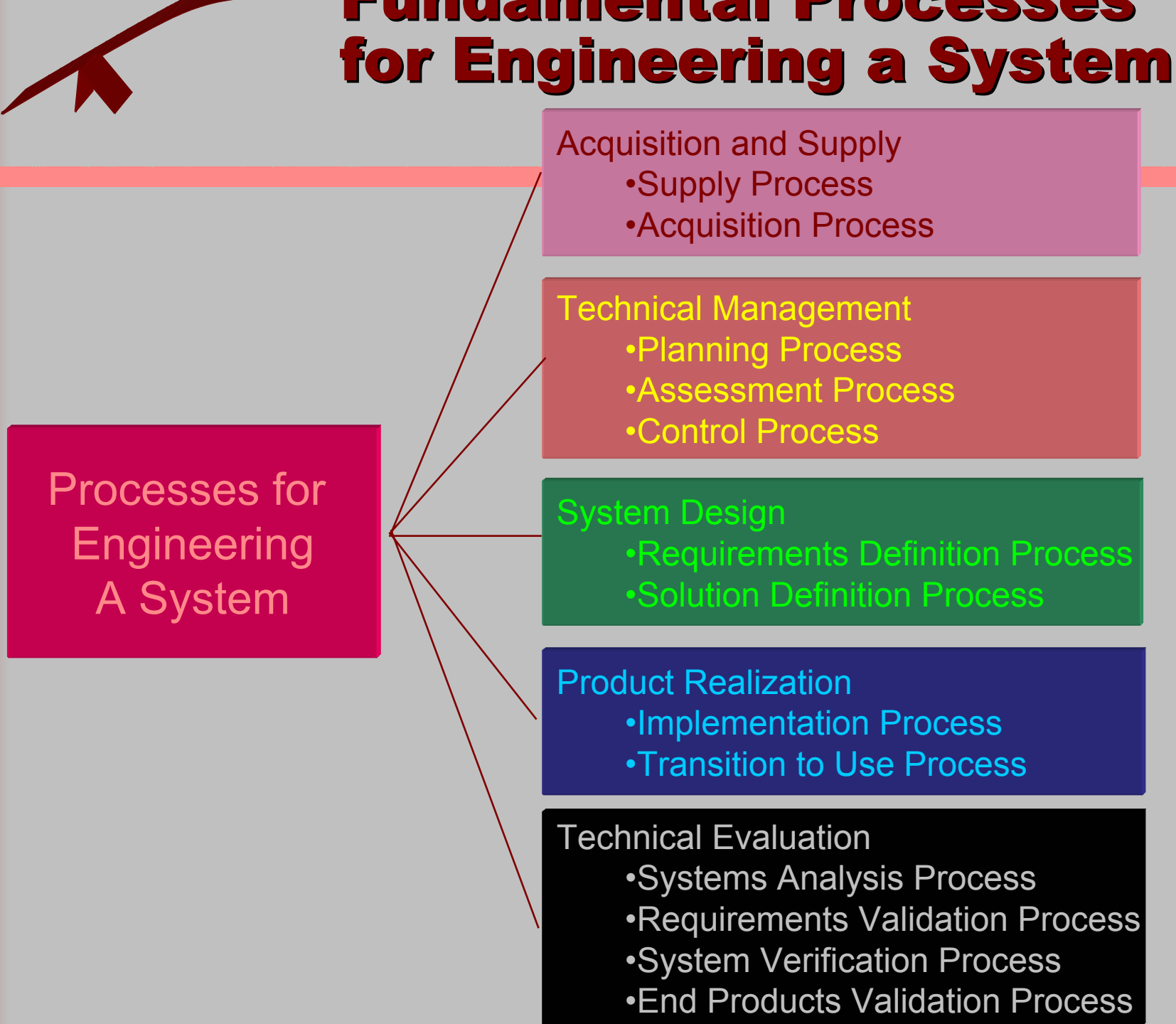


Requirements Engineering

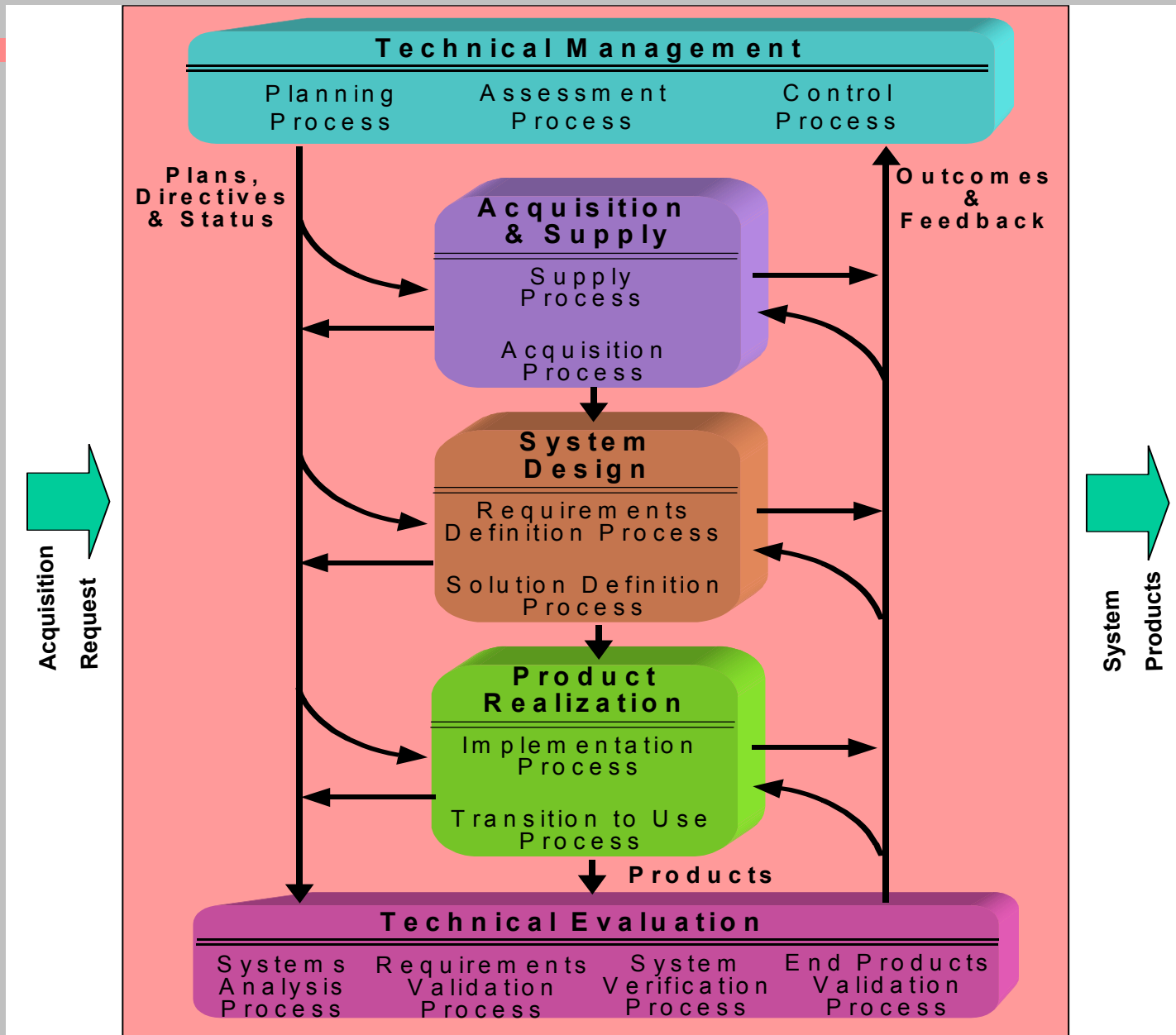
Requirements Development

Processes for Engineering a System EIA - 632

Fundamental Processes for Engineering a System



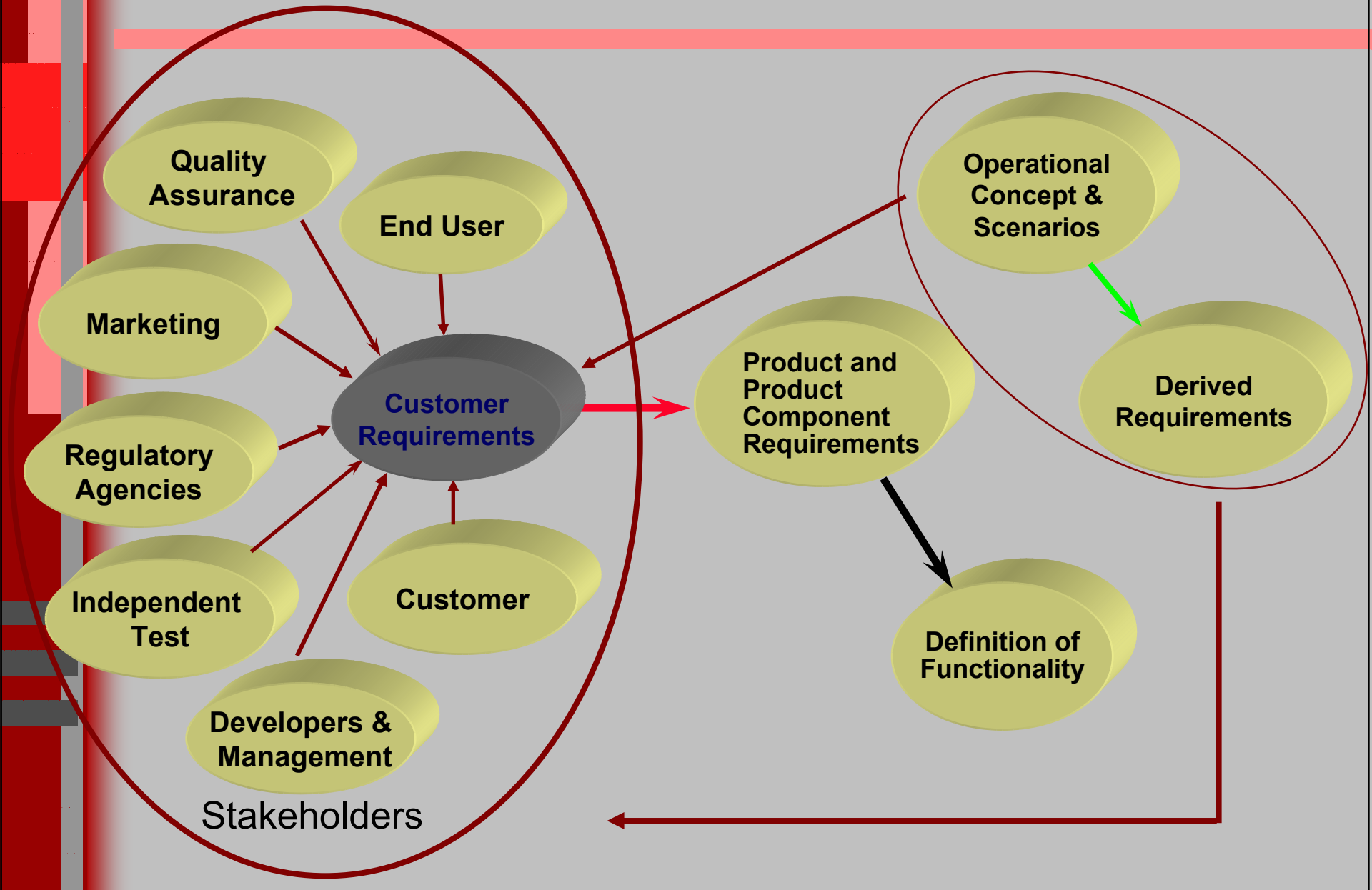
Relationship of Processes for Engineering a System



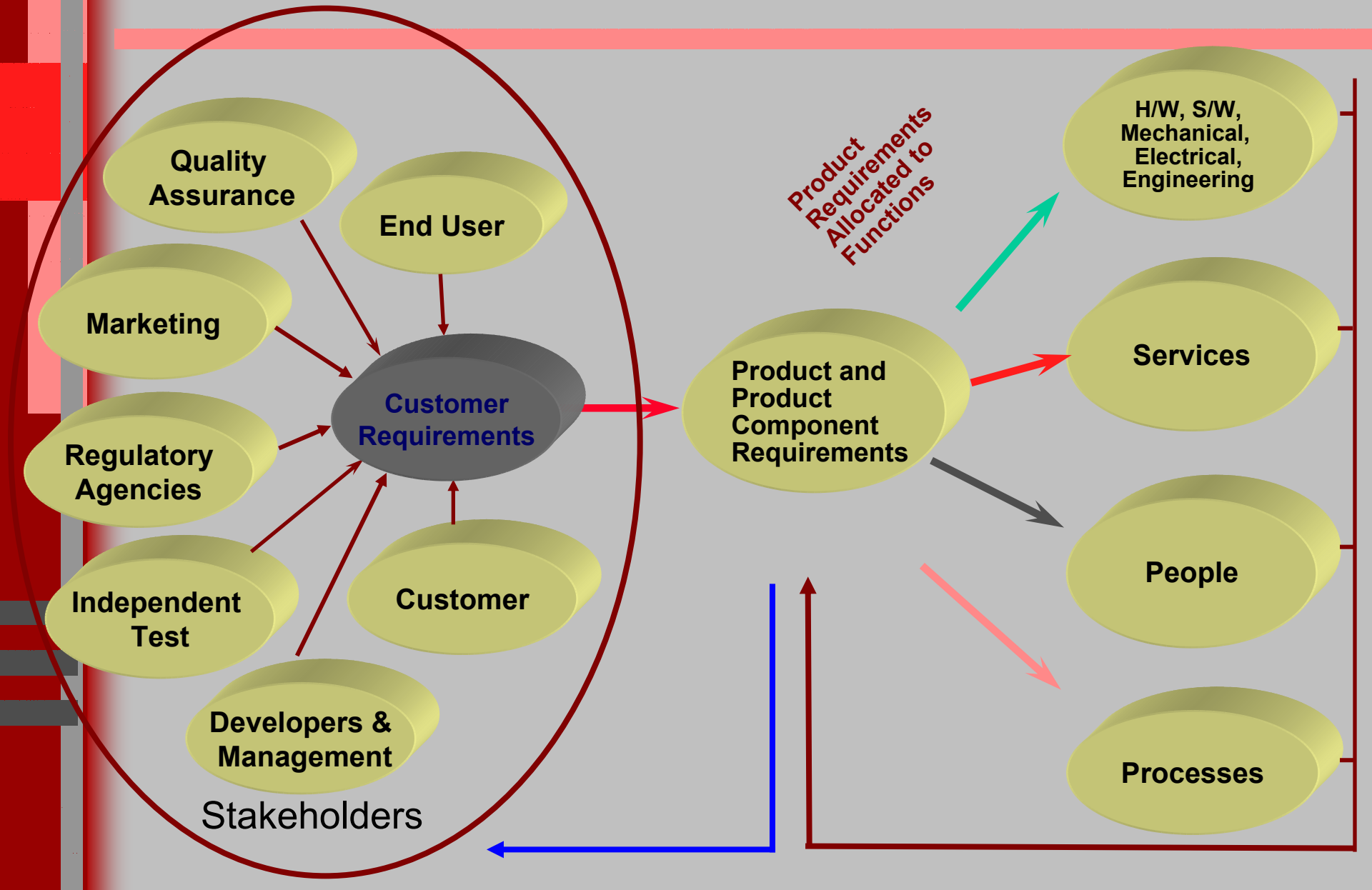
Customer Requirements

- Customer requirements represent Stakeholder needs, expectations, constraints, and interfaces
- Requirements invariably contain a mixture of
  - Problem information
  - Statements of system behavior
  - Systems properties
  - Design constraints
  - Manufacturing constraints
- This can and normally does result in **conflicts** that must be negotiated and resolved

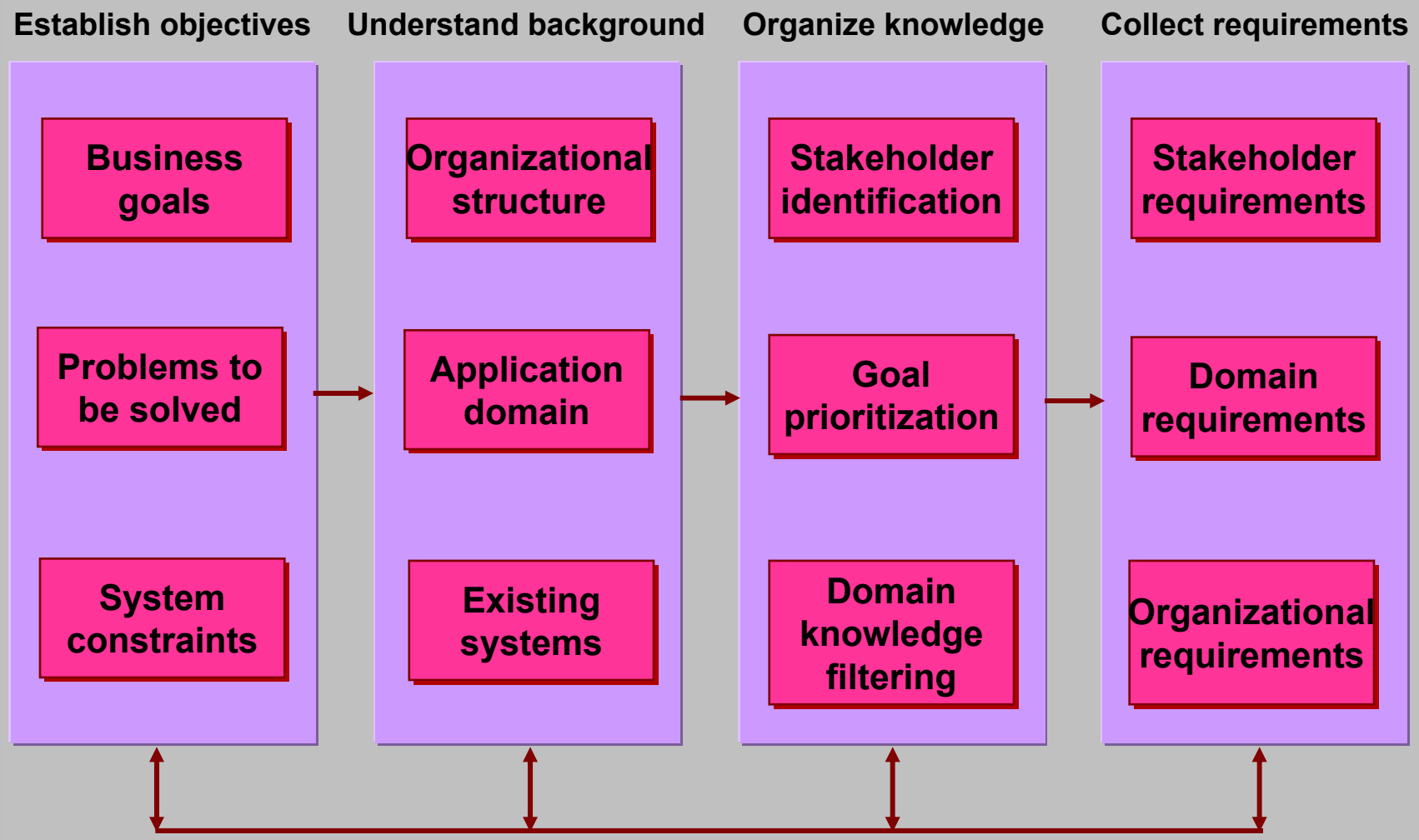
Customer, Product, and Product Component Requirements



Product Component Requirements - 2



Generic Requirements Elicitation Process



Gerald Kotonya and Ian Sommerville,
Requirements Engineering, John Wiley and Sons, 1998

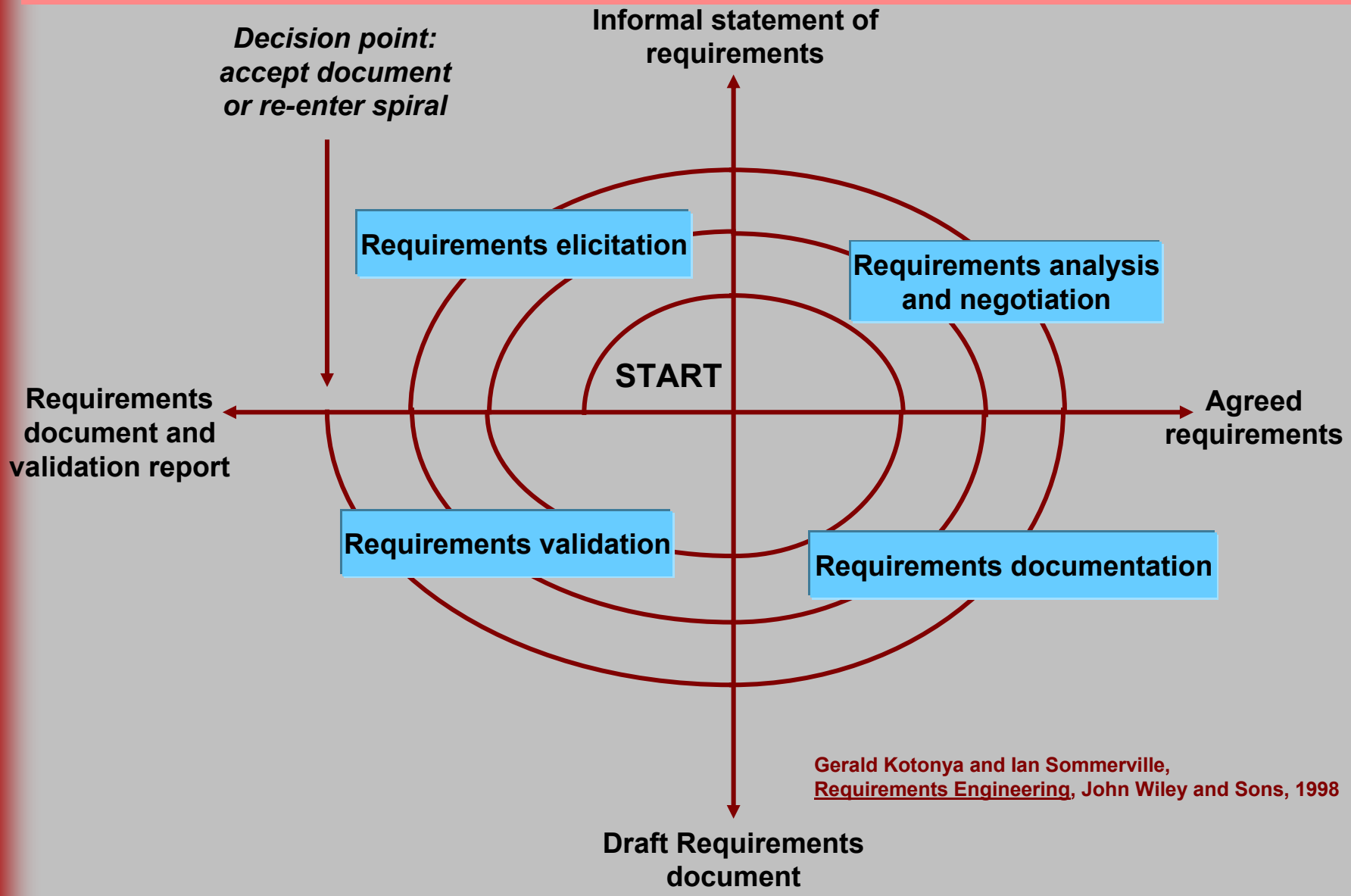
Operational Concepts and Scenarios

- Scenarios and Operational Concepts are developed, analyzed, and reviewed to refine existing requirements and discover new requirements, needs, and constraints
  - Scenarios are normally sequences of events that might occur in the use of the product
  - Operational concepts depend on both the design solution space and the scenarios
    - define the interaction of the product, the end user and the environment
    - define the operational, maintenance, support, and disposal needs

Product and Product Component Requirements

- Customer requirements are analyzed in conjunction with the development of the operational concept to derive a more detailed and precise set of requirements called "product and product component requirements"

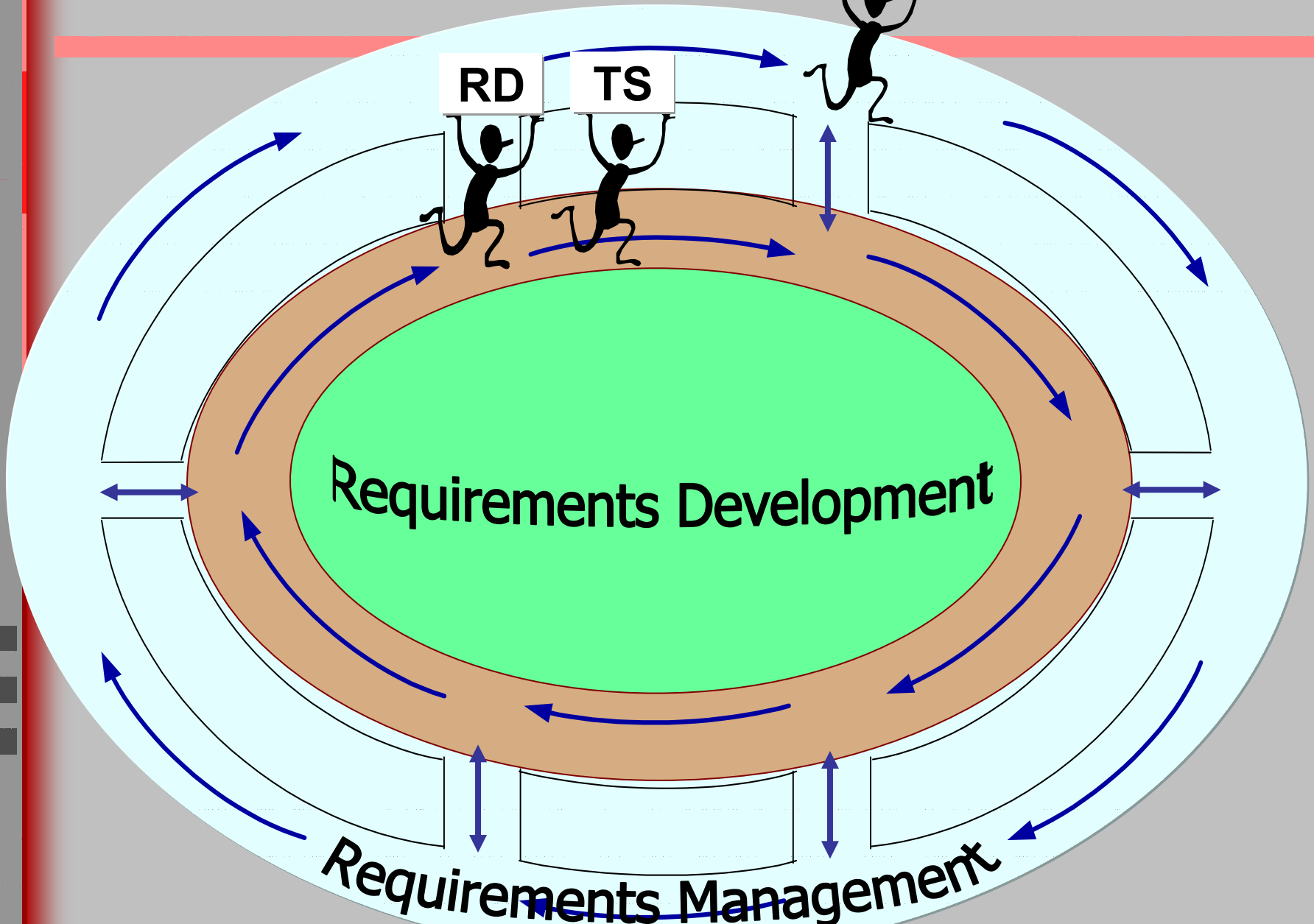
Spiral Model of the Product Requirements Engineering Process



Gerald Kotonya and Ian Sommerville, Requirements Engineering, John Wiley and Sons, 1998

Requirements Management

Requirements Development Partnership



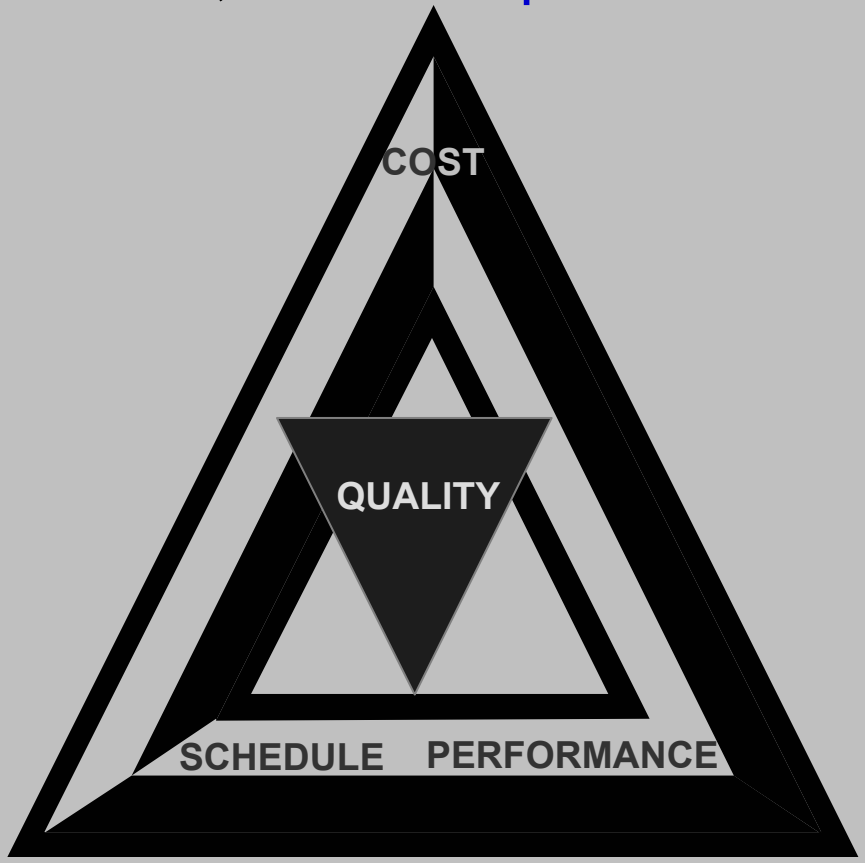
Impact Analysis for Requirements Change Requests

- Impact Analysis is made based on the requirements change request:
  - Development Schedule
  - Release Schedule
  - Changes required to this system
  - Staffing
  - Components
  - Development and Target equipment
  - Risks
  - SCOPE
  - Costs
  - Changes required to other systems or interfaces within the project
  - Other existing products or product lines

Alternative Solutions

Develop Detailed Alternative Solutions and Selection Criteria

- Problem: Alternative solutions need to be identified and analyzed to enable the selection of a *life-cycle balanced solution* in terms of the quadruple constraint of cost, schedule, technical performance and quality



Develop Detailed Alternative Solutions and Selection Criteria - 2

- Solution: This may be accomplished through the allocation of the requirements to:
  - Software
  - Hardware
  - Electronics
  - Mechanics
  - Optics
  - Hydraulics
  - Manufacturing Processes
  - Services
  - People
- It may be accomplished through:
  - In house development
  - Purchase of Commercial-Off-The-Shelf products
  - Use of Suppliers
  - Use of Re-use components

Develop the Product or Product Component Design

- Product or product component designs must provide the appropriate life-cycle content for:
  - Implementation
  - Modification
  - Reprocurement
  - Maintenance
  - Sustainment
  - Installation
- Design documentation provides a reference point to support the mutual understanding of the design by relevant stakeholders

Architecting

Systems Architecting

- Systems Architecting has been defined as the process of creating complex, unprecedented systems
- Building systems in today's world is tenuous at best
  - Requirements of the marketplace are ill-defined
  - Rapidly evolving technology provides new services at a global level instantly
  - Uncertainty is increasing about they way the system will be used, the components that will be incorporated and the interconnections that will be made

Systems Architecting - 2

- Generating a system architecture as part of the systems engineering process can be seen as a deliberate approach to deal with the uncertainty that characterizes these complex, unprecedented systems

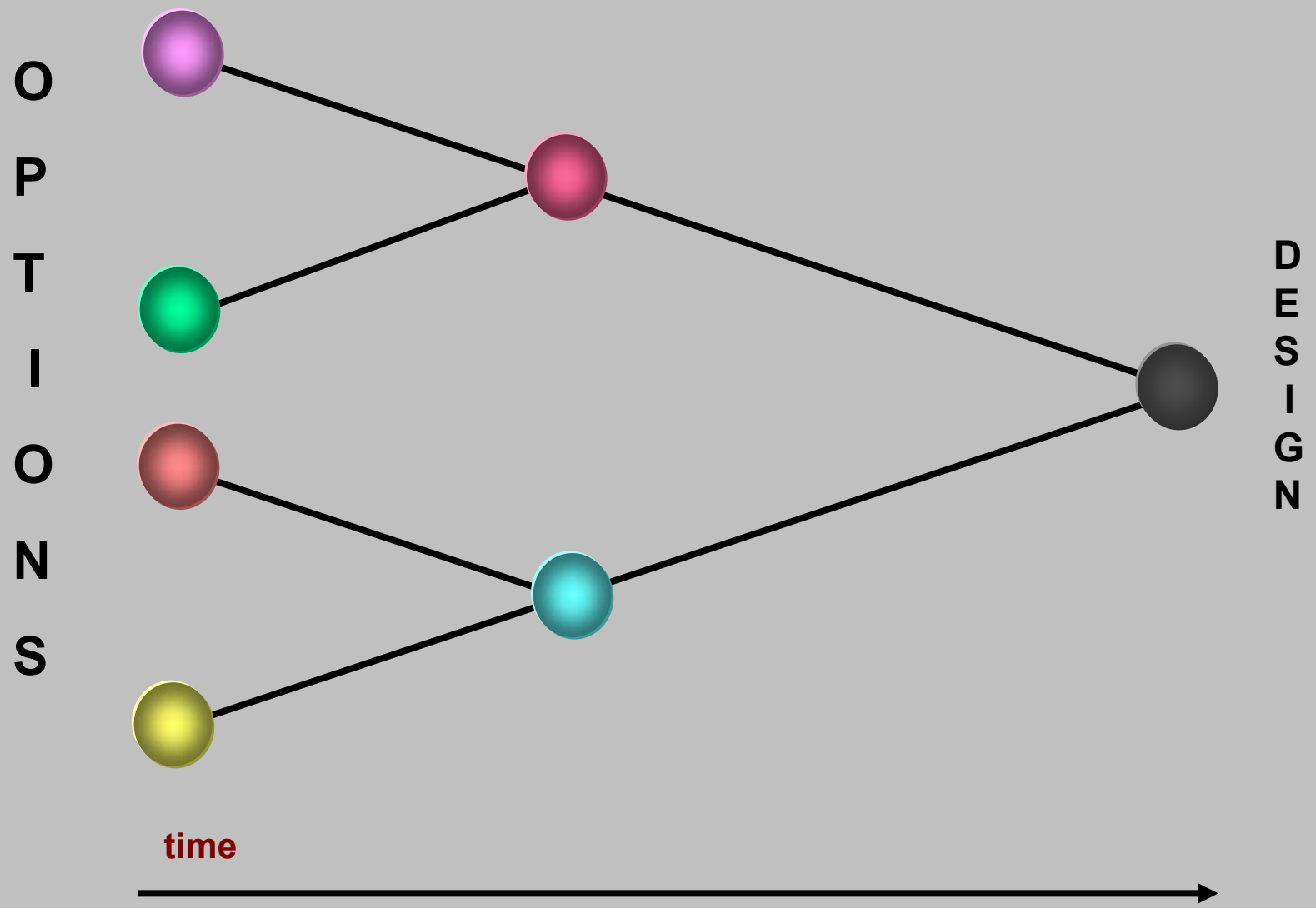
Traditional Approach to System Architecting

- Many methodologies have been developed to support a traditional system development model
  - Define the requirements
  - Consider several options
  - Emerge with a well-defined design through a process of elimination
  - Based on structured analysis and design

Traditional Approach to System Architecting - 2

- Effective when the requirements are well defined and remain essentially constant during the system development period
- Cannot handle change well
  - If the implementation of the system is long – on the order of years – the requirements change because of changing needs and new technology offers different alternatives and opportunities

The Traditional Approach



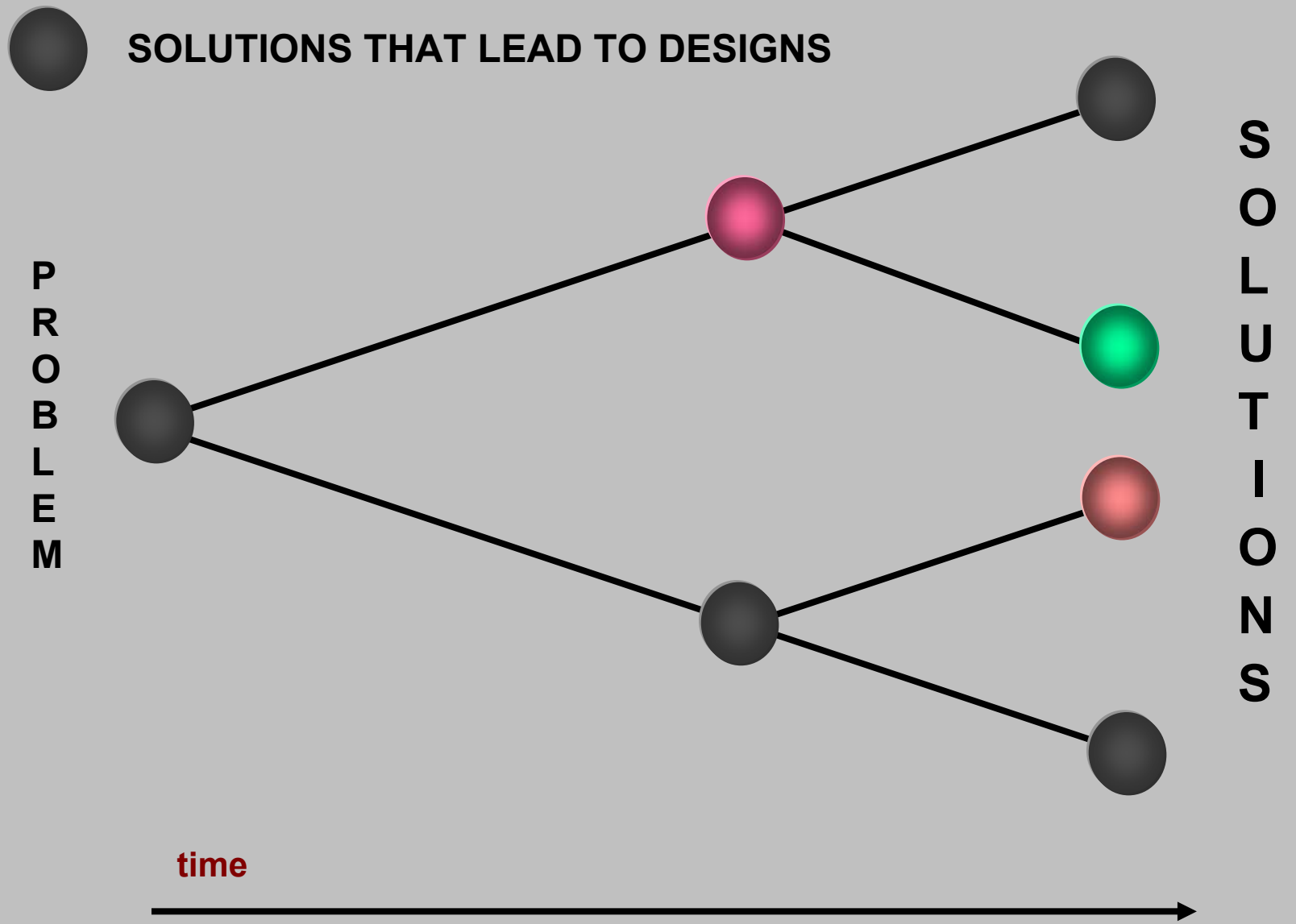
Evolutionary Approach

- New approach that is emerging with roots in software systems engineering
- Deals with uncertainty in requirements and in technology, especially for systems with a long development time and expected long life cycle
  - Evolutionary development
  - Build-a-little, Test-a-little
- Requirements are allowed to be more abstract and therefore subject to interpretation
- Alternative solutions are explored and pursued further as new technology options become available

Evolutionary Approach - 2

- Intermediate designs are saved
- Some intermediate designs are implemented as prototypes but not operationally implemented while others are implemented in traditional ways
- Advantages of Object-Oriented approach:
  - Allows flexibility in the design as it evolves over time
- Disadvantages of Object-Oriented approach:
  - Requires some early elimination of technology alternatives in the absence of reliable information

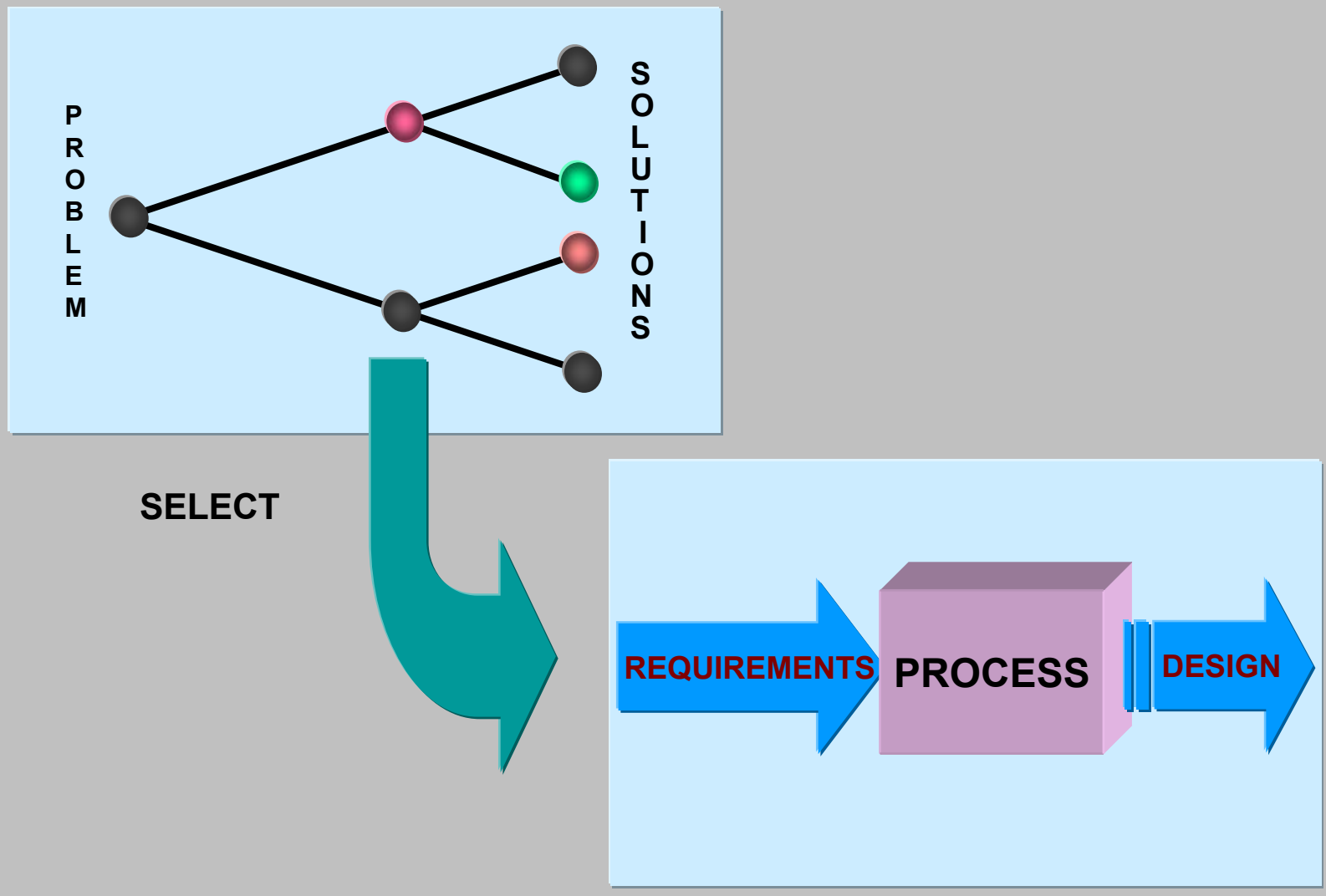
Evolutionary Approach - 3



Select, Build, and Field

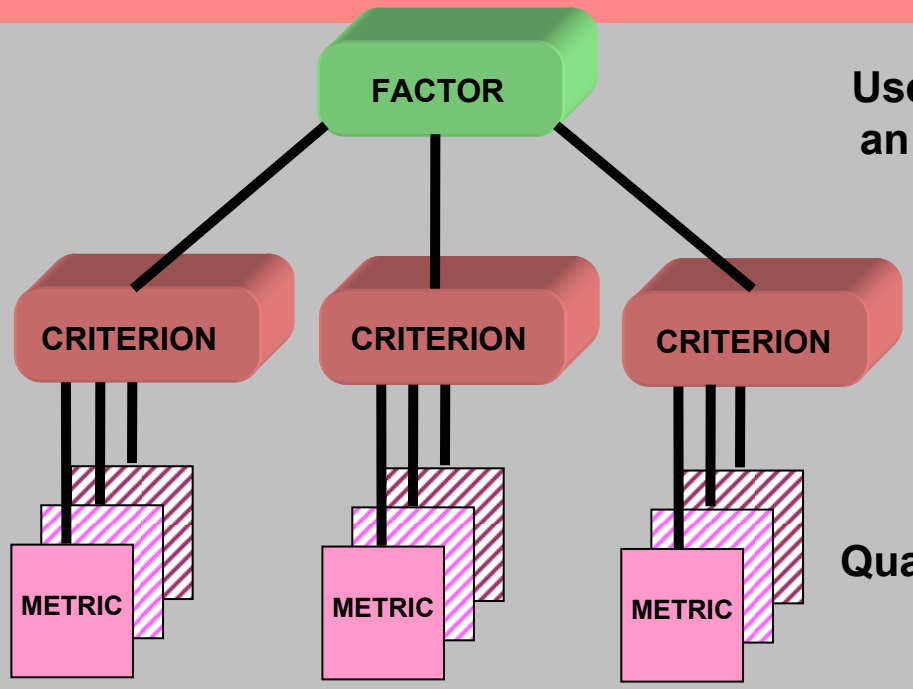
- At any time in the development process, when there is a need to build a system, the available solution that best meets the current requirements is selected and implemented using any systems engineering approach

Select, Build, and Field - 2



Quality Factors

Product Quality Metrics



User oriented view of an aspect of product quality

Product oriented characteristics or quality attributes indicate

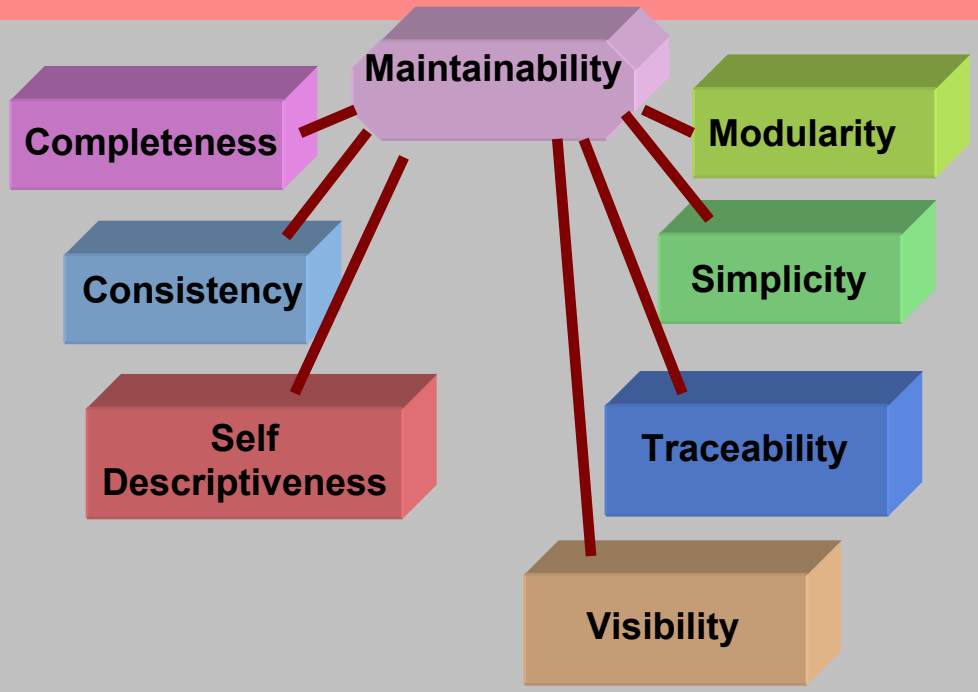
Quantitative measures of characteristics

- Product Quality is described through a number of factors (reliability, maintainability)
- Each factor has several attributes that describe it called criteria
- Each criterion has associated with it several metrics which taken together quantify the criterion

Quality Factors

- Correctness
- Efficiency
- Expandability
- Flexibility
- Integrity
- Interoperability
- Maintainability
- Manageability
- Portability
- Reliability
- Reusability
- Safety
- Survivability
- Usability
- Verifiability

Maintainability



- Maintainability deals with the ease of finding and fixing errors
- Fitness for use regarding maintainability means that the software is productive through the maintenance lifecycle, covering error detection through the issue of a new release

From Components to Products

Integration Strategy

- The basis for effective product integration is an integration strategy that uses combinations of techniques in an incremental manner
  - An integration strategy should be developed early in the project, concurrently with product development plans and specifications
  - The integration plan should identify a sequence for receipt, assembly, and activation of the various components that make up the product

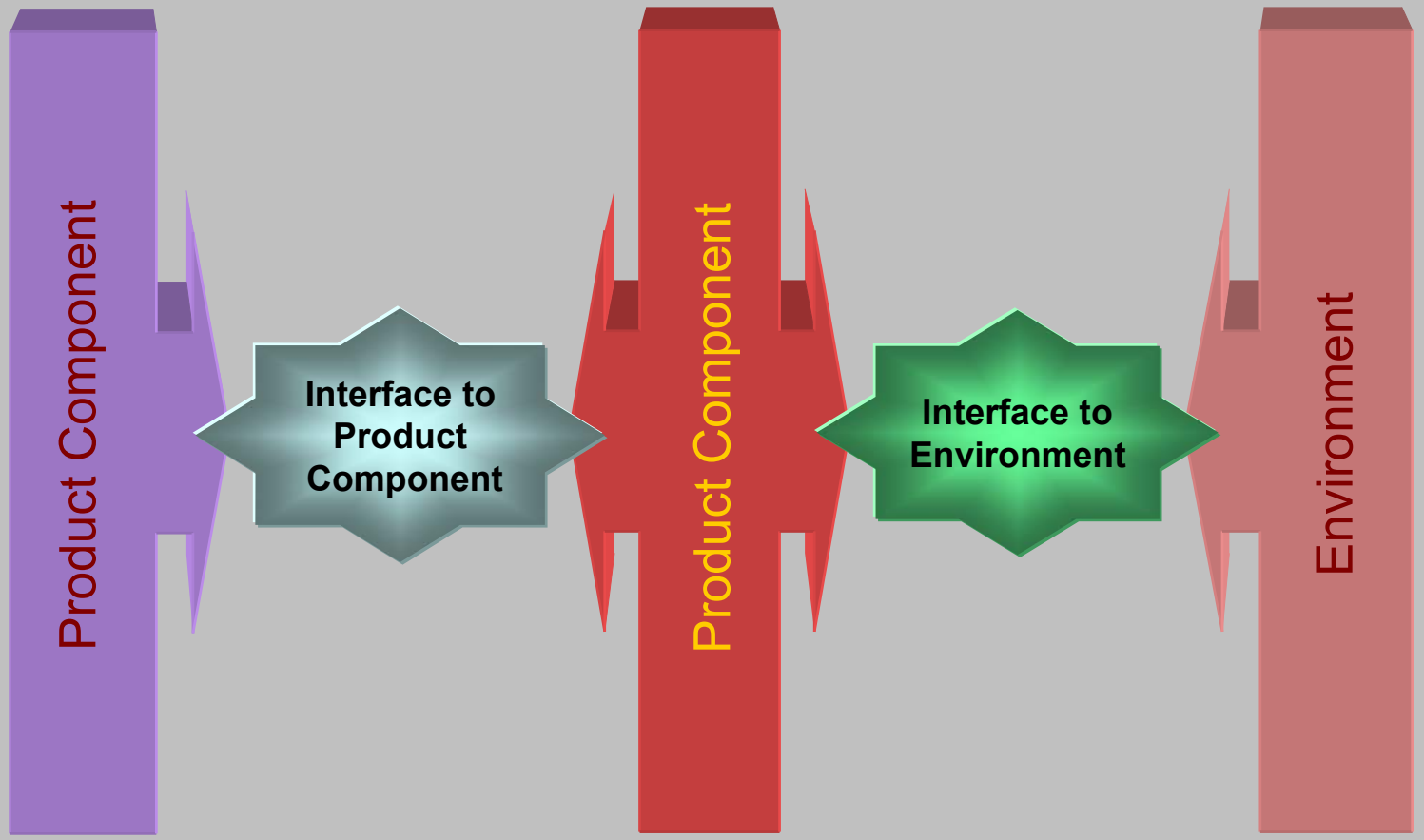
Integration Strategy - 2

- Establishing the product integration strategy including the following:
  - Integration sequence
  - Work to be done
  - Responsibilities for each activity
  - Resources required
  - Schedule to be met
  - Procedures to be followed
  - Tools required
  - Environment
  - Personnel skills

Product Integration Environment

- Establish and maintain the environment needed to support the integration of the product components
- The product integration strategy may identify needs for an environment that must be acquired or developed
- The product integration environment may include the reuse of existing organizational resources

Ensure Interface Compatibility



Confirm Readiness of Product Components for Integration

- Confirm that each product component is compliant with its interface requirements
  - Ensure that the product components are delivered to the product integration environment in accordance with the planned product integration strategy
  - Verify the receipt of each product component
  - Verify the configuration status of the product component against the expected configuration
  - Verify the configuration status of the accompanying interface documentation against the expected configuration
  - Perform pre-checks of all physical interfaces before connecting product components together

Verification

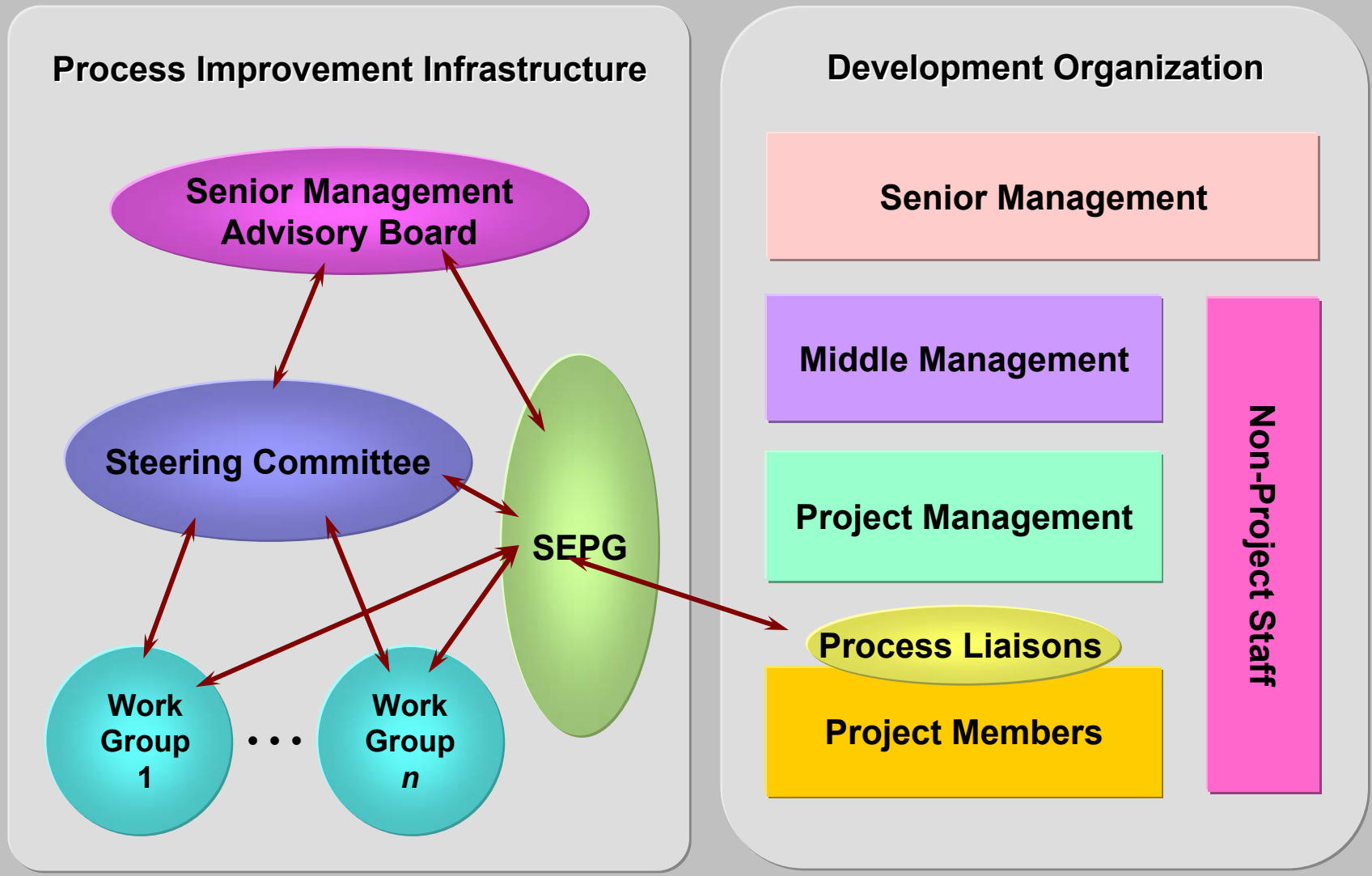
- Verification includes verification of the product and intermediate work products against all selected requirements, including customer, product, and product component requirements

Validation

- Demonstrate that a product or product component fulfills its intended use when placed in its intended environment
- Validate Maintenance, Training, and Support Services
  - Demonstrate that the maintenance tools are operating in the actual product
  - Verify in the field that support of the product is effective as specified by the customer (e.g., Mean Time to Repair)
  - Demonstrate adequate training of the products and services

Improving Processes at the Organizational Level

Sample Improvement Infrastructure



Organization's Process Assets

Measurement Repository

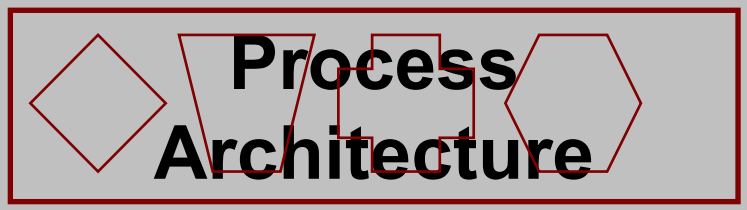
Process Asset Library

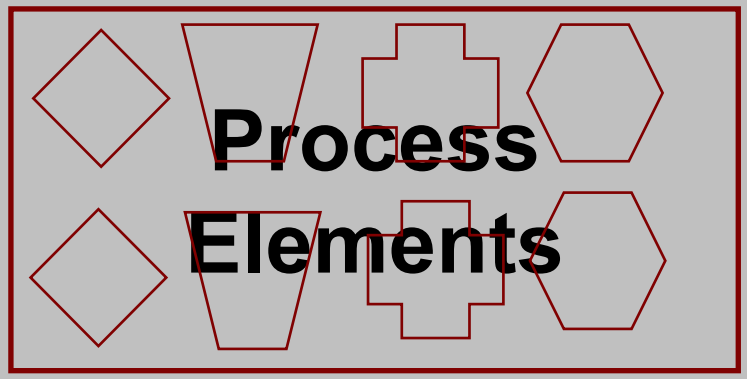
Life-cycle Models

Tailoring Guidelines

Support Environment

Organization's Standard Process Definition





The Knowledge and Skills Base

Core Competencies

- What business is the organization in?
- What are the core competencies required to perform the organization's business and remain competitive?
- What is the organizational workforce knowledge and skills base?
- What training, mentoring, and coaching does each person need in order to develop the necessary skill set to do their everyday job and gain in the organization's core competencies?
- What must recruiters do to find appropriate candidates with either the necessary knowledge and skills or the proven ability to learn

Organization-Level Training

- The organization's strategic business objectives and improvement plans should be analyzed to plan for current, intermediate, and future training needs in order for the organization to remain competitive

Organization-Level Training - 2

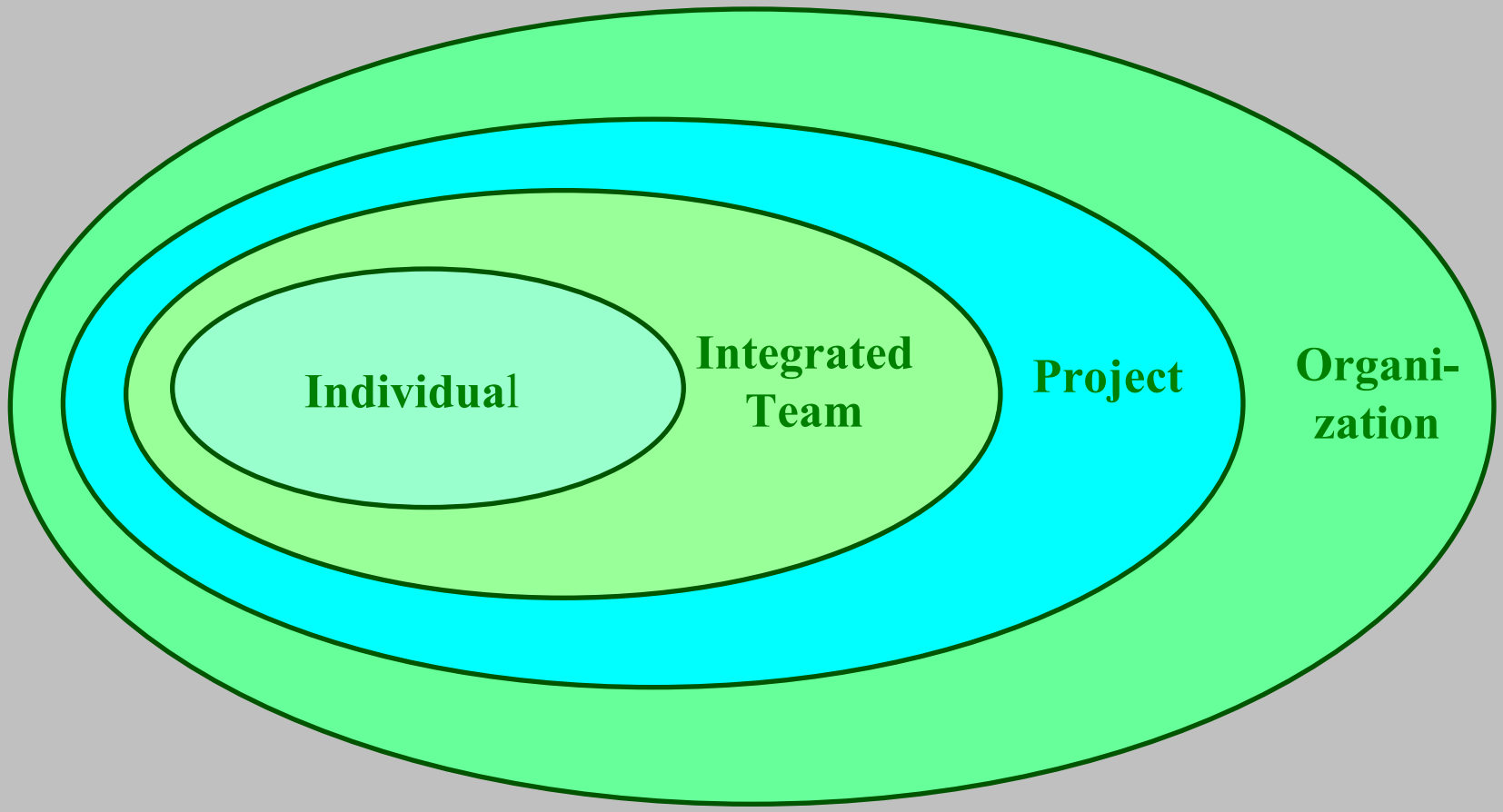
- Determine which training needs will be focused on at the organizational level
- Analyze the project and support groups' needs to identify common training needs that can be most efficiently addressed organization-wide
- Negotiate specific training needs with various projects and support groups
- "Economy of Scale" must always be considered when planning for organizational vs. project-level training
- Critical Corporate Asset.doc

Integrated Teams

Integrated Teaming

- Successful Integrated Teaming depends on:
  - Integrated Project Management which emphasizes proactively integrate the concepts in the Project Plan and all supporting plans
  - Collaboration skills from Integrated Team members to satisfy customer and business needs that would not normally be achieved by normal project members
  - Shared Vision
  - Organizational Environment for Integration
  - Team members who have strong interpersonal skills and ability to work in a team environment and the ability to complement the mix and knowledge and skills in the team

Shared Vision Context



Reducing Variation

CMMI Overview

Level	Process Characteristics	Process Areas
5 Optimizing	Focus is on quantitative continuous process improvement	Causal Analysis and Resolution Organizational Innovation and Deployment
4 Quantitatively Managed	Process is measured and controlled	Quantitative Project Management Organizational Process Performance
3 Defined	Process is characterized for the organization and is proactive	Requirements Development Technical Solution Product Integration Verification Validation Organizational Process Focus Organization Process Definition Organizational Training Integrated Project Management Integrated Teaming Organizational Environment For Integration Integrated Supplier Management Risk Management Decision Analysis & Resolution
2 Managed	Process is characterized for projects and is often reactive	Requirements Management Project Planning Project Monitoring and Control Supplier Agreement Management Product and Process Quality Assurance Configuration Management Measurement and Analysis
1 Initial	Process is unpredictable, poorly controlled, and reactive	

Variation Among Individuals

- One of the traits of CMMI Maturity Level 1 is that the process “belongs” to the people. If others follow a process, it is normally due to the strong personality of someone on the project who has experienced using processes in another environment.
- From a variation point of view, a level one organization has great variation based on its individual employees following their own process paths. This is why maturity level one companies depend so heavily on the heroics of its people.

Project's Processes to Reduce Variation

- At CMMI Maturity Level 2, processes normally belong to the project and are enforced by the Project Manager
- The processes, standards, guidelines, checklists, and templates are enforced for all of the project members to achieve more uniformity in development and product quality
- Assuming that all projects follow some form of process, the amount of variation that was seen in organizations of maturity level 1 is reduced even if all of the projects followed a different process

Organizational Processes to Reduce Variation

- At The Organizational Level, an organization that wishes to achieve CMMI Maturity Level 3 needs to have its processes owned by the organization for economy of scale to be realized and process measurement to make practical sense
- These process definitions are tailored and incorporated into the project's defined processes throughout the organization and thus variation in project development and product and service quality is again reduced

Organizational Processes to Reduce Variation - 2

- An organizational measurement repository is established and maintained which contains both product and process measures based on the organization's set of standard processes along with the information needed to understand and interpret the measures
  - Trends can be seen and predictability can be achieved
  - Process performance baselines can now be developed to support quantitative management later

Quantitative Project Management

- Quantitative Management is tied to the organization's strategic goals for product quality, service quality, and process performance
- When higher degrees of quality and performance are demanded, the organization and projects must determine if they have the ability to improve the necessary processes to satisfy the increased demands
- Achieving the necessary quality and process performance objectives requires stabilizing the processes or subprocesses that contribute most to the achievement of the objectives and reducing process variation to support the quantitative management objectives.

Establishing a Measurement Program

Measurement and Analysis Overview

- A measurement initiative involves the following:
  - Specifying the objectives of measurement and analysis such that they are aligned with established information needs and business objectives
  - Defining the measures to be used, the data collection process, the storage mechanisms, the analysis processes, the reporting processes, and **the feedback processes**
  - Implementing the collection, storage, analysis, and presentation of the data
  - Providing objective results that can be used in making business judgments and taking appropriate corrective actions

Basic Measures

- Project Management Measures
  - Size and complexity
  - Effort and Cost
  - Schedule
  - Computer Resources
  - Data Management
  - Knowledge and Skills
  - Stakeholder Involvement
  - Technical Performance
  - Commitments
  - Critical Dependencies
  - Quality

Effectiveness of Processes

- We must not only define and follow processes but we must determine if the processes are working for us the way we expected them to
  - How well are the processes working?
- Requirements Management Processes Effectiveness - Example
  - Number of change requests per month compared with the original number of requirements for the project
    - Critical change requests
    - Intermediate change requests
    - Nice to have change requests

More Advanced Measures

- Peer Review Effectiveness
- Testing Effectiveness
- Test Coverage

Quantitative Project Management

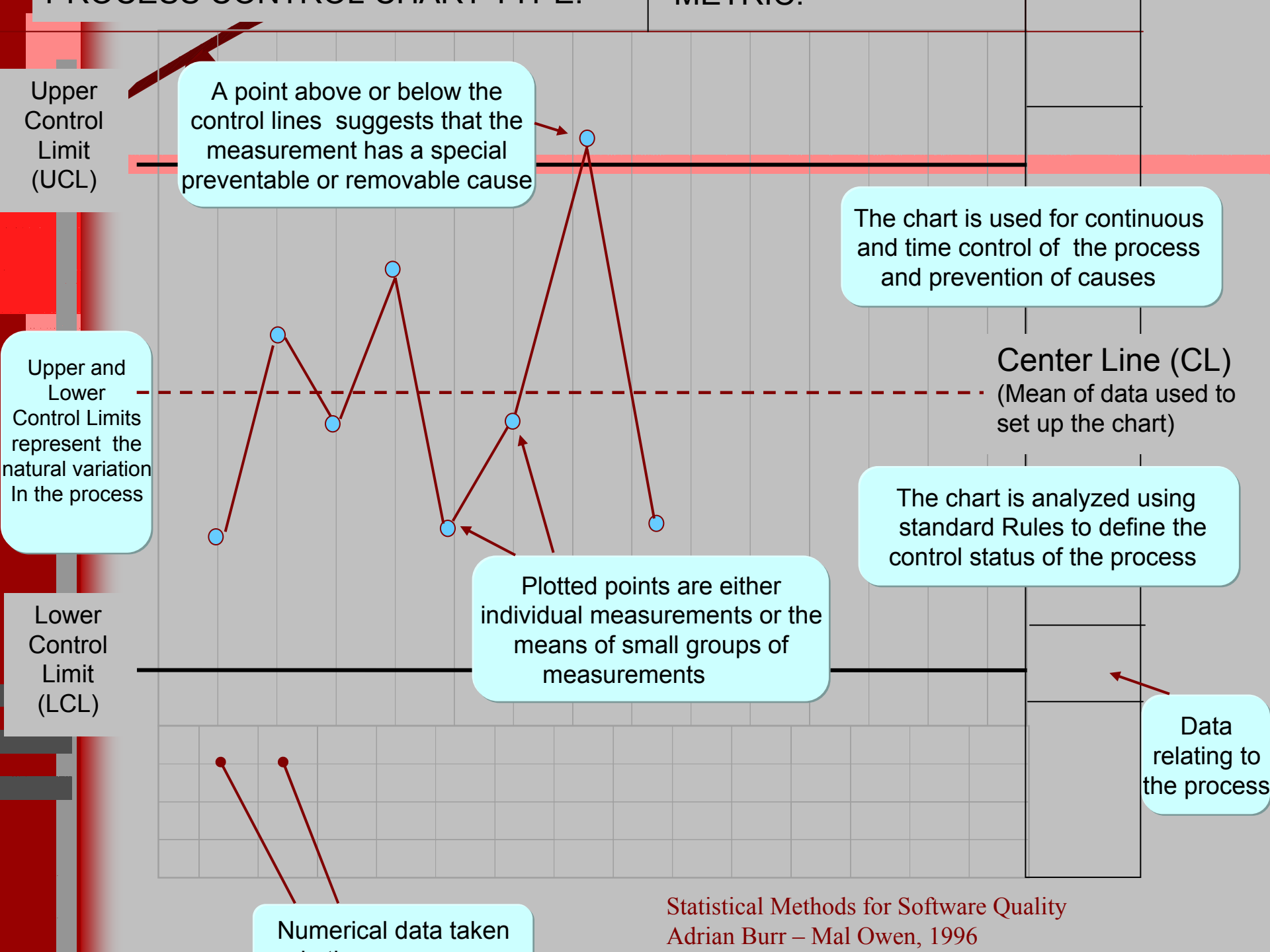
Quantitative Management Concepts

- Quantitative Management is tied to the organization's strategic goals for product quality, service quality, and process performance
- When higher degrees of quality and performance are demanded, the organization and projects must determine if they have the ability to improve the necessary processes to satisfy the increased demands
- Achieving the necessary quality and process performance objectives requires stabilizing the processes or subprocesses that contribute most to the achievement of the objectives
- Assuming the technical requirements can be met, the next decision is to determine if it is cost effective

Quality and Process Performance Objectives

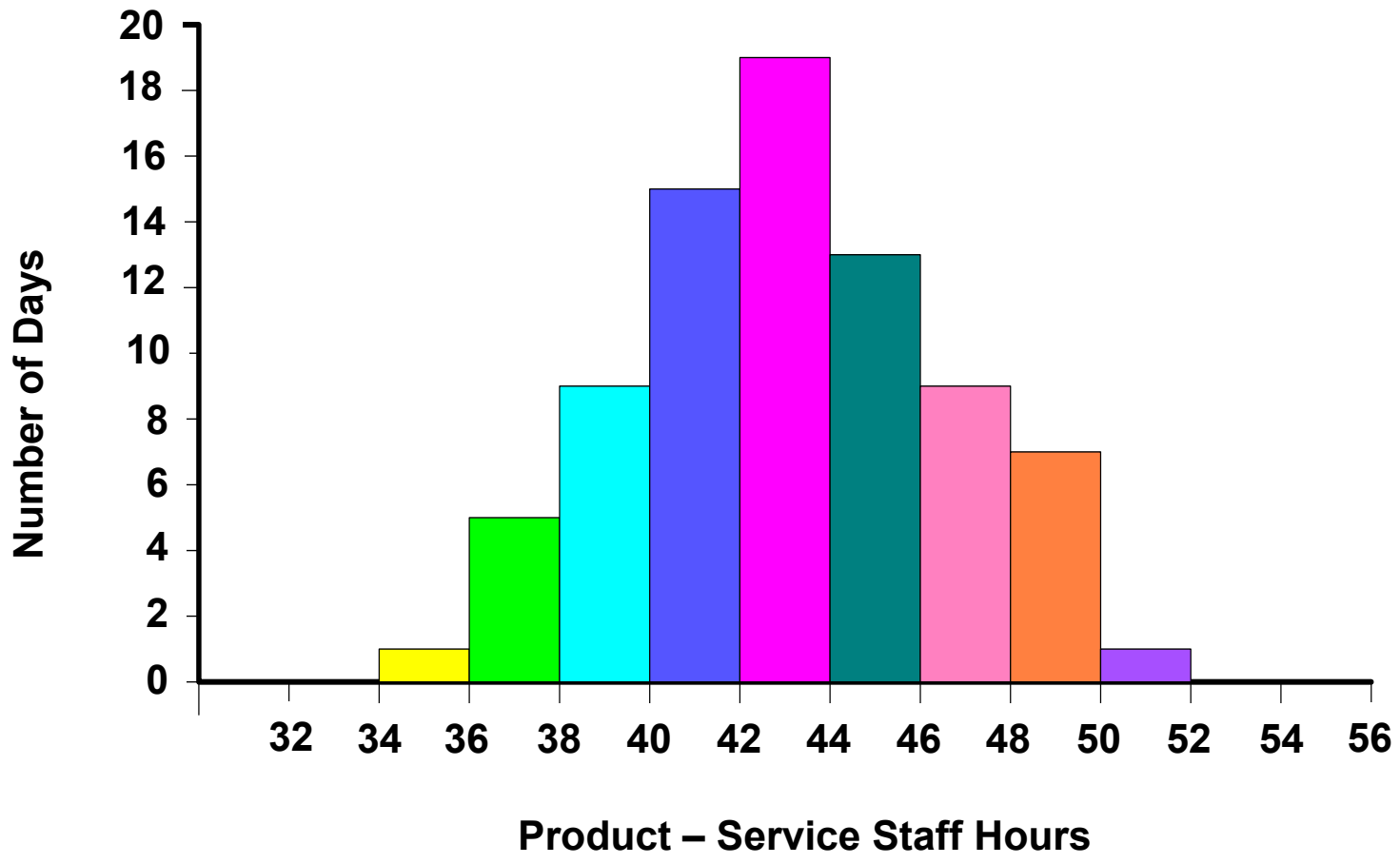
- Define and document measurable quality and process performance objectives for the project
- Examples of Quality Objectives
  - Mean time between failures
  - Critical resource utilization
- Examples of Process Performance Objectives
  - Percentage of defects removed by type of verification activity
  - Defect escape rates
  - Number and density of defects (by severity) found during the first year following product delivery
  - Rework time as a percentage of total project life-cycle time

Measures and Analytic Techniques



Statistical Methods for Software Quality
Adrian Burr – Mal Owen, 1996

Histograms

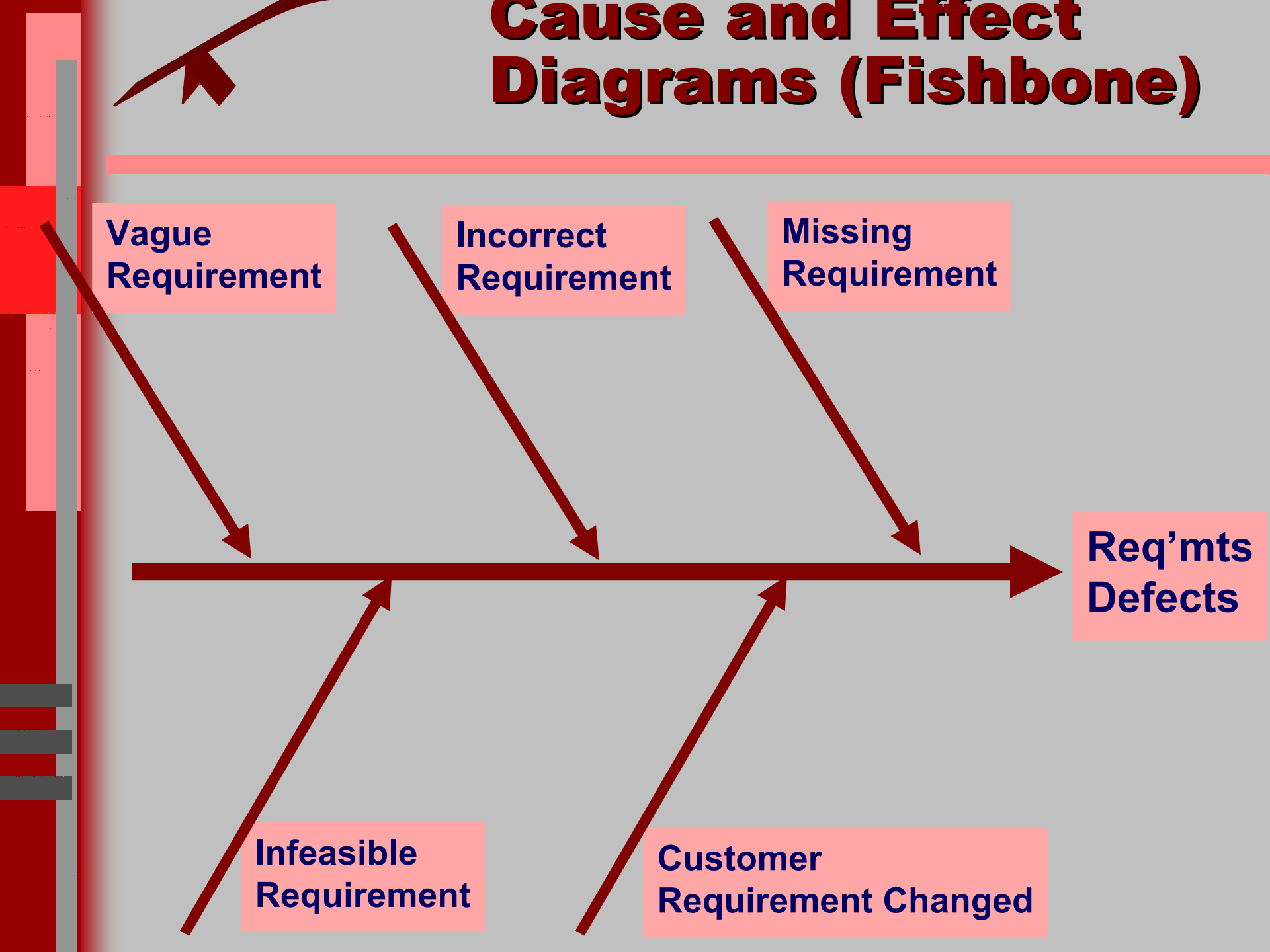

Number of Days
20
18
16
14
12
10
8
6
4
2
0
32
34
36
38
40
42
44
46
48
50
52
54
56
Product – Service Staff Hours

Improving Beyond Stability

Insight into Causal Analysis and Resolution

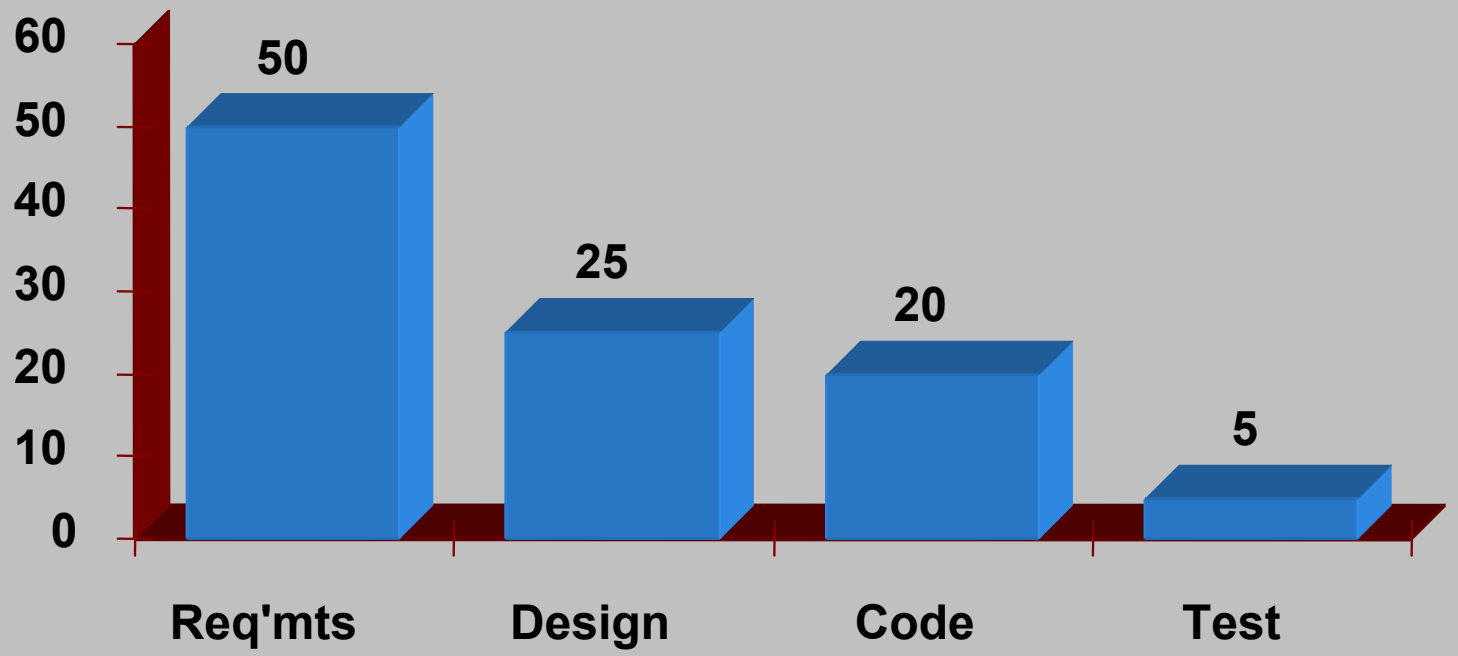
- **Causal analysis and resolution is the process of improving quality and productivity by preventing the introduction of defects into a product**
- Based on an understanding of the defined process in use and how it is implemented, the root causes of the defects and the future implications of the defects are determined

Cause and Effect Diagrams (Fishbone)

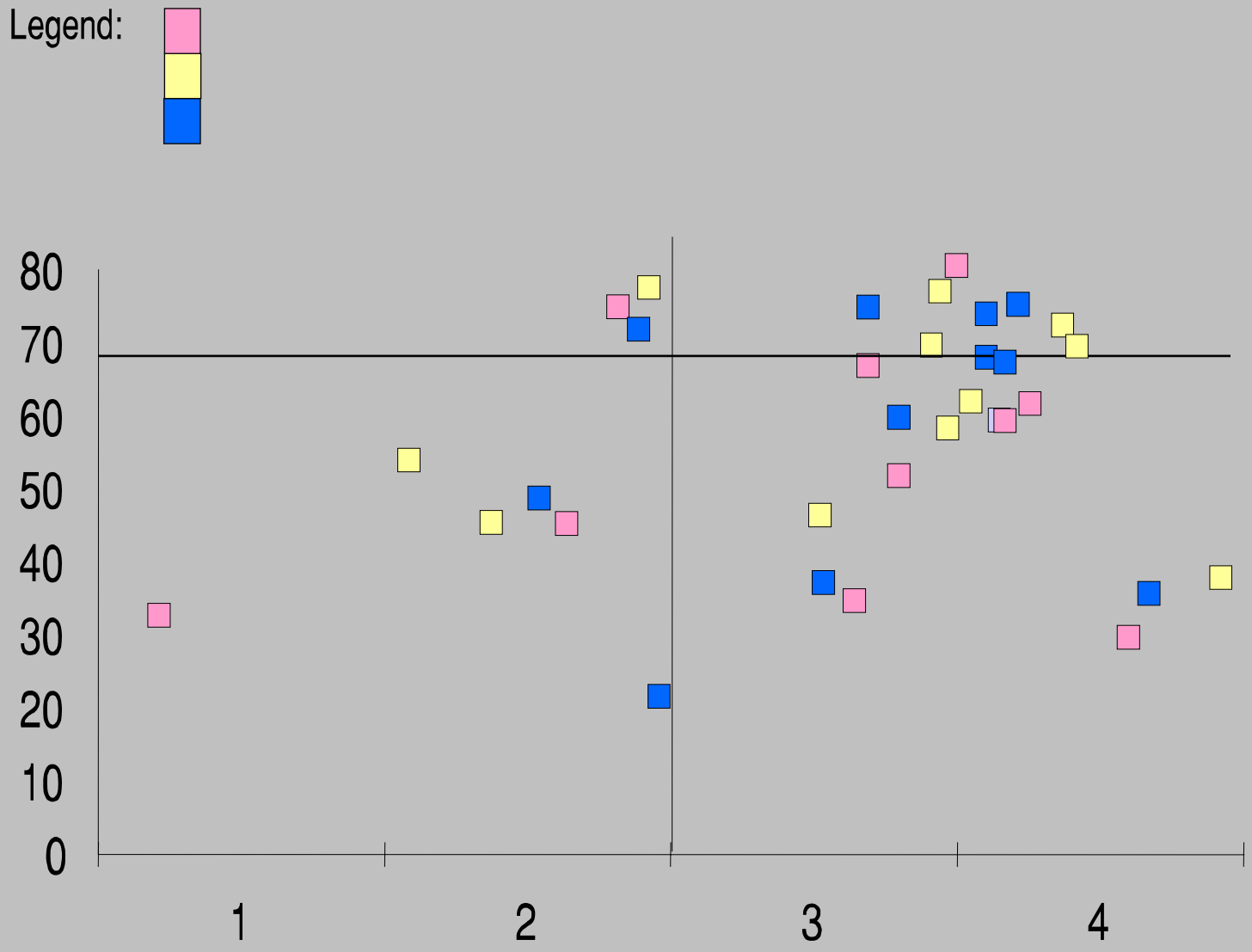


Pareto Charts

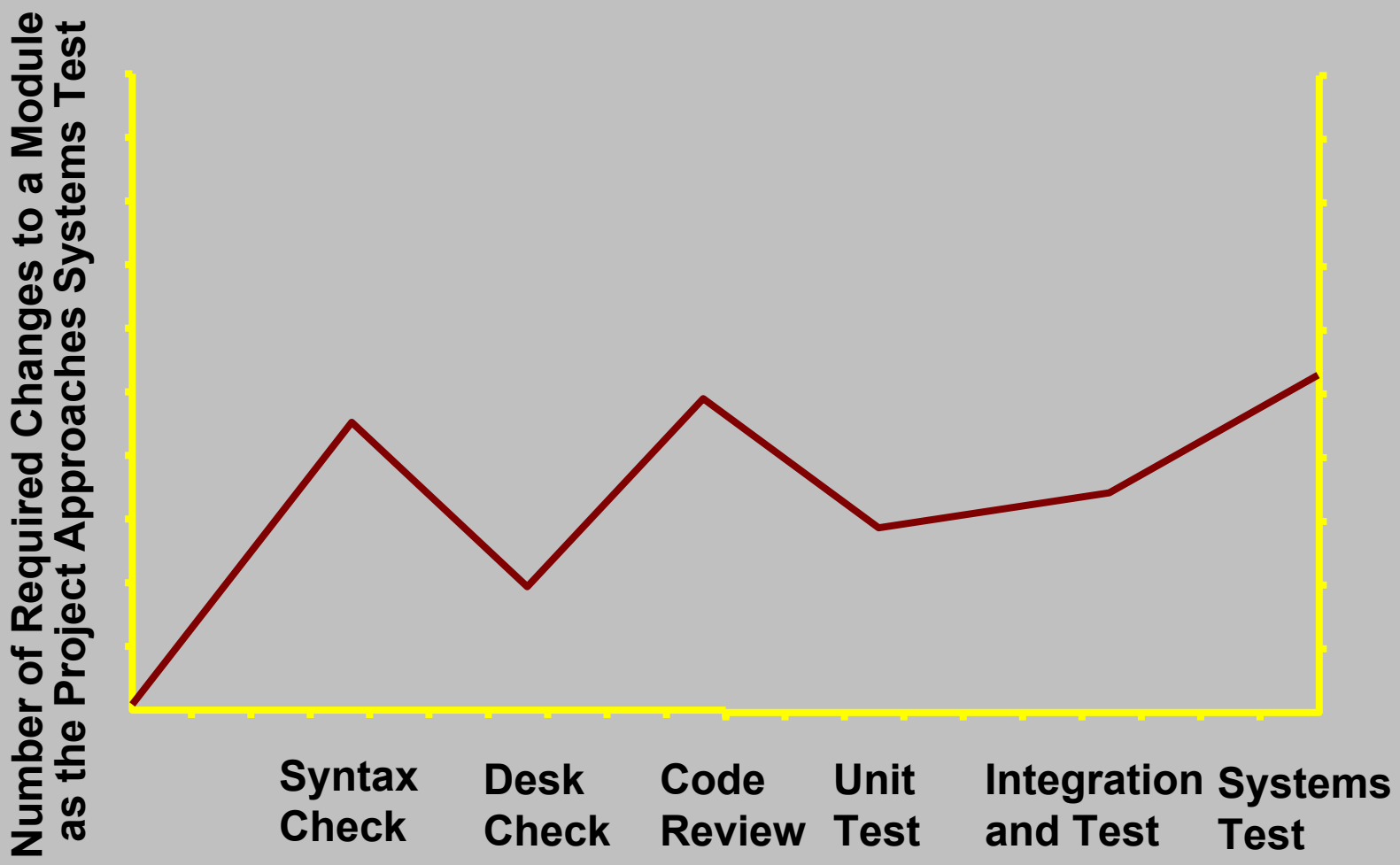
- Percentage of Defects Detected During System Testing by Phase Where Defect Was Injected



Scatter Diagrams

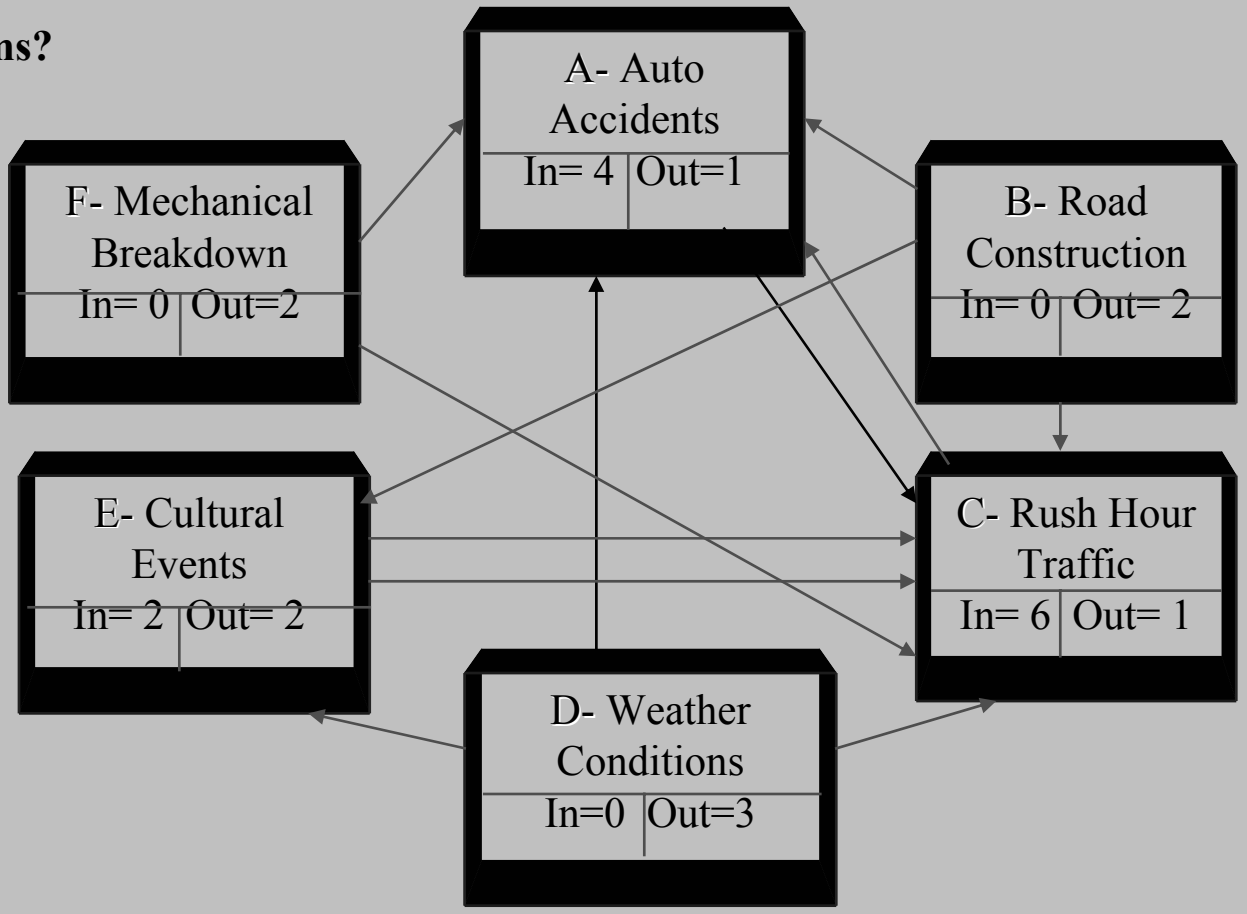


Run Chart


Number of Required Changes to a Module as the Project Approaches Systems Test
Syntax Check
Desk Check
Code Review
Unit Test
Integration and Test
Systems Test

Interrelationships Diagraph

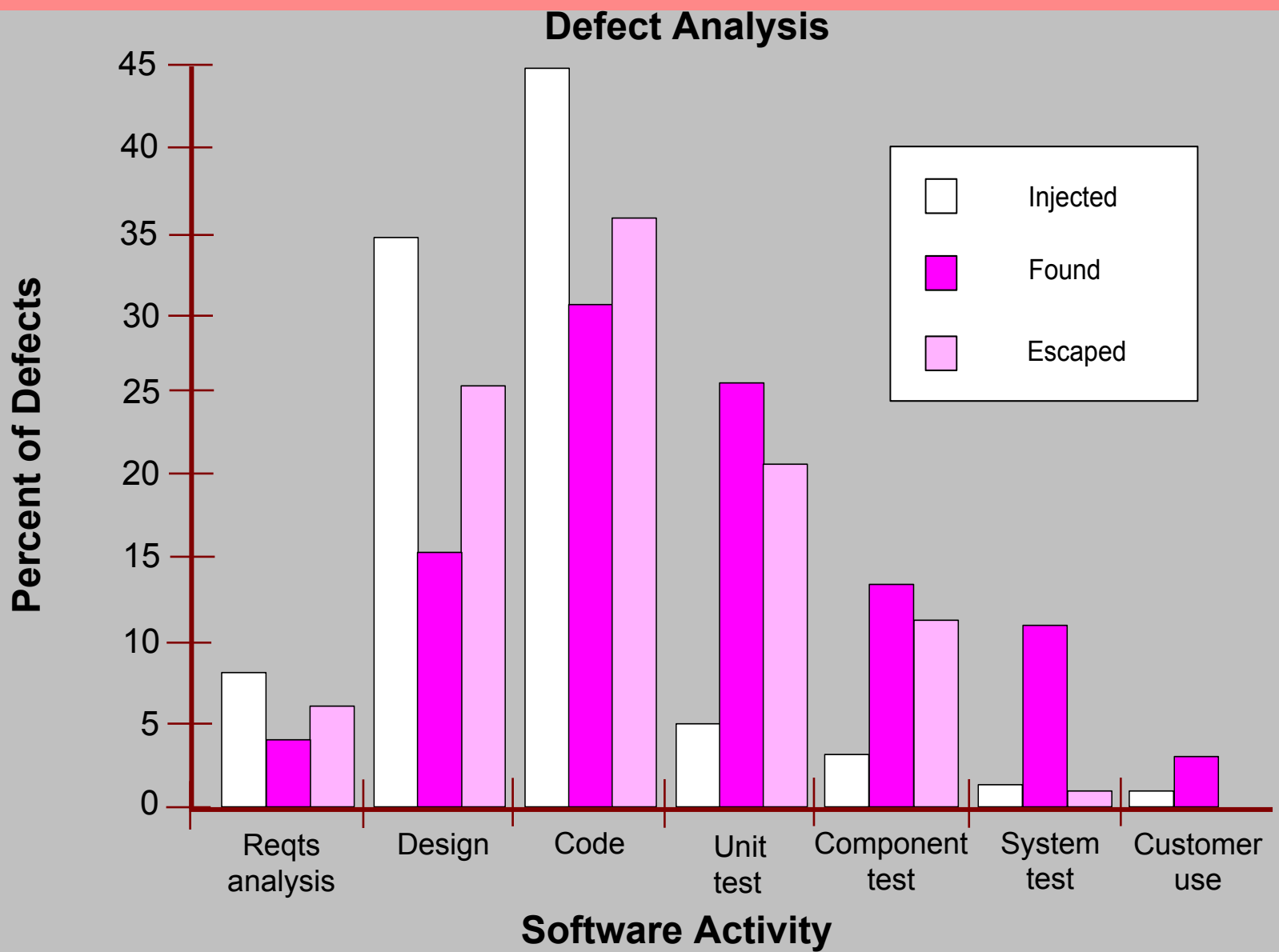
What are the issues relating to traffic jams?



Check Sheet
(Proof and Checking Errors)

Errors Classification	Book Chapters					
	1	2	3	4	5	Total
Spelling	////	///	//	////	///	16
Punctuation	//	///	//	//	///	12
Missing Information	/	//	//	/		6
Redundancy	//	///	/	/	//	9
Technical Errors	//	/	//	/	//	8
Format Errors			//	/		3
Incomplete Concepts						
Total	11	12	11	10	10	54

Bar Chart


Defect Analysis
Percent of Defects
45
40
35
30
25
20
15
10
5
0
Injected
Found
Escaped
Reqts analysis
Design
Code
Unit test
Component test
System test
Customer use
Software Activity

Force Fields

Fear of Public Speaking

Driving Forces	Restraining Forces
Increases Self-Esteem →	← Past Embarrassments
Helps career →	← Afraid to make mistakes
Communicates ideas →	← Lack of knowledge on the topic
Contributes to a plan/solution →	← Afraid people will be indifferent
Encourages others to speak →	← Afraid people will laugh
Helps others to change →	← May forget what to say
Increases energy of group →	← Too revealing of personal thoughts
Helps clarify speaker's ideas by getting feedback from others →	← Afraid of offending group
Helps others to see new perspective →	← Fear that nervousness will show
	← Lack of confidence in personal appearance

Organizational Innovation and Deployment Overview

- The Organizational Innovation and Deployment process area selects and deploys improvements that can enhance the organization's ability to meet its quality and process performance objectives
- Quality and process performance objectives that this process area might address include:
  - Improved product quality
  - Increased productivity
  - Decreased cycle time
  - Greater customer and end user satisfaction
  - Shorter development or production time to change functionality, add features or adapt to new technologies

Organizational Innovation and Deployment Overview - 2

- Process performance is a measure of the actual process results achieved and is characterized by both process measures and product measures.
- Process measures include:
  - Effort
  - Cycle time
  - Defect removal efficiency
- Product measures include:
  - Reliability
  - Defect density
  - Response time

Organizational Innovation and Deployment Overview - 3

- Process and Quality performance objectives that will be deployed are selected from proposals based on the following criteria:
  - A quantitative understanding of the organization's current quality and process performance
  - The organization's quality and process-performance objectives
  - The resources and funding available for that deployment
  - Estimates of the improvement resulting from the deployment
  - The expected benefits weighed against the cost and impact to the organization

Repeatable
Effective
and
Long Lasting

Institutionalization

- Institutionalization involves implementing practices that
  - Ensure the process areas are effective, repeatable and long lasting
  - Provide needed infrastructure support
  - Ensure processes are defined, documented, understood
  - Enable organizational learning to improve the processes

Capability Level 0

- Capability Level 0 deals with Incomplete processes
- An incomplete process is a process that is either not performed or only performed partially
  - One or more ***Specific Goals*** of the process are not performed

Capability Level 1

- Capability Level 1 deals with Performed processes
- The process performance may not be stable and may not meet specific objectives such as quality, cost, and schedule, but useful work can be done
- A critical distinction between an incomplete process and a performed process is that a performed process satisfies all of the specific goals of the process area

Capability Level 1 - 2

- GP 1.1 Perform Base Practices
  - Perform the base practices of the process area to develop work products and provide services to achieve the specific goals of the process area
  - The purpose of this generic practice is to produce the work products and deliver the services that are expected by performing the process
  - These activities may be done informally, without following a documented process description or plan

CL-2 Generic Practices

- GP 2.1 Establish an Organizational Policy
  - Establish and maintain an organizational policy for planning and performing the process
    - Policies exist for Project Planning
    - New Client Offers
- GP 2.2 Plan the Process
  - Establish and maintain the requirements, objectives, procedures and plan for performing the process
- GP 2.3 Provide Resources
  - Provide adequate resources for performing the planned process, developing the work products, and providing the services of the process

CL-2 Generic Practices - 2

- GP 2.4 Assign Responsibility
  - Assign responsibility and authority for performing the process, developing the work products, and providing the services of the process
- GP 2.5 Train People
  - Train the people performing or supporting the planned process as needed
- GP 2.6 Manage Configurations
  - Place designated work products of the process under appropriate levels of configuration management
- GP 2.7 Identify and Involve Relevant Stakeholders
  - Identify and involve the relevant stakeholders as planned

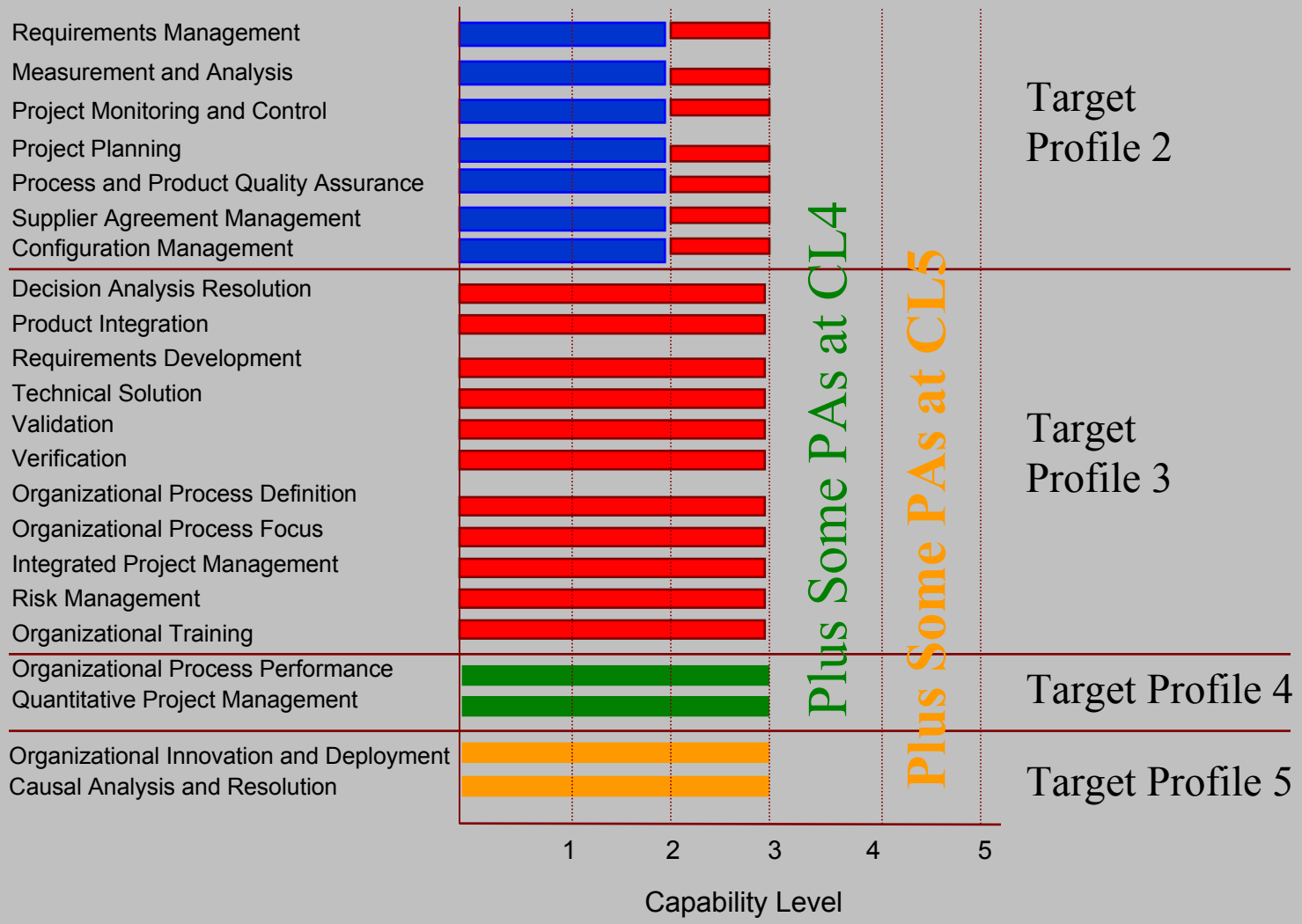
CL-2 Generic Practices - 3

- GP 2.8 Monitor and Control and Measure the Process
  - Monitor and control the process against the plan and take appropriate corrective action
- GP 2.9 Objectively Evaluate Adherence
  - Objectively evaluate adherence of the process, and the work products and services of the process to the applicable requirements, objectives, and standards, and address non-compliance
- GP 2.10 Review Status with Higher-Level Management
  - Review the activities, status, and results of the process with higher-level management and resolve issues

CL-3 Generic Practices

- GP 3.1 Establish Defined Process
  - Establish and maintain the description of the defined process
- GP 3.2 Collect Improvement Information
  - Collect work products, measures, measurement results, and improvement information derived from planning and performing the process to support the future use and improvement of the organization's processes and process assets

Equivalent Staging

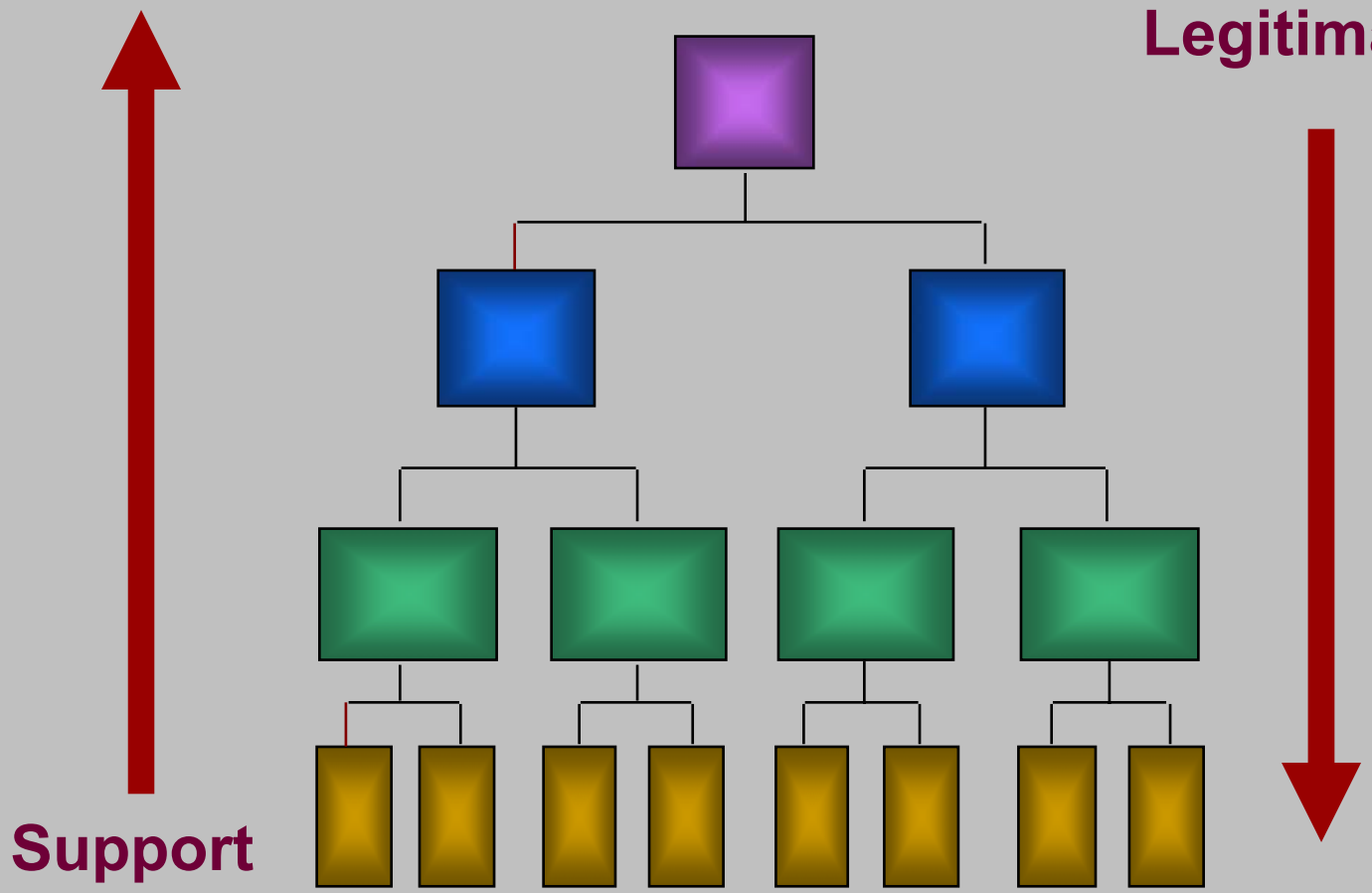


Process Improvement Means *Change!*

Principles of Process Change

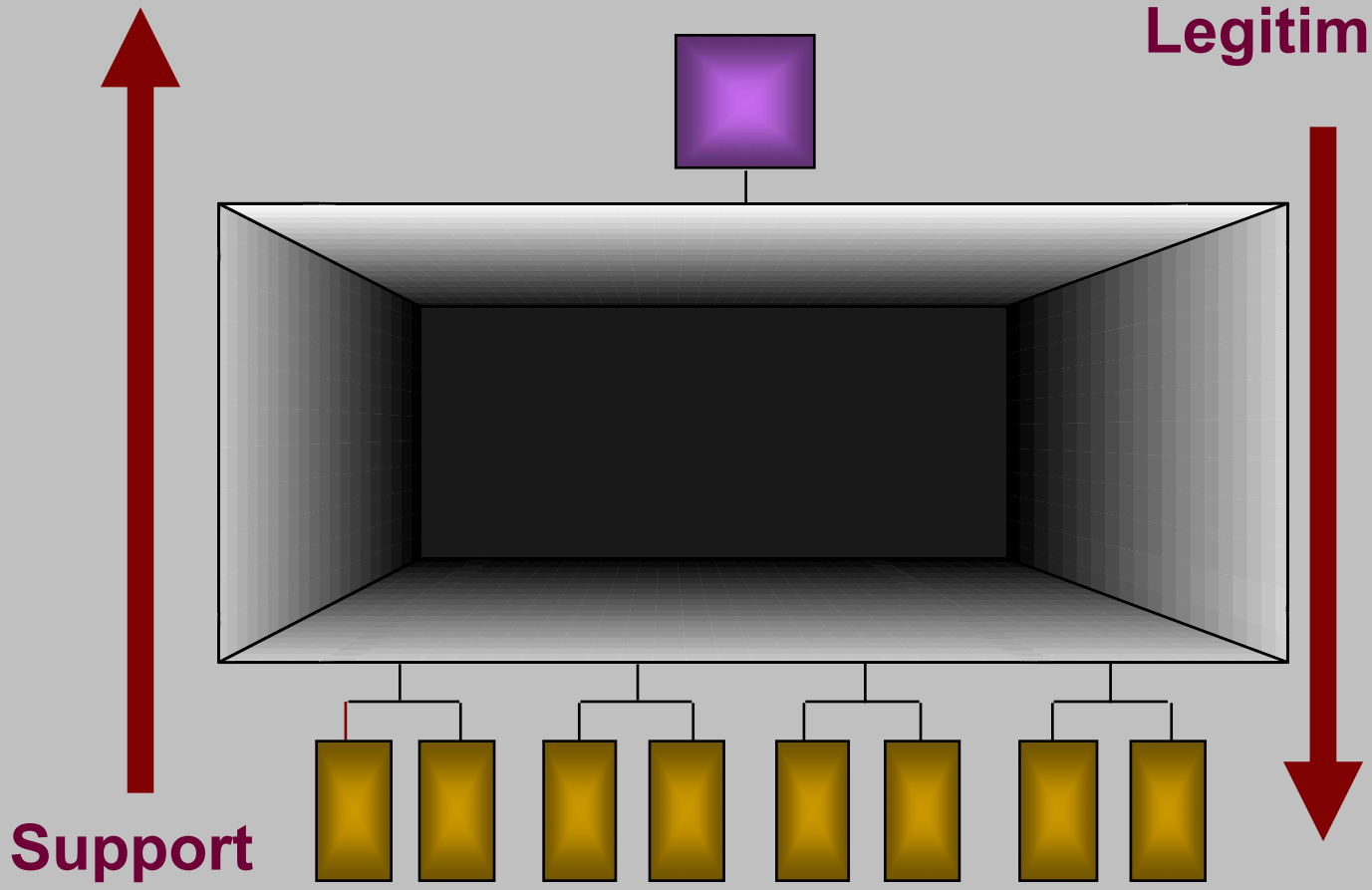
- Major changes must be sponsored by Senior Management
- Focus on fixing the process, not assigning the blame
- Understand current process first
- Change is continuous
- Improvement requires investment
- Retaining improvement requires periodic reinforcement

Building Support for Change

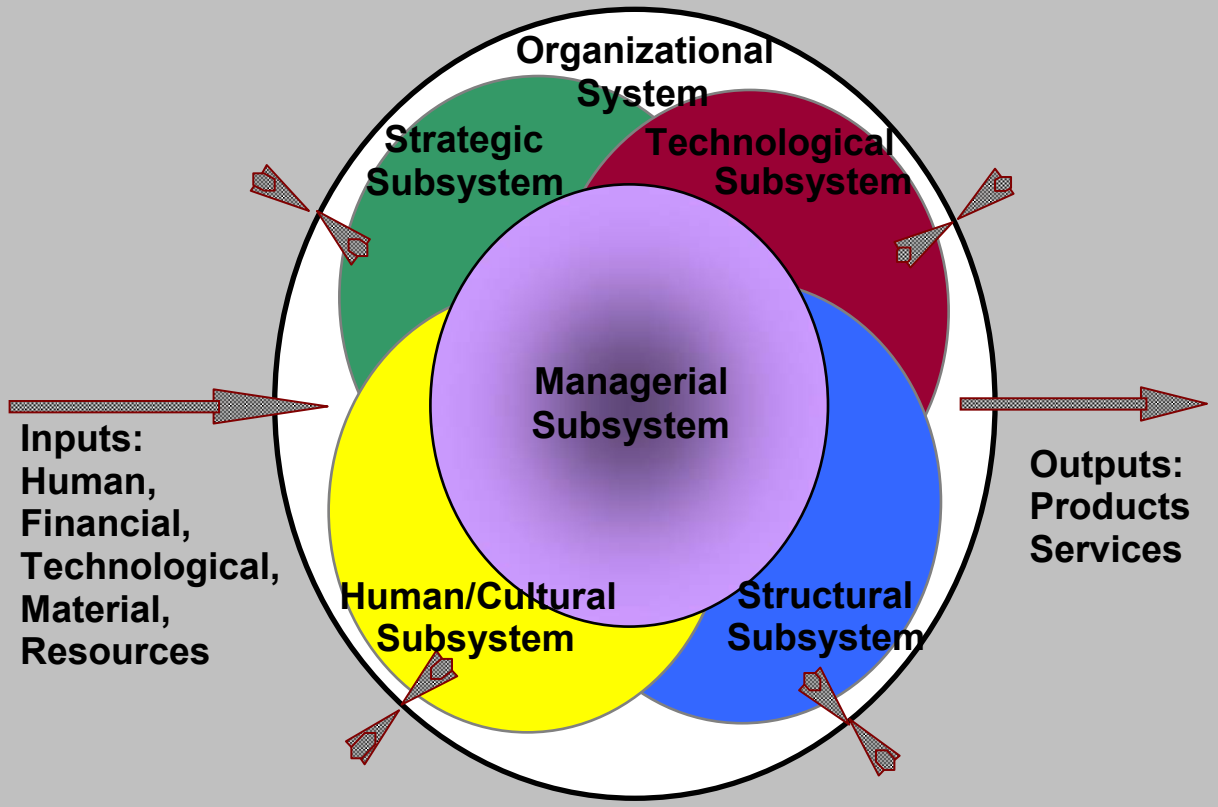


[courtesy JMaher]

Building Support for Change - 2

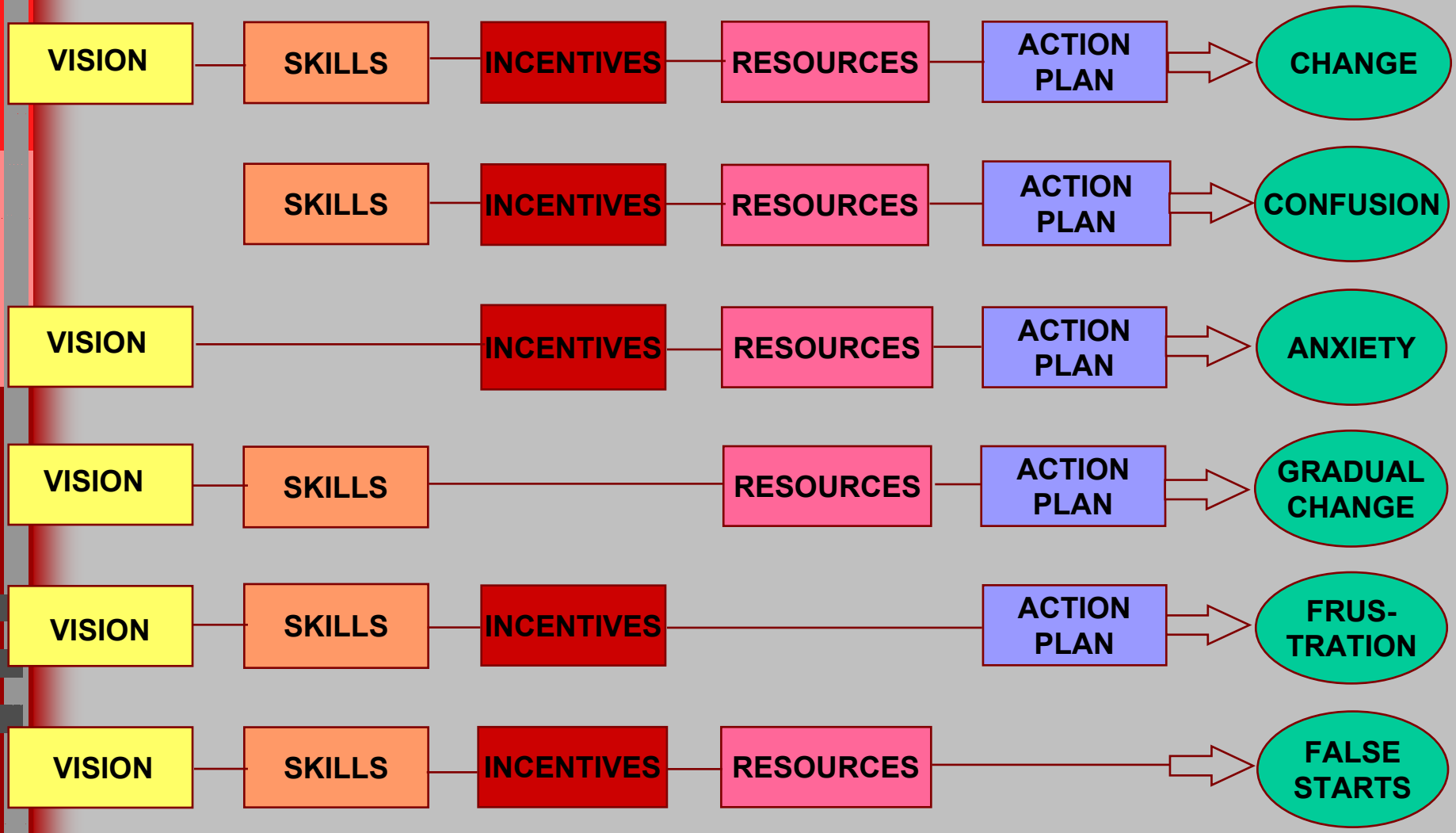


Organizations as Systems



[Source: Morgan, 1986]

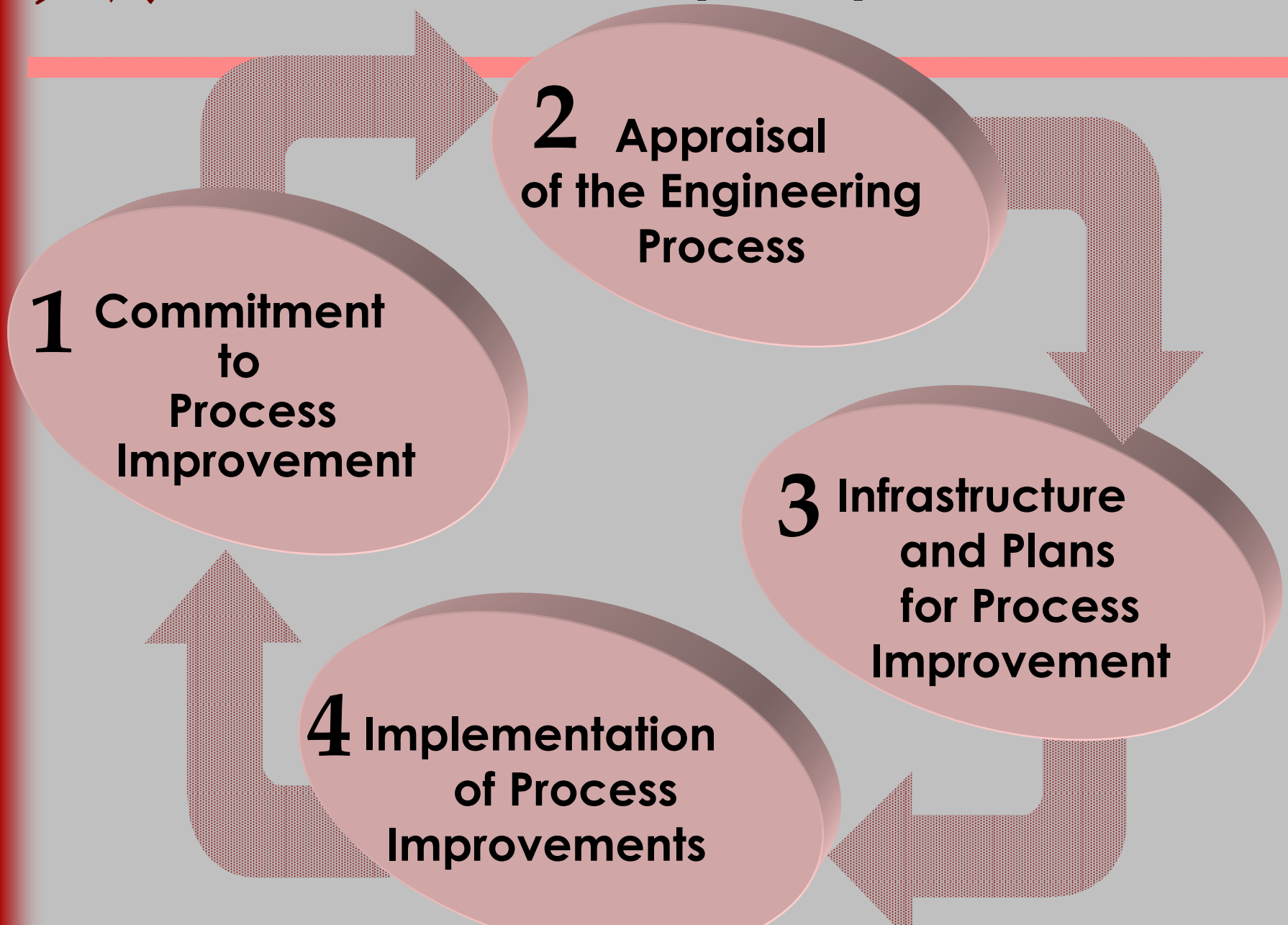
Managing Complex Change Requirements

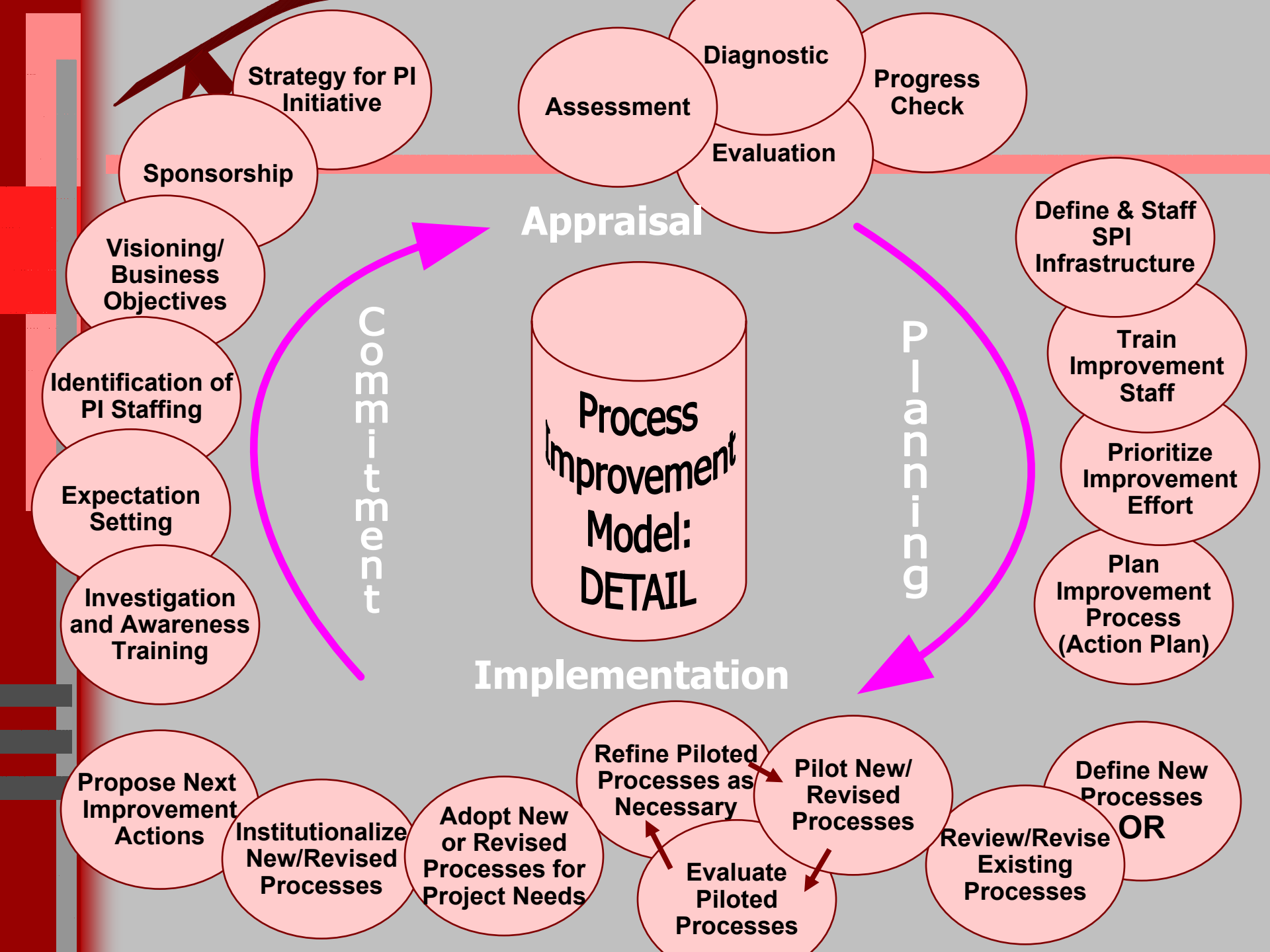


"Managing Technological Change"
Carnegie Mellon University
Software Engineering Institute

Process Improvement Model

Process Improvement Model (PIM)




Strategy for PI Initiative
Sponsorship
Visioning/ Business Objectives
Identification of PI Staffing
Expectation Setting
Investigation and Awareness Training
Assessment
Diagnostic
Progress Check
Evaluation
Appraisal
Commitment
Process Improvement Model: DETAIL
Planning
Define & Staff SPI Infrastructure
Train Improvement Staff
Prioritize Improvement Effort
Plan Improvement Process (Action Plan)
Implementation
Propose Next Improvement Actions
Institutionalize New/Revised Processes
Adopt New or Revised Processes for Project Needs
Refine Piloted Processes as Necessary
Pilot New/ Revised Processes
Evaluate Piloted Processes
Review/Revise Existing Processes
Define New Processes
OR

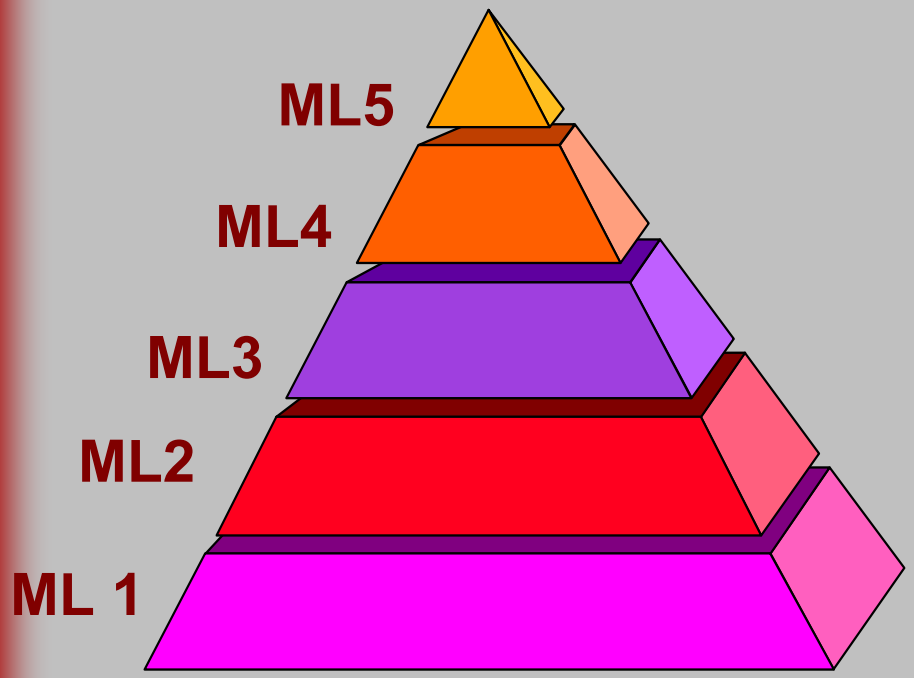
Constagedeous Approach to Process Improvement

Constagedeous Approach

- Both the Staged Representation and the Continuous Representation not only can be but **must** be used together to provide proper guidance that results in effective process improvement that supports an organization's business objectives

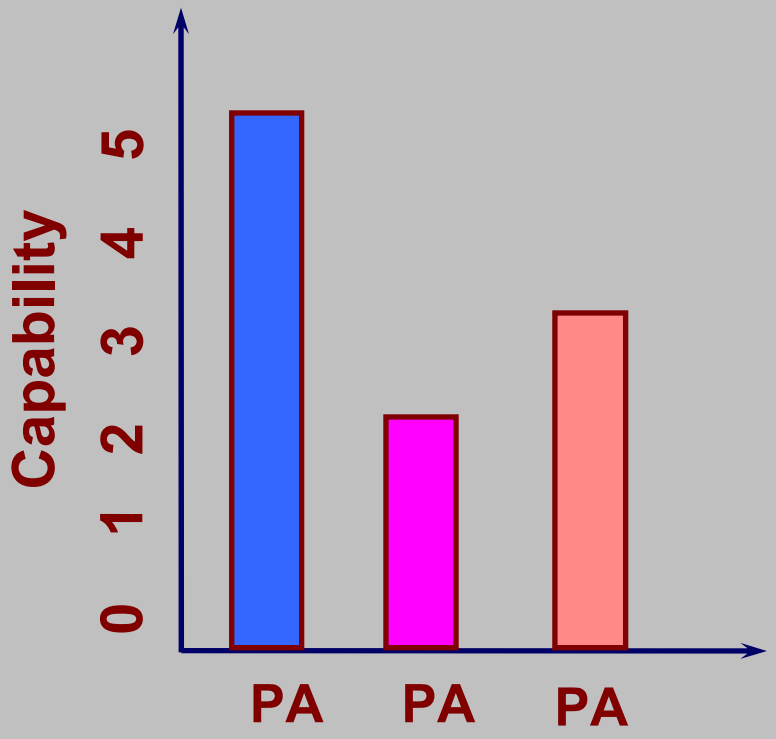
CMMI Model Representations

Staged



Organization

Continuous



Process

Summary

- The CMMI has evolved from contributions of engineers, managers, and social psychologists over the past 100 years
- The multiple views of the CMMI contribute to the picture that process improvement must concern itself with people, technology, measurement, risk, and customer satisfaction if an organization's business objectives are to be supported with the CMMI-based process improvement initiative

Thank You

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CMMI® Version 1.2 and Beyond …a Tutorial

Mike Phillips
Software Engineering Institute
Carnegie Mellon University

® CMMI is registered in the U.S. Patent and Trademark Office by Carnegie Mellon University.

CMMI Today

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CMMI Today

Version 1.1 CMMI Product Suite was released January 2002.

Errata sheets cover known errors and changes with book publication are available on CMMI website.

SCAMPI “classes” of methods support many needs

- internal process improvement
- supplier source selection
- contract process monitoring

SCAMPI B/C Team Leader Training available

Introduction to CMMI (Staged and Continuous) available

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CMMI Adoption Trends: Website Visits[1]

CMMI web pages hits

- 1.8M/month
- Exceeded 60K/day in August 2005

443 organizations visited the CMMI Website more than 200 times during September 2005:

29 Defense contractor organizations

12 DoD organizations

49 Universities

328 Commercial companies

25 Non-DoD government agencies

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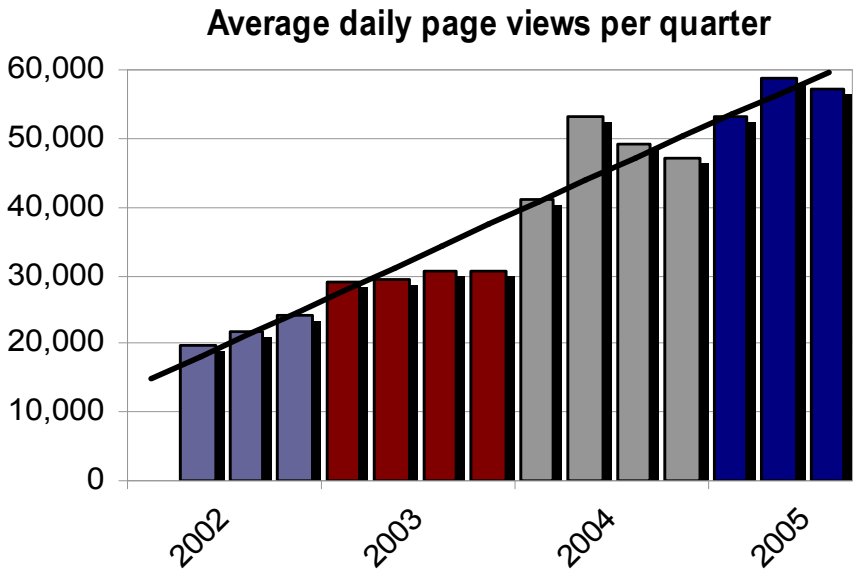
CMMI Adoption Trends: Website Visits$_2$

The following were the top viewed pages on the CMMI Website in September 2005:

- CMMI Main Page
- What is CMMI?
- CMMI Models and Modules
- Getting Started with CMMI Adoption
- CMMI Training, Events, & Forums



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Organizations Using CMMI

The following is an abbreviated list of organizations that are using CMMI.

Accenture
Boeing
Dyncorp
FAA
General Dynamics
Honeywell
Intel
L3 Communications
NASA
Nokia
NTT Data
Raytheon
Samsung
U.S. Air Force
U.S. Treasury Department
Bank of America
Bosch
EDS
Fannie Mae
General Motors
IBM Global Services
J. P. Morgan
Lockheed Martin
NDIA
Northrop Grumman
OUSD (AT&L)
Reuters
Social Security Administration
U.S. Army
Wipro
BMW
Ericsson
Fujitsu
Hitachi
Infosys
KPMG
Motorola
NEC
NRO
Polaris
SAIC
TRW
U.S. Navy
Zurich Financial Services

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CMMI Transition Status – 10/31/05

Training

- Introduction to CMMI – 40,809 trained
- Intermediate CMMI – 1,777 trained
- Introduction to CMMI Instructors – 384
- SCAMPI Lead Appraisers – 577 trained

Authorized

- Introduction to CMMI V1.1 Instructors – 292
- SCAMPI V1.1 Lead Appraisers – 405

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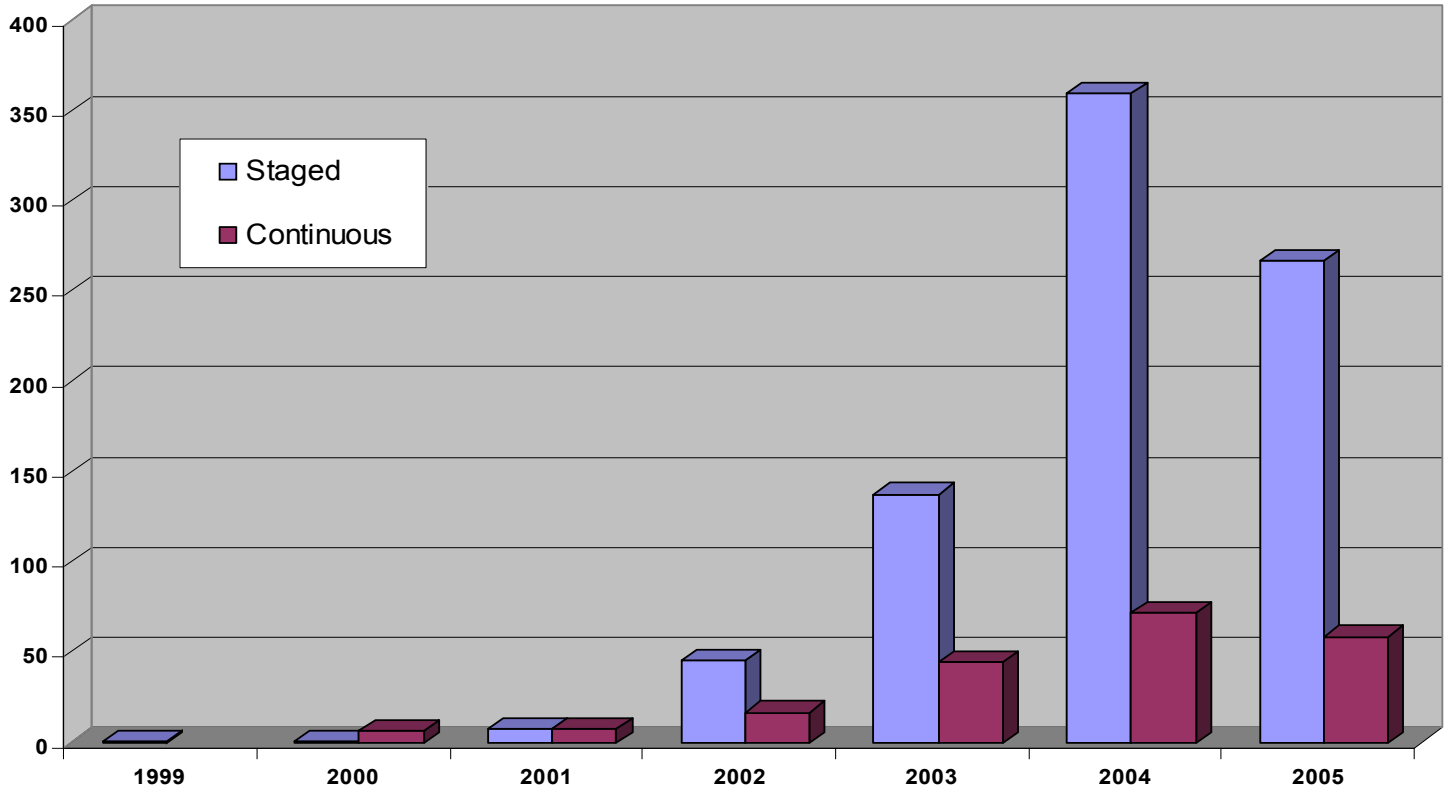
Number of SCAMPI vx.x Class A Appraisals Conducted by Year by Model Representation*
Reported as of 30 September 2005
*Where representation is reported



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Current Appraisal Synopsis

Based on SCAMPI℠ V1.1 Class A appraisals conducted since April 2002 release through August 2005 and reported to the SEI by September 2005.

977	appraisals
878	organizations
206	participating companies
86	reappraised organizations
3,686	projects
59.6%	non-USA organizations

Organizations previously appraised against CMMI V1.0 and who have not reappraised against V1.1 are not included in this report

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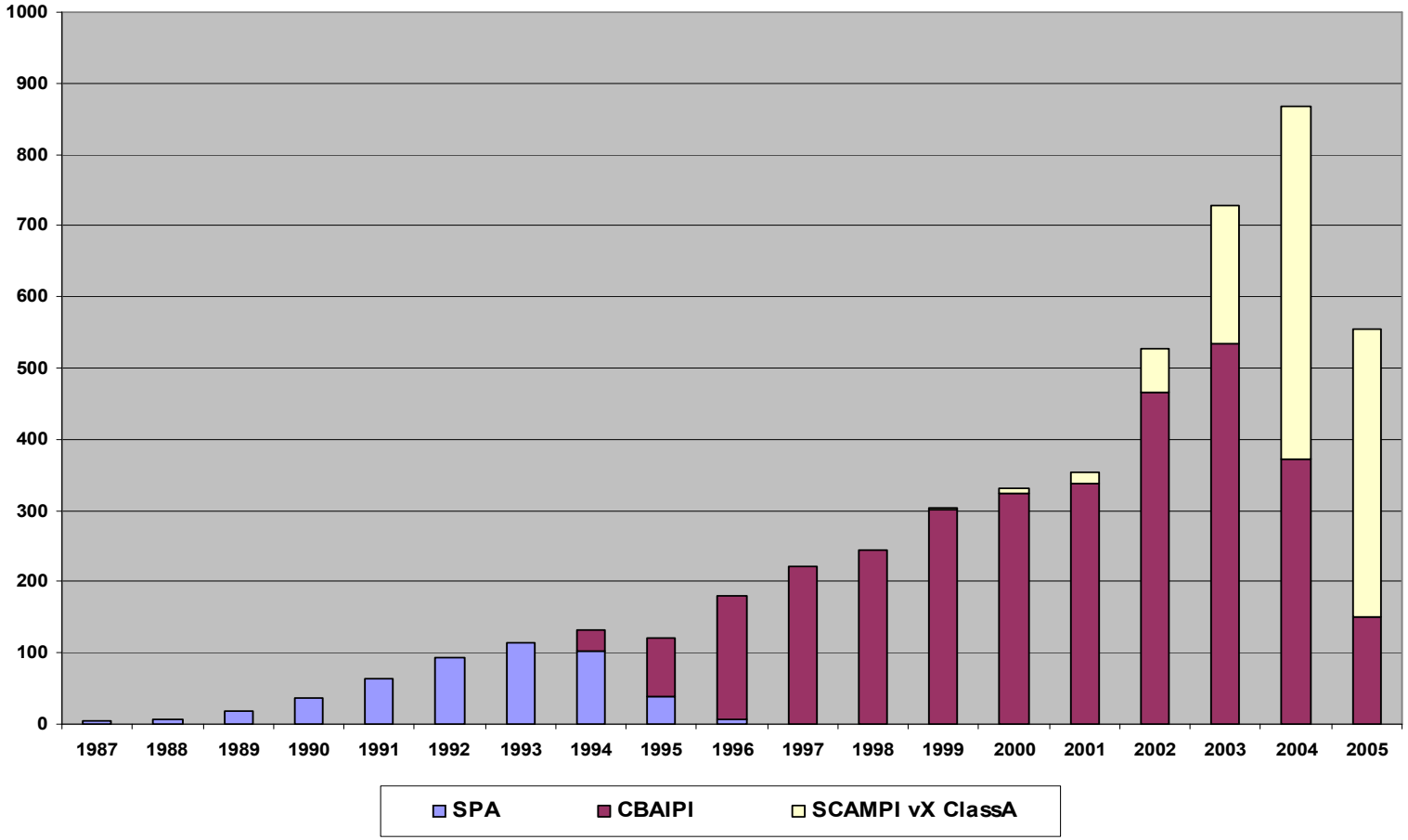
Number of Appraisals Conducted by Year
Reported as of 31 October 2005



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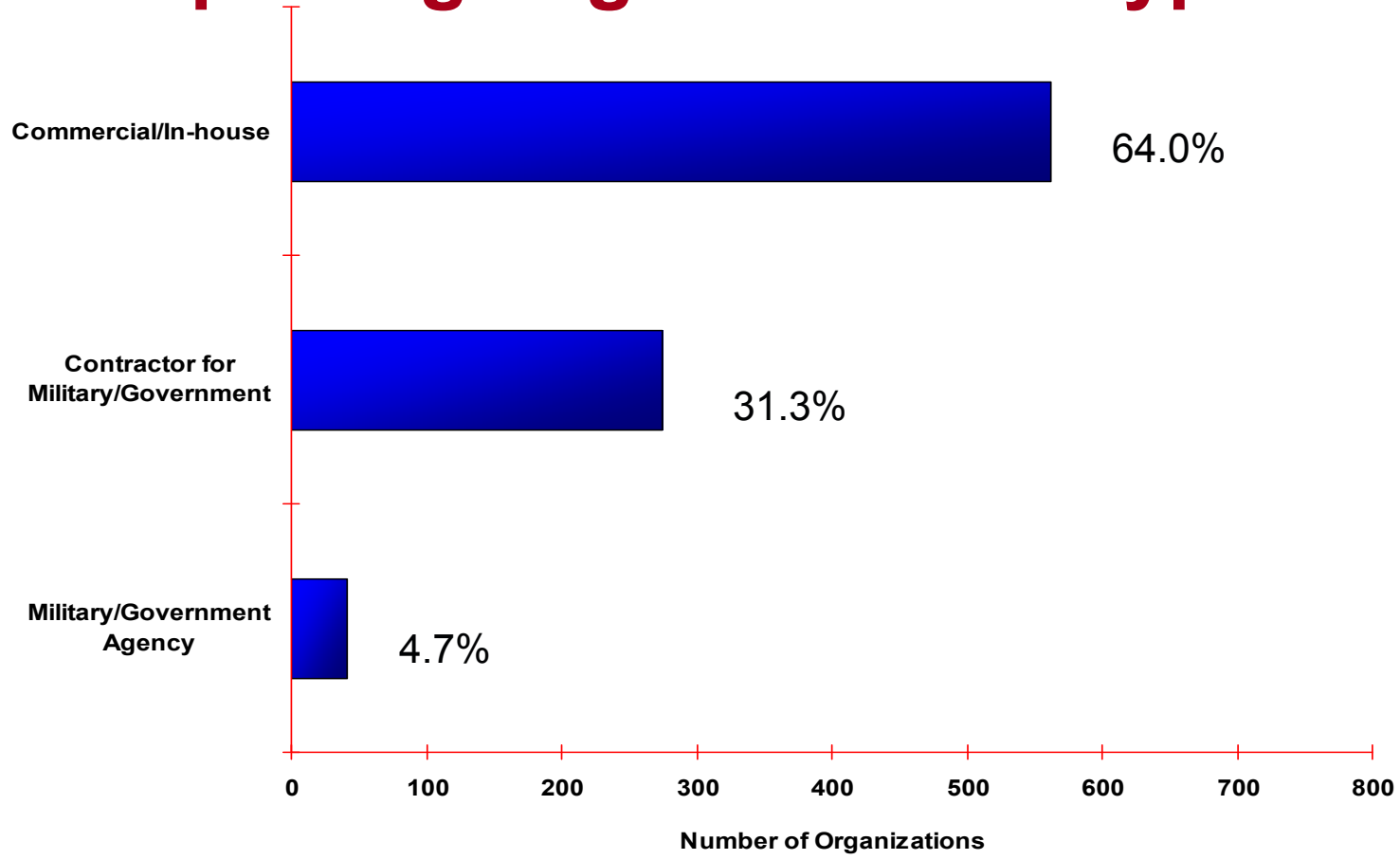
Reporting Organizational Types



Based on **878** organizations

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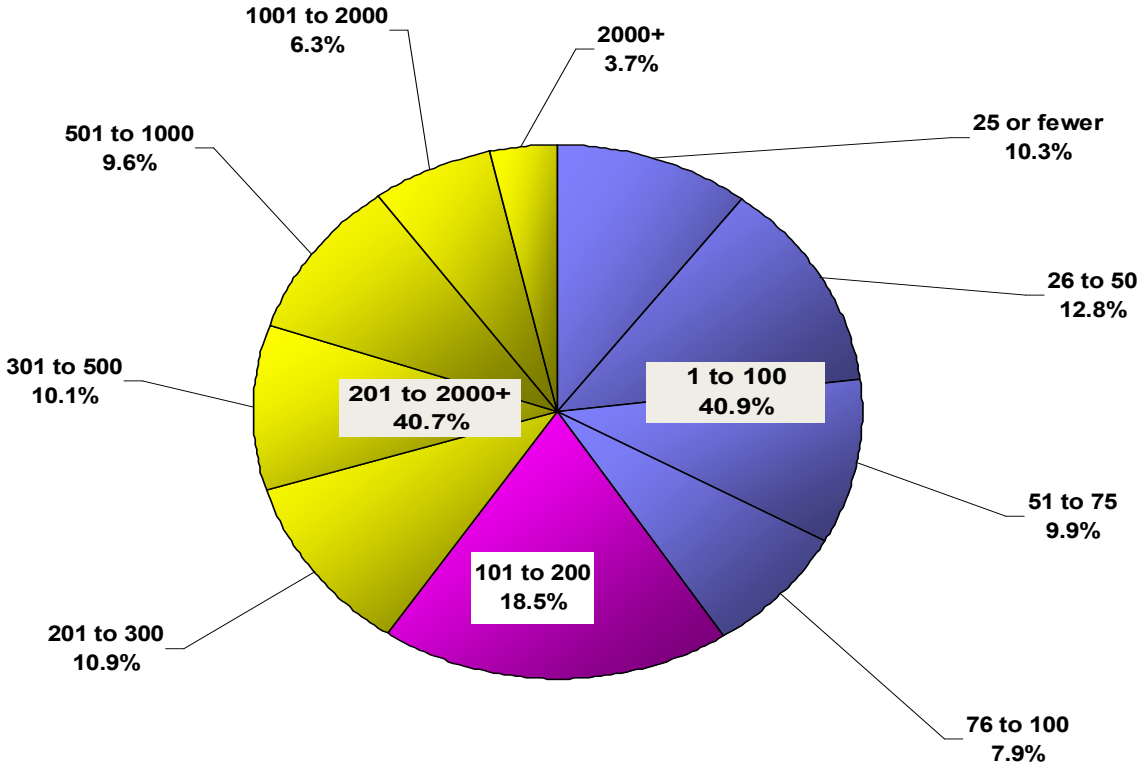
Organizational Size

Based on the total number of employees within the area of the organization that was appraised



Based on **861** organizations reporting size data

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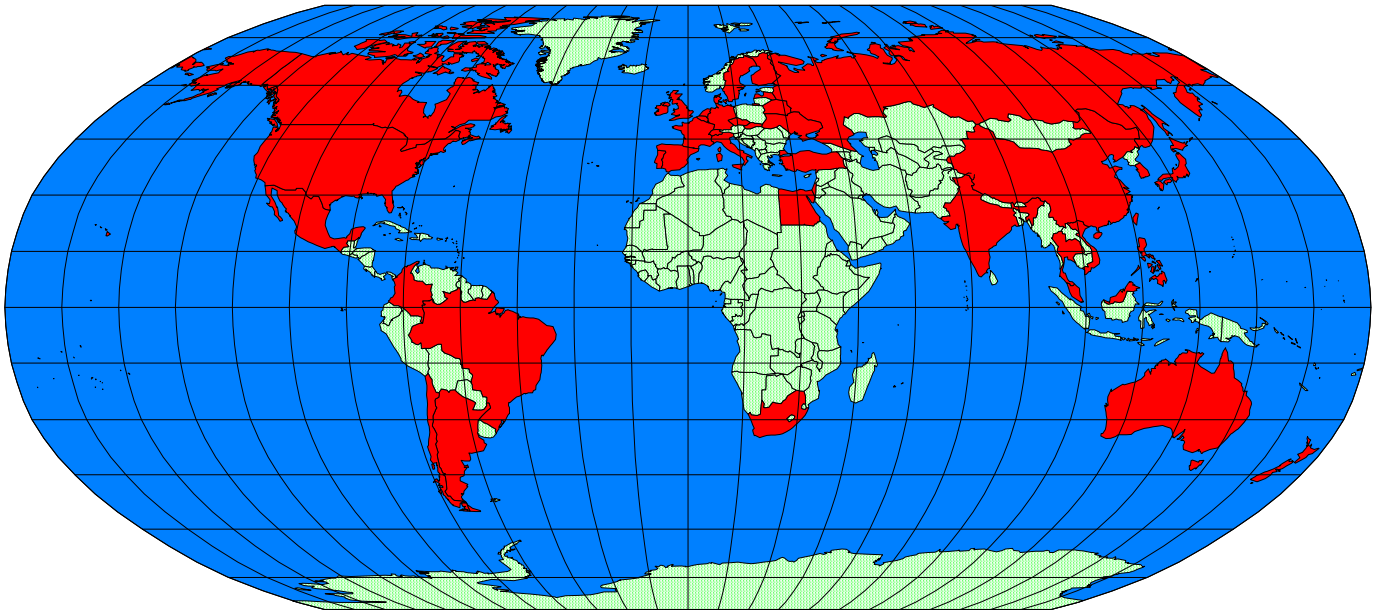
Countries where Appraisals have been Performed and Reported to the SEI



Argentina	Australia	Belarus	Belgium	Brazil	Canada	Chile
China	Colombia	Czech Republic	Denmark	Egypt	Finland	France
Germany	Hong Kong	India	Ireland	Israel	Italy	Japan
Korea, Republic of	Latvia	Malaysia	Mexico	Netherlands	New Zealand	Philippines
Portugal	Russia	Singapore	Slovakia	South Africa	Spain	Sweden
Switzerland	Taiwan	Thailand	Turkey	Ukraine	United Kingdom	United States
Vietnam						

Purple country name: new additions with this reporting since Nov. 2004

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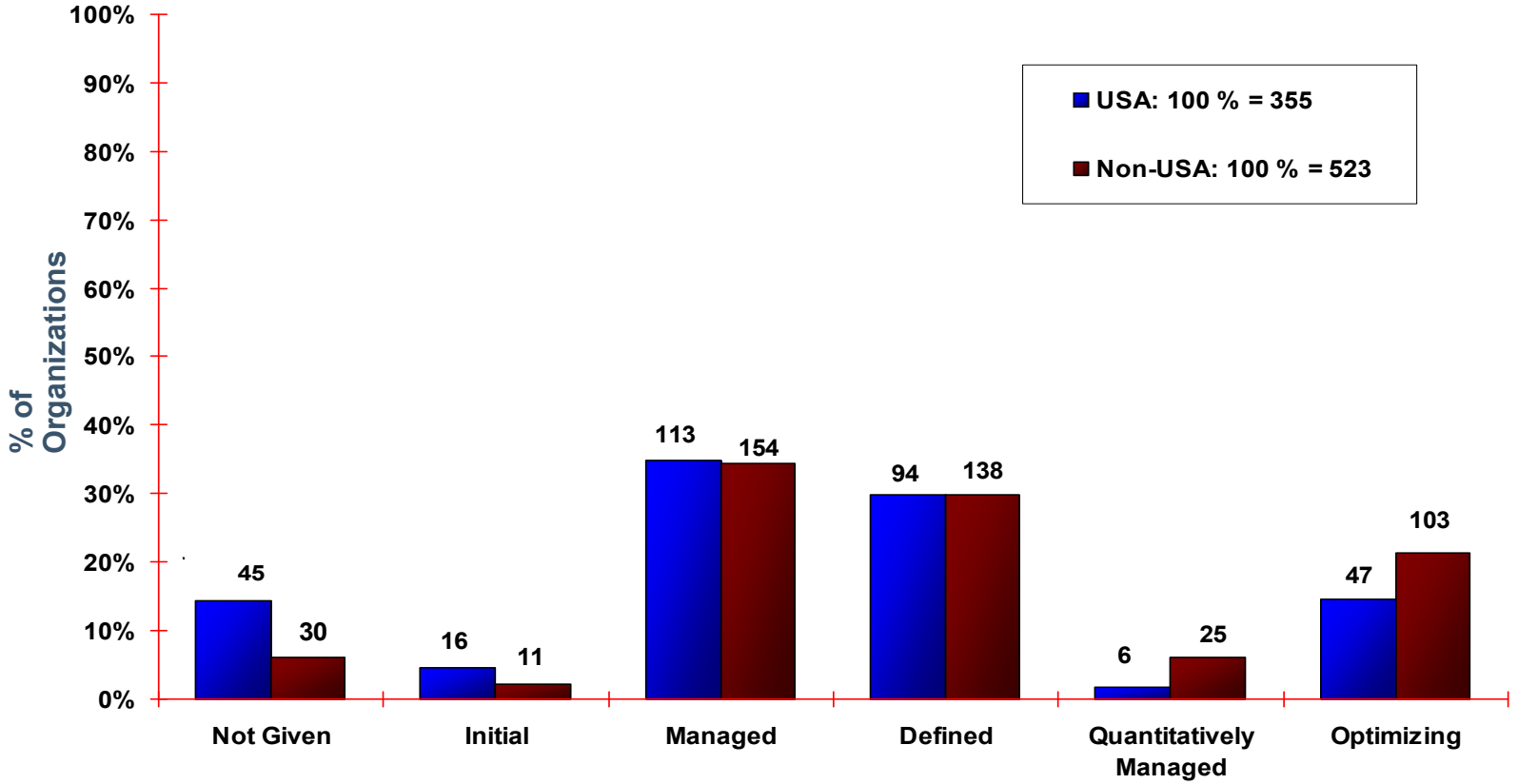
Maturity Profile by All Reporting USA and Non-USA Organizations



Based on **355** USA organizations and **523** Non-USA organizations

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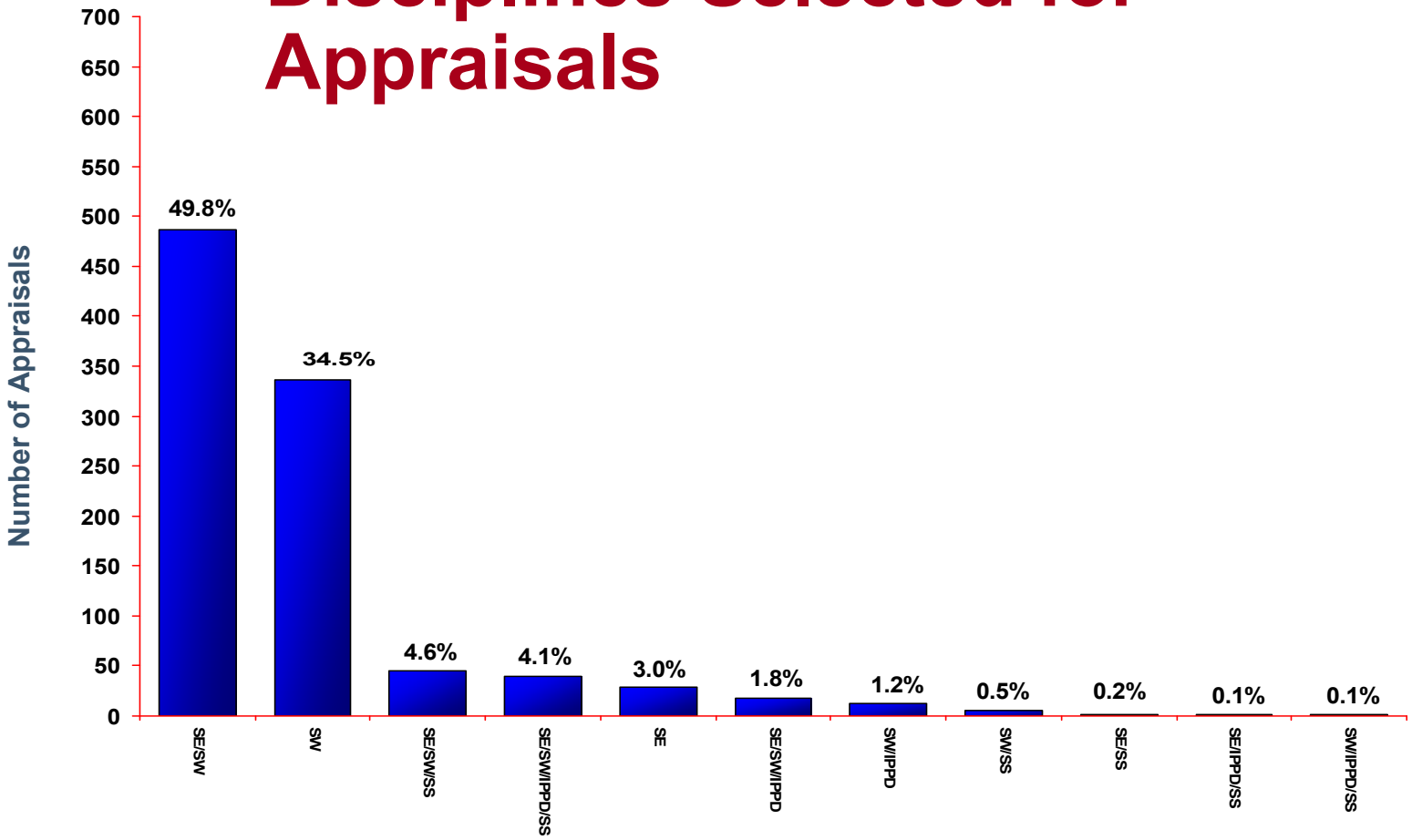
Disciplines Selected for Appraisals



Based on **977** appraisals reporting coverage

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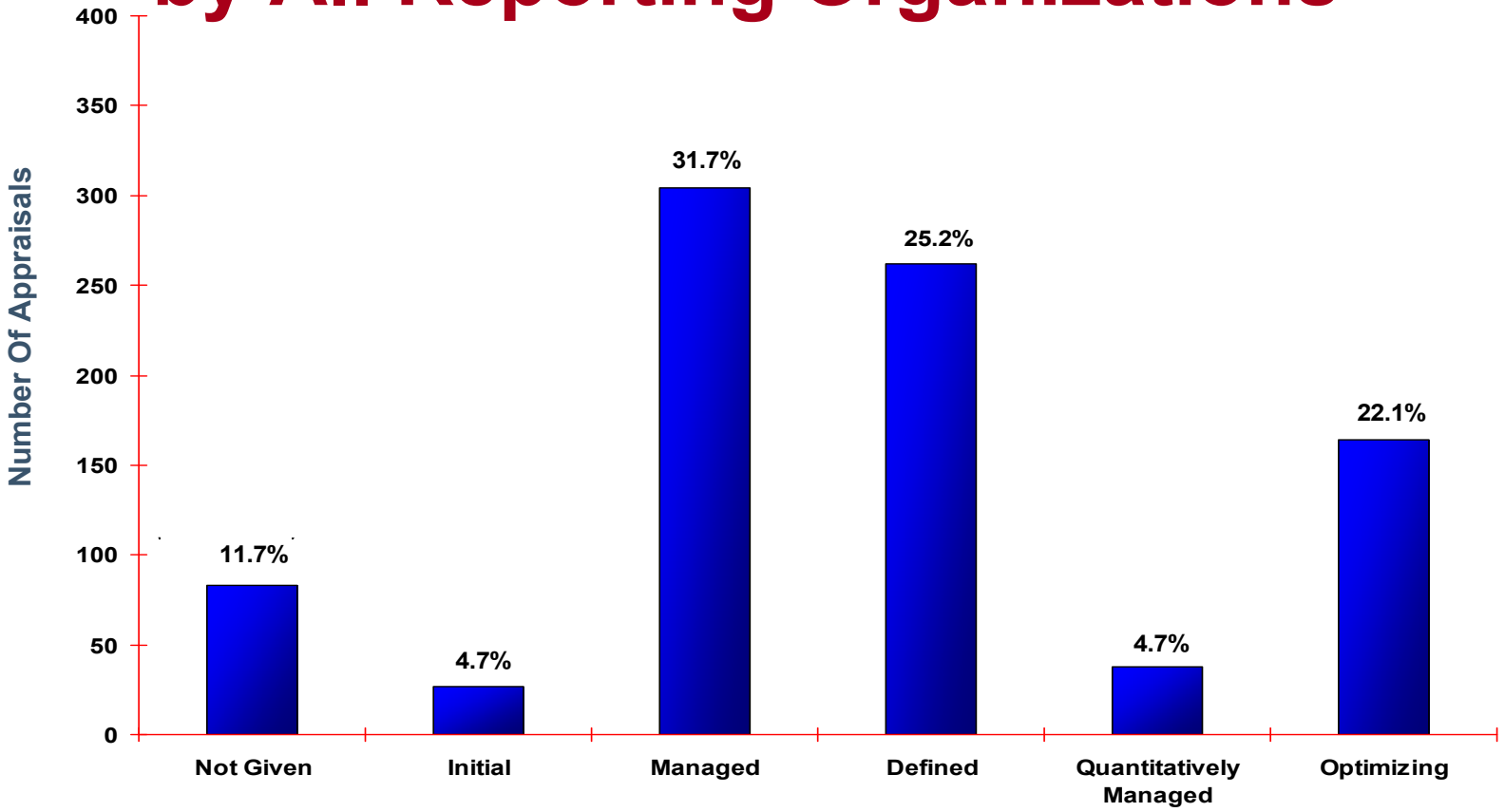
Maturity Profile by All Reporting Organizations



Based on most recent appraisal of **878** organizations

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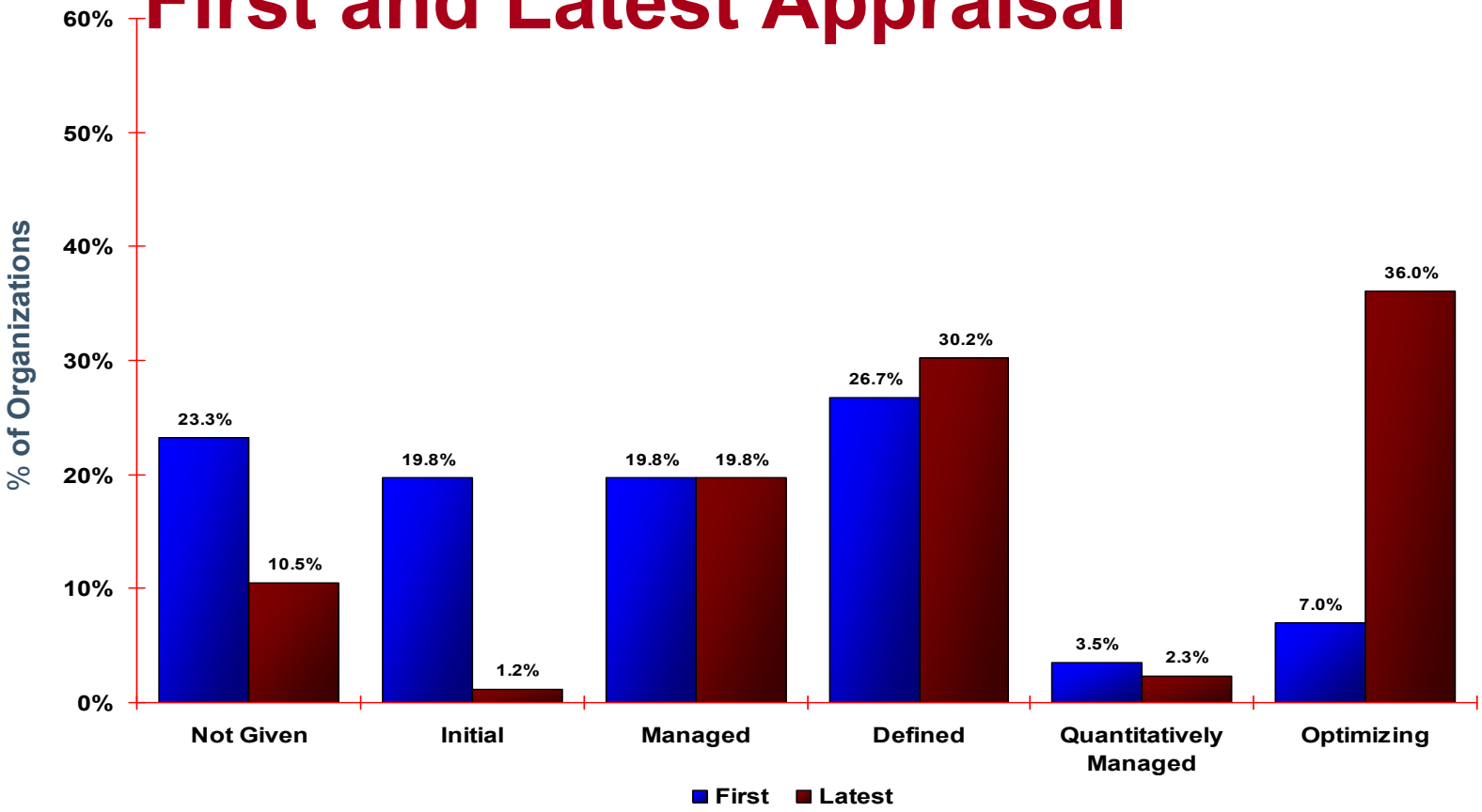
Maturity Level of First and Latest Appraisal



Based on **86** reappraised organizations using their first and latest appraisal

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Appraisal Results Summary

977 appraisals have been reported since the April 2002 SCAMPI Class A Version 1.1 release.

Commercial/In-House organizations reporting appraisals is increasing more rapidly than other organizational categories.

Government/Military and Government/Military Contractors reporting appraisals is increasing at a stable and consistent rate.

The highest percentage of Commercial/In-House organizations reporting appraisals is from outside the USA.

The highest percentage of Government/Military Contractors reporting appraisals is from the USA.

Comparing early reports of the SW-CMM maturity profile with early CMMI data reflects a more mature CMMI profile.

Additional information and charts will be released as more appraisals are reported and more data is available to support the breakdowns.

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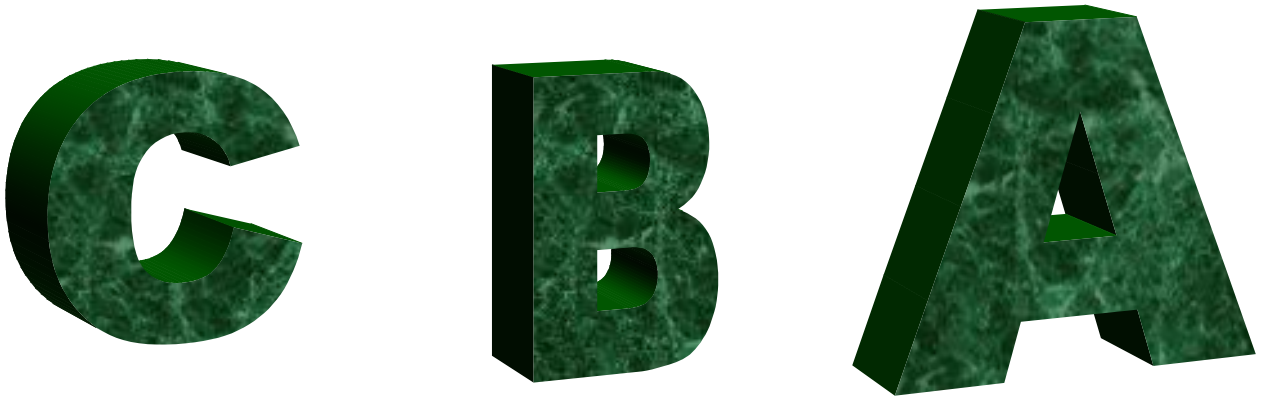
Three Classes of Appraisals

Characteristic	Class C	Class B	Class A
Amount of objective evidence	Low	Medium	High
Ratings generated	No	No	Yes
Resource needs	Low	Medium	High
Team Size	Small	Medium	Large



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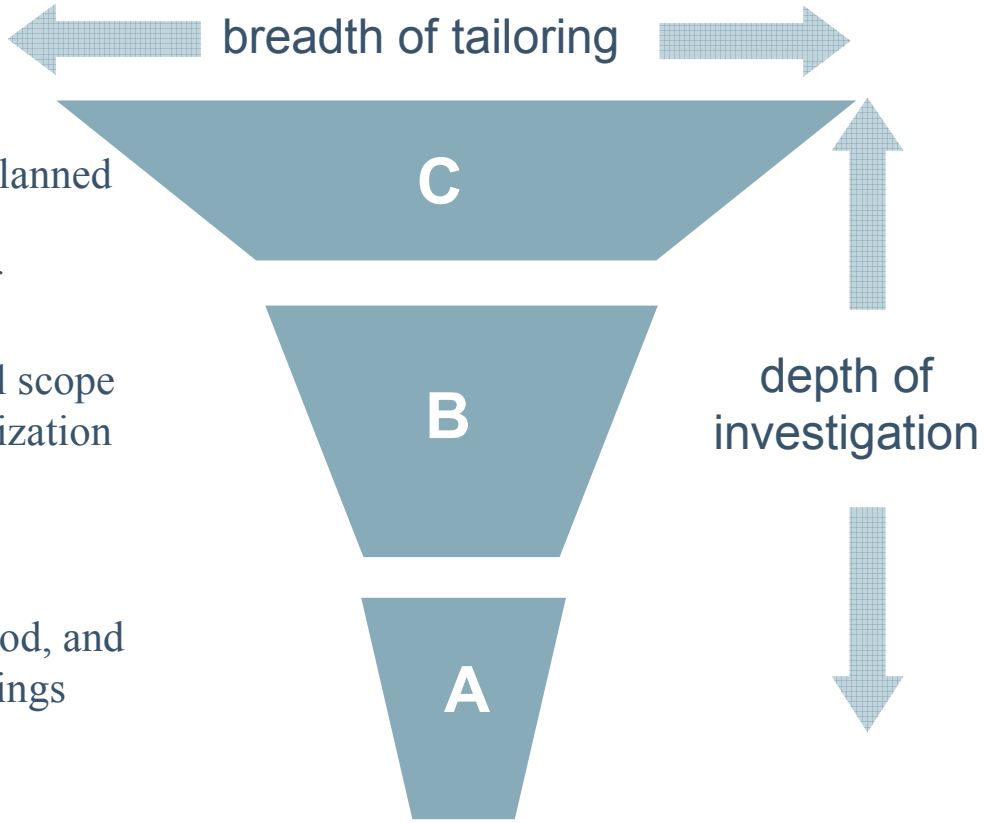
SCAMPI Family

SCAMPI C: provides a wide range of options, including characterization of planned approaches to process implementation according to a scale defined by the user

SCAMPI B: provides options in model scope and organizational scope, but characterization of practices is fixed to one scale and is performed on implemented practices

SCAMPI A: Is the most rigorous method, and is the only method that can result in ratings



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Approach, Deployment, Institutionalization

	Approach	Deployment	Institutionalization
A			
B			
C			

- SCAMPI family methods can be used in a range from:
  - looking at the approach planned to satisfy process improvement goals to
  - examining deployment of processes in selected instances in an organizational unit (OU) to
  - benchmarking the institutionalization of CMMI in an OU

Reliability, rigor and cost may go down from A to B to C, risk may go up

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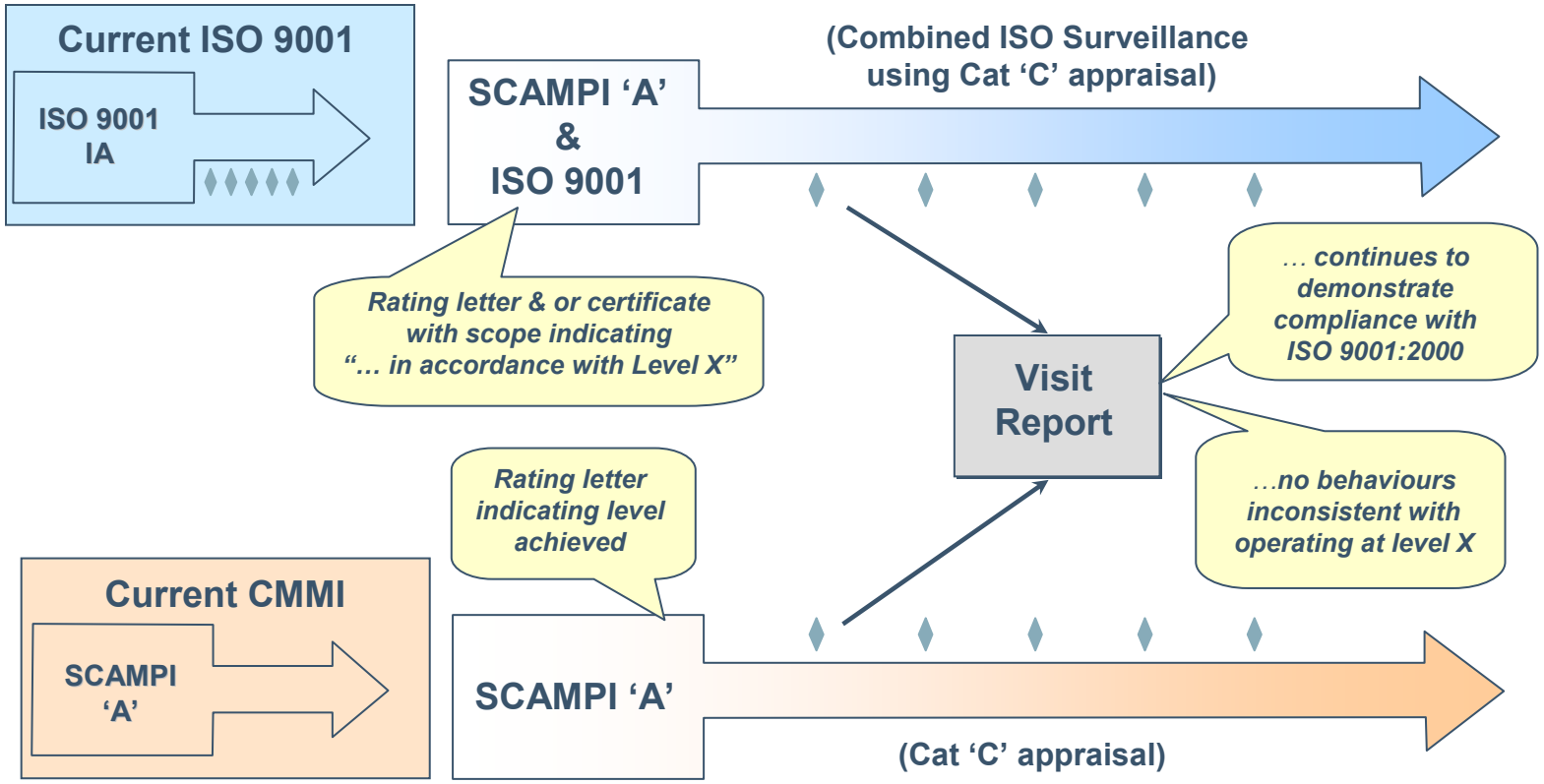
Combined Appraisal Opportunities



The possible options for assessment and surveillance

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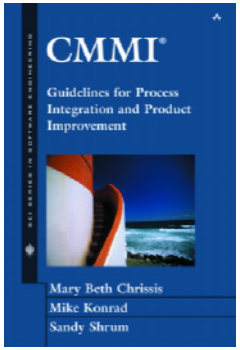
Adoption: What Else Is Happening?

The Addison-Wesley SEI Series Book and:

- CMMI Distilled: Second Edition
- Practical Insight into CMMI
- Interpreting the CMMI
- Real Process Improvement Using the CMMI
- Making Process Improvement Work
- CMMI: Un Itinéraire Fléché
- A Guide to the CMMI
- CMMI: A Framework…
- CMMI SCAMPI Distilled
- CMMI Assessments
- Systematic Process Improvement Using ISO 9001:2000 and CMMI
- Balancing Agility and Discipline



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How about SEI Publications?

Technical notes and special reports:

- Interpretive Guidance Project (Two Reports)
- CMMI and Product Line Practices
- CMMI and Earned Value Management
- Interpreting CMMI for Operational Organizations
- Interpreting CMMI for COTS Based Systems
- Interpreting CMMI for Service Organizations
- CMMI Acquisition Module (CMMI-AM) (V1.1)
- Interpreting CMMI for Marketing (in progress)
- Demonstrating the Impact and Benefits of CMMI (and web pages – www.sei.cmu.edu/cmmi/results)

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Performance Results Summary[1]

Improvements	Median	# of data points	Low	High
Cost	38%	14	5%	87%
Schedule	50%	14	20%	90%
Productivity	50%	13	11%	376%
Quality	50%	16	29%	94%
Customer Satisfaction	14%	5	10%	55%
Return on Investment	3 : 1	8	2 : 1	13 : 1

- N = 18, as of 5 March 2005 (out of total N = 26)
- Organizations with results expressed as change over time

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CMMI V1.2…and Beyond

Version 1.2 Changes$_1$

- Eliminate concept of advanced practices and common features from text
- Bring ISM into baseline to eliminate
  - separation from SAM
  - supplier sourcing designation
- Recognize, given hardware additions, that providing separate development models no longer useful
  - “single book” approach (CMMI-DEV+IPPD)
- “Not applicable” process areas (PAs) for maturity levels will be significantly constrained (SAM/ISM, IPPD)

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Version 1.2 Changes$_2$

- Clarify material based on 1000+ Change Requests (e.g., improve high maturity verbiage, appraisal terminology)
- Two work environment specific practices added:
  - one to OPD for organizational look
  - One to IPM for project specifics
- Glossary improved (e.g., higher level management, bidirectional traceability, subprocess)
- Overview text improved
- IPPD coverage consolidated and simplified

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Integrated Product and Process Development (IPPD) Changes

IPPD material is being revised significantly.

- Organization Environment for Integration PA removed and material moved to Organizational Process Definition (OPD) PA.
- Integrated Teaming PA removed and material moved to Integrated Project Management (IPM) PA.
- IPPD goals have been consolidated.
  - "Enable IPPD Management" in OPD
  - "Apply IPPD Principles" in IPM
- Overall material condensed and revised to be more consistent with other PAs.

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SCAMPI A Changes Being Considered for V1.2

Method implementation clarifications

- interviews in “virtual” organizations
- practice characterization rules
- organizational unit sampling

Appraisal Disclosure Statement (ADS) improvements

- reduce redundancy with other appraisal documents
- improve usability for sponsor and government
- require sponsor’s signature on the ADS

Responsibility for determination of “applicability” for SAM/ISM and IPPD

Establish maturity level and capability level shelf life – 3 years

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Published Appraisal Results

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List of Published SCAMPI Appraisal Results

ORGANIZATION NAME:	Satyam Computer Services Ltd.
SPONSOR NAME:	Nagaraj Chevour
LEAD APPRAISER NAME:	Raghavan Nandyal
SEI PARTNER:	SITARA Technologies Pvt. Ltd.
APPRAISAL END DATE:	4/3/2004
MATURITY LEVEL ASSIGNED:	5
APPRAISED ORGANIZATIONAL UNIT:	
Entity Name:	SRU GE-GDC
Location(s):	Secunderabad, AP, India
CMMI MODEL USED:	CMMI-SW/IPPD, V1.1, Continuous
APPRAISAL METHOD USED:	SCAMPI v1.1

MODEL SCOPE & CAPABILITY RATINGS ASSIGNED:

Process Management		Project Management		Engineering		Support	
OPF	Capability Level 3	PP	Capability Level 4	REQM	Capability Level 3	CM	Capability Level 3
OPD	Capability Level 3	PMC	Capability Level 4	RD	Capability Level 4	PPQA	Capability Level 3
OT	Capability Level 3	SAM	Not Applicable	TS	Capability Level 5	MA	Capability Level 3
OPP	Capability Level 3	IPM	Capability Level 3	PI	Capability Level 3	DAR	Capability Level 3
OID	Capability Level 3	RSKM	Capability Level 4	VER	Capability Level 5	OEI	Capability Level 3
		IT	Capability Level 3	VAL	Capability Level 3	CAR	Capability Level 3
		ISM	Not Rated				
		QPM	Capability Level 3				

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CMMI Training v1.2

Introduction to CMMI (Staged and Continuous)
- editorial update released 9/05
- will be updated for v1.2

Introduction to CMMI, Staged Representation and *Introduction to CMMI, Continuous Representation*
- sunset at the end of 2005

Intermediate Concepts of CMMI
- will be updated for v1.2
- will better prepare students for SCAMPI training

CMMI Instructor Training
- updated earlier this year to reflect “combined” Introduction to CMMI course
- will be updated to reflect v1.2 changes

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Beyond V1.2$_1$

Improved architecture will allow post-V1.2 expansion.

- Extensions of the life cycle (Services, Outsourcing/Acquisition) could expand use of a common organizational framework:
  - allows coverage of more of the enterprise or potential partnering organizations
  - adapts model features to fit non-developmental efforts (e.g., CMMI Services, CMMI Acquisition)

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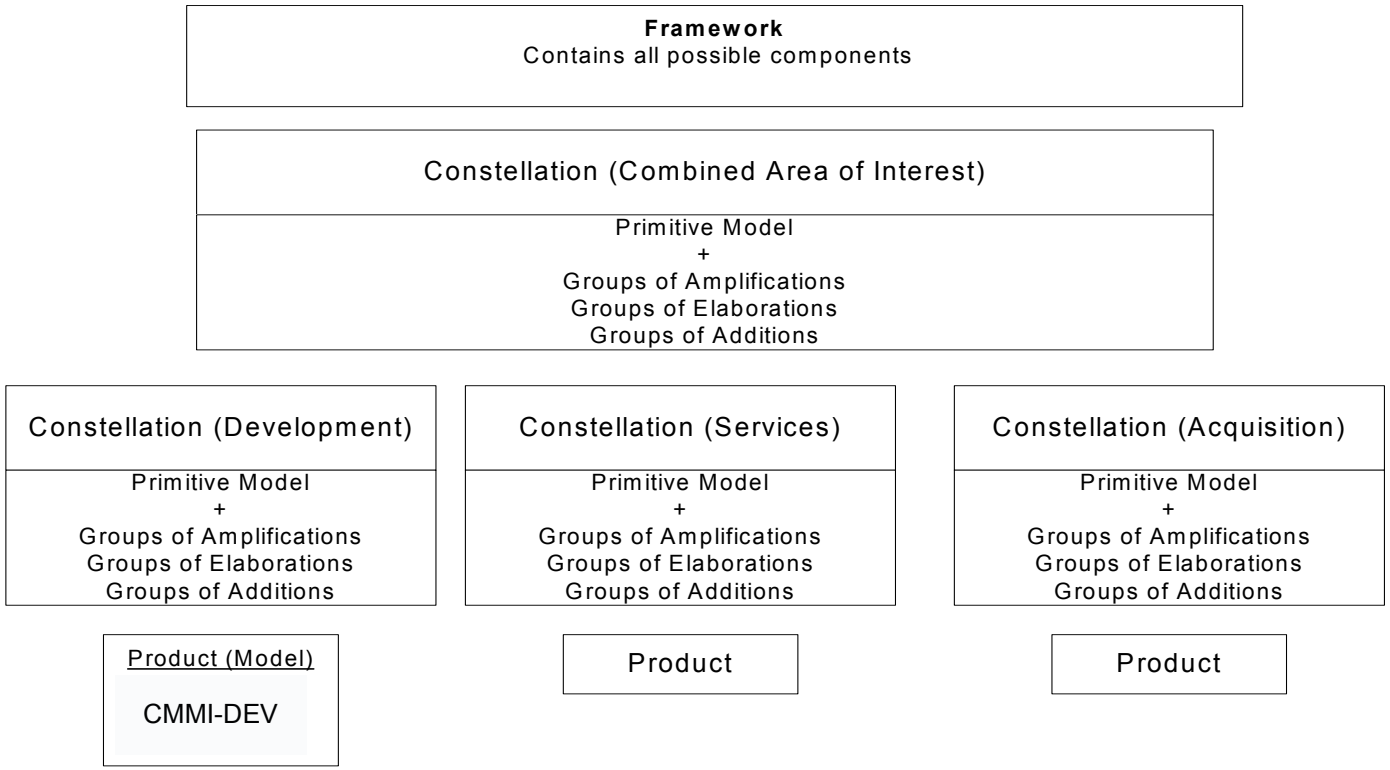
CMMI v1.2 Architectural Framework



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Beyond V1.2$_2$

First two constellations, CMMI Services and CMMI Acquisition, have been “commissioned” by CMMI Steering Group. Development will be in parallel with V1.2 effort; publication sequenced after V1.2 rollout.

Northrop-Grumman is leading industry group for CMMI Services.

- Initial focus will be for organizations providing “DoD services” as well as internal IT:
  - System maintenance
  - Network Management, IT Services
  - IV&V

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Beyond V1.2$_3$

SEI is coordinating requirements elicitation for CMMI Acquisition.

- Will build upon existing CMMI Acquisition Module and General Motors IT Sourcing expansion
- Will add government perspectives from both DoD and civil agencies

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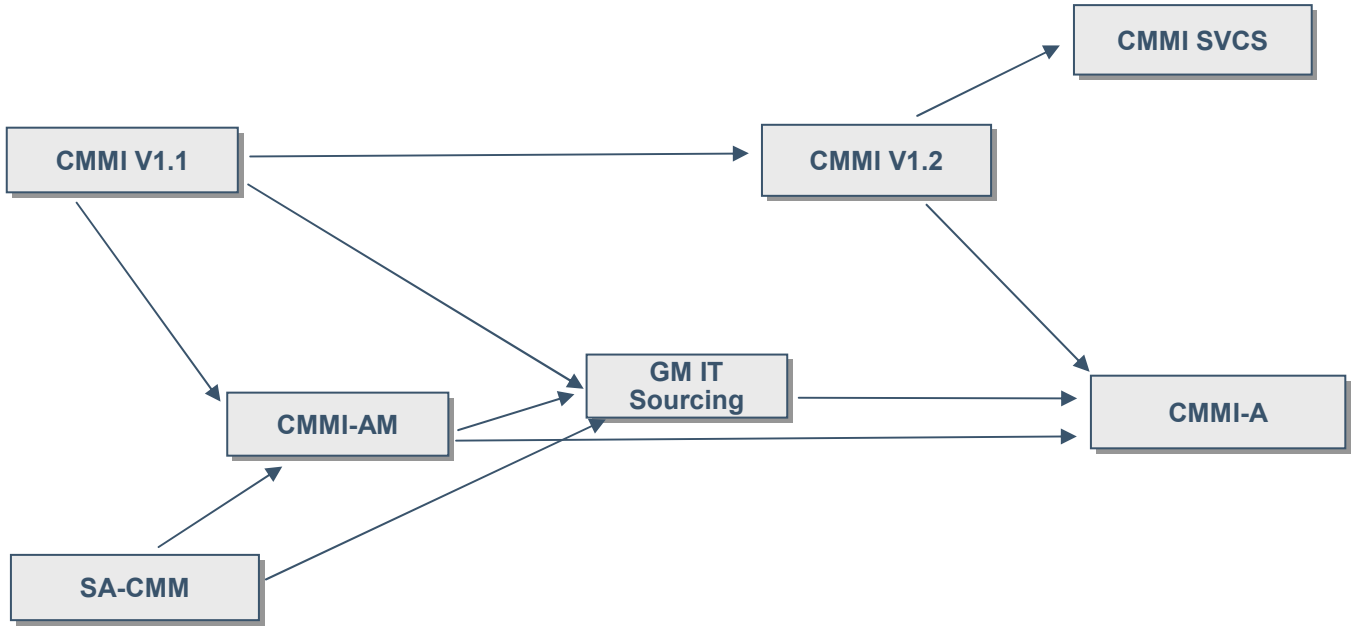
Planned Sequence of Models



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CMMI V1.2…and Beyond …the details

The Steps

A long-term strategy, the V1.2 A-Spec, and the upgrade criteria approved by the Steering Group.

The teams review the Change Requests to identify possible Change Packages (CP) for a V1.2 of model, training, and/or method.

Change Control Boards determine which CPs, if any, should be accepted (stability goal remains).

Implementation Packages developed to create a “beta” for piloting (model, method, and training)

Piloting will be conducted in FY 06.

V1.2, incorporating piloting feedback, will be released in FY 06.

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CCB Membership (for content changes)

Mike Konrad	SEI
Mike Phillips	SEI
Roger Bate	SEI
Bob Rassa	Raytheon
Bill Schoening	Boeing & INCOSE
Nils Jacobsen	Motorola
Karen Richter	OSD
Warren Schwomeyer	Lockheed Martin
Tom Bernard	USAF
Mary Beth Chrissis	SEI
Bill Peterson	SEI
Rick Hefner	Northrop Grumman
Stephen Gristock	JP Morgan Chase
Gary Wolf	Raytheon
Paul Croll	CSC
Shane Atkinson	CMMI Partner
Millee Sapp	USAF
Katie Smith	USNavy
Larry Osiecki	USArmy
Sandy Shrum	SEI
Rhonda Brown	SEI

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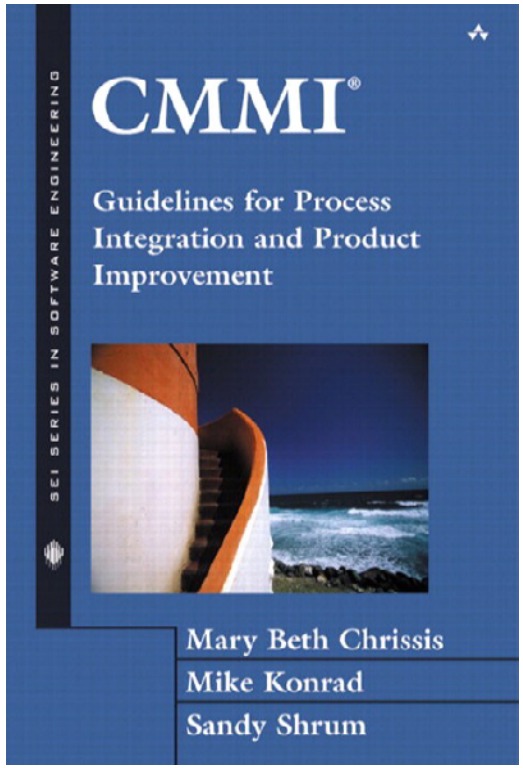
The Model Baseline for V1.2

Textbook:

CMMI: Guidelines for Process Integration and Product Improvement

Continuing the “Single model, single course” strategy

V1.2 release will be as a Technical Report



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Model Activities: Version 1.2

Model development team
- completing implementation packages
- model baseline redline

Configuration Control Board
- actively reviewing changes

Pilot planning underway

Expected release of v1.2 is summer 2006

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Major Themes

Reduce size/complexity

Increase coverage

- in existing elements
- discipline additions

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Reduce size and complexity

Single Technical Report, not 8 as in V1.1
Common features and advanced practice distinctions eliminated
Two process areas consolidated into other PA's
One "addition" or "discipline," Supplier Sourcing, eliminated as a separable "model."
Discipline distinctions reduced in amplifications

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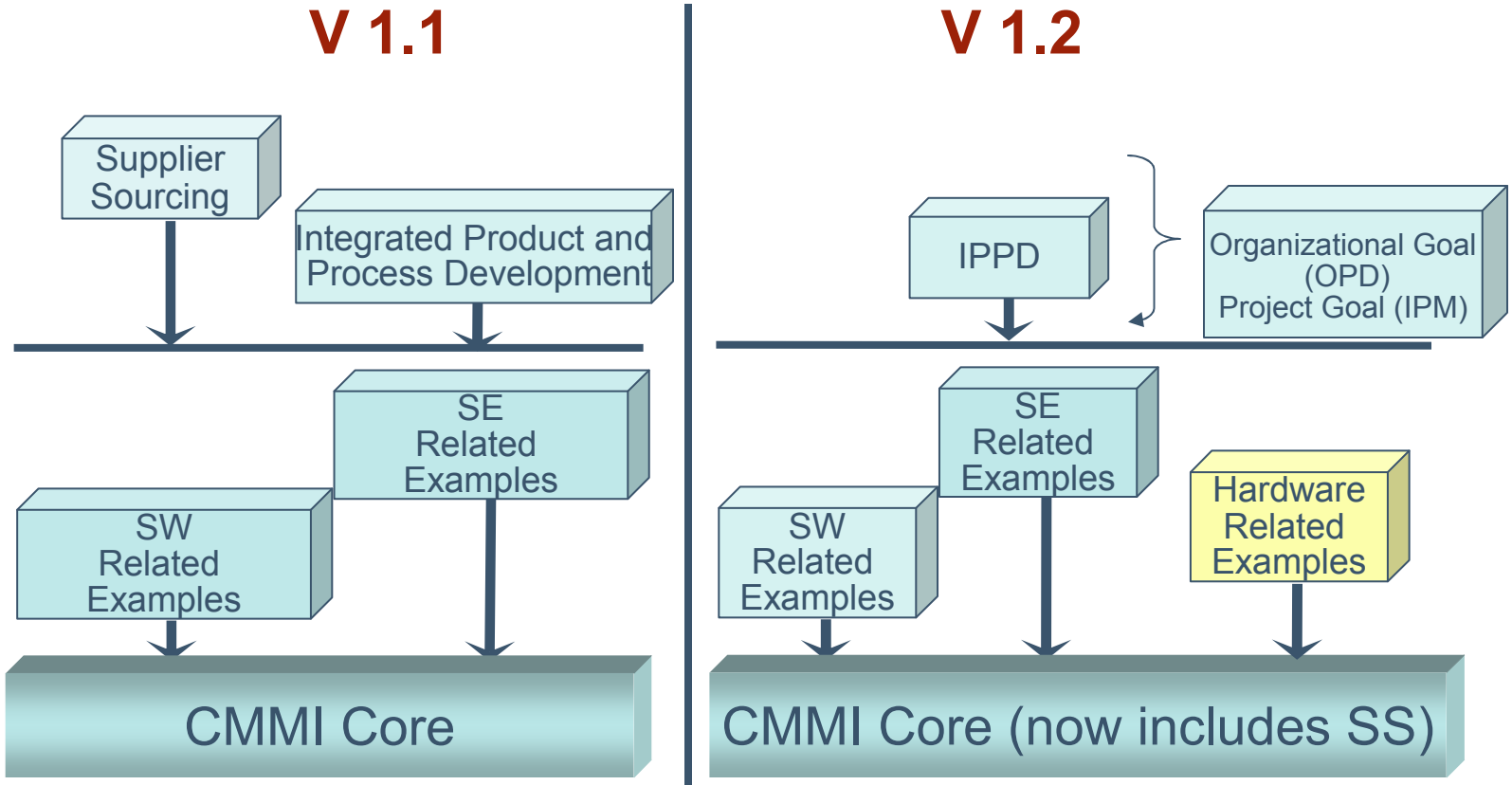
CMMI Model Combinations



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Example Hardware Amplification

Technical Solution

SP 2.1 Design the Product or Product Component
Develop a design for the product or product component.

For Hardware Engineering
Detailed design is focused on product development of electronic, mechanical, electro-optical, and other hardware products and their components. Electrical schematics and interconnection diagrams are developed, mechanical and optical assembly models are generated, and fabrication and assembly processes are developed.

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Version 1.2 Changes

Amplifications improved

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Amplifications Improved

Proposed Conceptual Solution: “Review amplifications and where appropriate modify the amplification to provide more insight into the discipline that is being described. For information that applies more generally and is captured as an amplification, move the information into a "note" rather than identifying it as an amplification.”

From Technical Solution V1.1

For Systems Engineering
Examples of criteria include the following:
- *Maintainability*
- *Reliability*
- *Safety*

Amplification removed from Technical Solution V1.2 since it is not unique to Systems Engineering

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Version 1.2 Changes

Common features and advanced practices eliminated

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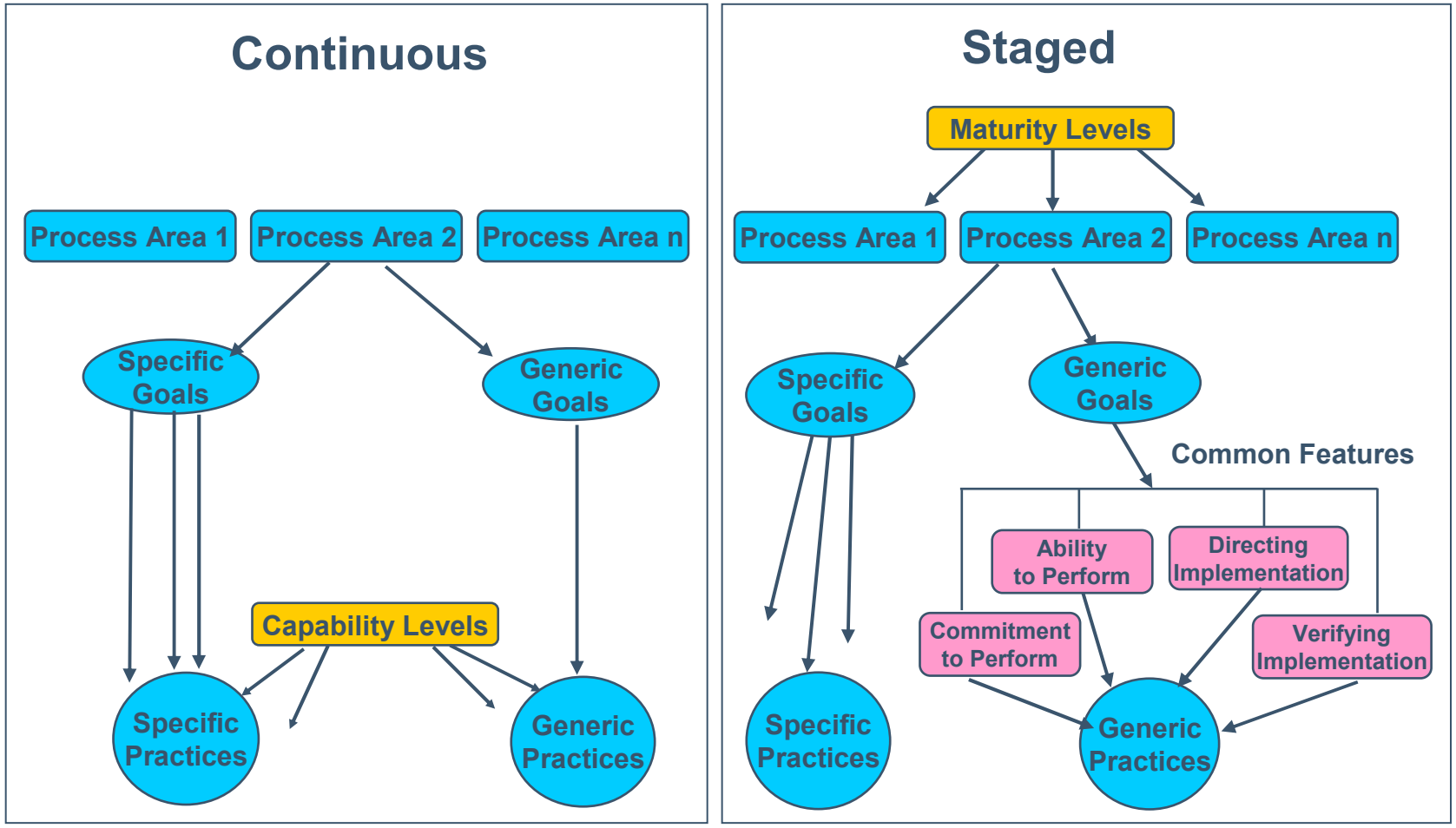
CMMI Model Structure (V1.1)



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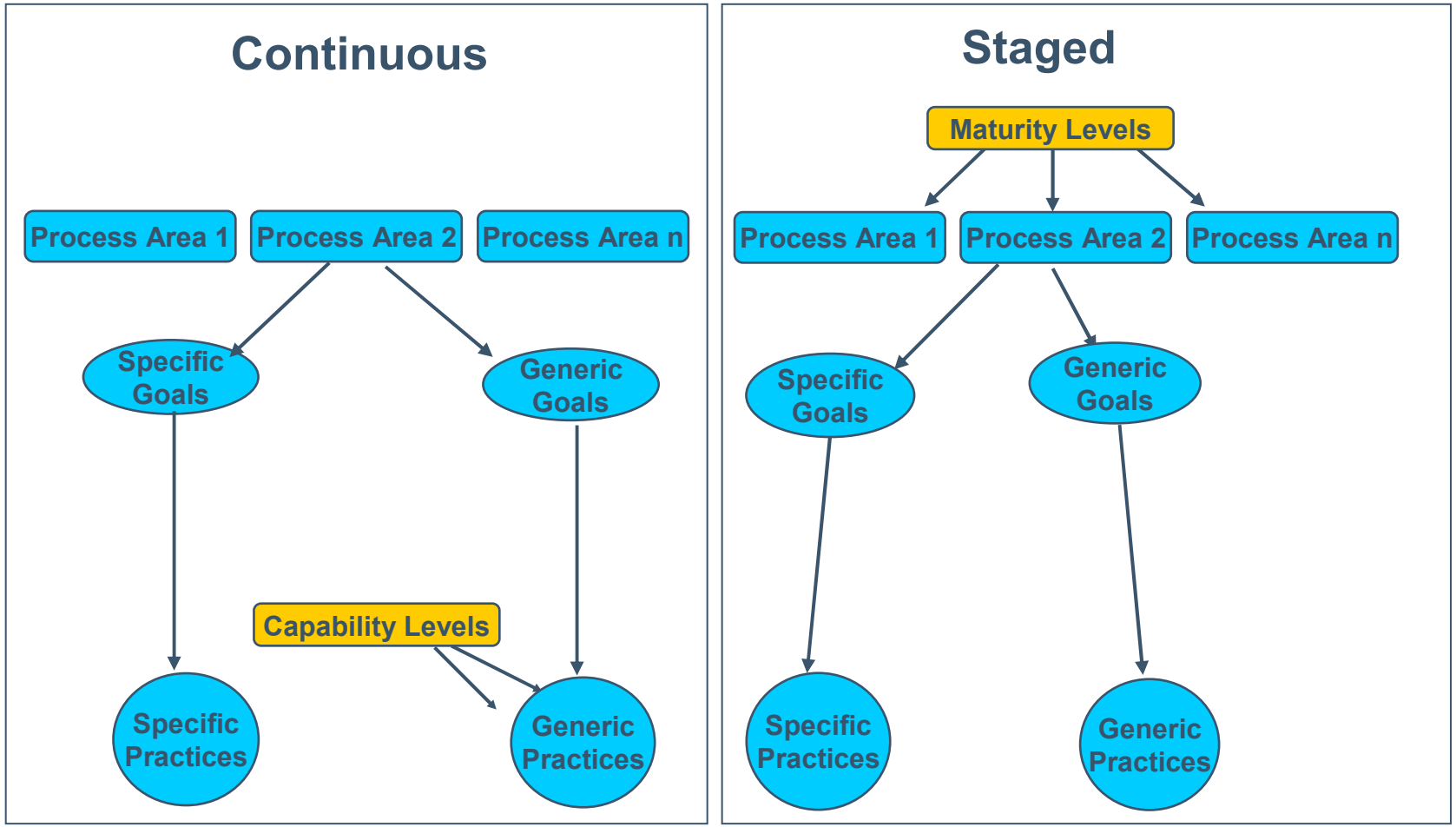
CMMI Model Structure (V1.2)



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Requirements Management

Specific Goal	Specific Practice
Manage Requirements	1.1 – Obtain an Understanding of Requirements 1.2 – Obtain Commitment to Requirements 1.3 – Manage Requirements Changes 1.4 – Maintain Bidirectional Traceability of Requirements 1.5 – Identify Inconsistencies Between Project Work and Requirements

v1.2 SP 1.4 practice statement now reads, “Maintain bidirectional traceability among the requirements and work products.” Project plans are no longer mentioned in this SP statement.
Bidirectional Traceability description is improved in the notes and Glossary.

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Requirements Development -1

Specific Goal	Specific Practice
Develop Customer Requirements	**1.1 – Elicit Needs** **1.2 – Develop the Customer Requirements**
Develop Product Requirements	**2.1 – Establish Product and Product-Component Requirements** **2.2 – Allocate Product-Component Requirements** **2.3 – Identify Interface Requirements**

Base practice “Collect Stakeholder Needs” is eliminated.
Informative materials are added to SP1.1 to address standards and policies.

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Requirements Development -2

Specific Goal	Specific Practice
Analyze and Validate Requirements	**3.1 – Establish Operational Concepts and Scenarios** **3.2 – Establish a Definition of Required Functionality** **3.3 – Analyze Requirements** **3.4 – Analyze Requirements to Achieve Balance** **3.5 – Validate Requirements with Comprehensive Methods**

"Evolve Operational Concepts and Scenarios" (from TS SP1.1 in v1.1) is now part of SP 3.1.
The base practice "Validate Requirements" has been eliminated.

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Technical Solutions -1

Specific Goal	Specific Practice
Select Product-Component Solutions	**1.1 – Develop Detailed Alternative Solutions and Selection Criteria**
	1.2 – Select Product-Component Solutions

v1.1 SP 1.1 “Evolve Operational Concepts and Scenarios” is now part of RD SP 3.1.
Base practice “Develop Alternative Solutions and Selection Criteria” is eliminated.
“Identify candidate COTS products that satisfy requirements” is a new subpractice under SP1.1.

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Technical Solutions -2

Specific Goal	Specific Practice
Develop the Design	**2.1 – Design the Product or Product Component** **2.2 – Establish a Technical Data Package** **2.3 – Design Interfaces Using Criteria** **2.4 – Perform Make, Buy, or Reuse Analyses**
Implement the Product Design	**3.1 – Implement the Design** **3.2 – Develop Product Support Documentation**

Base practice “Establish Interface Descriptions” is eliminated.

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Product Integration -1

Specific Goal	Specific Practice
Prepare for Product Integration	**1.1 – Determine Integration Sequence**
	1.2 – Establish the Product Integration Environment
	1.3 – Establish Product Integration Procedures and Criteria
Ensure Interface Compatibility	**2.1 – Review Interface Descriptions for Completeness**
	2.2 – Manage Interfaces

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Product Integration -2

Specific Goal	Specific Practice
Assemble Product Components and Deliver the Product	**3.1 – Confirm Readiness of Product Components for Integration**
	3.2 – Assemble Product Components
	3.3 – Evaluate Assembled Product Components
	3.4 – Package and Deliver the Product or Product Component

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Verification -1

Specific Goal	Specific Practice
Prepare for Verification	**1.1 – Select Work Products for Verification** **1.2 – Establish the Verification Environment** **1.3 – Establish Verification Procedures and Criteria**
Perform Peer Reviews	**2.1 – Prepare for Peer Reviews** **2.2 – Conduct Peer Reviews** **2.3 – Analyze Peer Review Data**

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Verification -2

Specific Goal	Specific Practice
Verify Selected Work Products	**3.1 – Perform Verification** **3.2 – Analyze Verification Results and Identify Corrective Action**

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Validation

Specific Goal	Specific Practice
Prepare for Validation	**1.1 – Select Products for Validation** **1.2 – Establish the Validation Environment** **1.3 – Establish Validation Procedures and Criteria**
Validate Product or Product Components	**2.1 – Perform Validation** **2.2 – Analyze Validation Results**

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Version 1.2 Addition – Work Environment Coverage

Work Environment material added to OPD and IPM

- OPD, SP 1.6: Establish Work Environment Standards
- IPM, SP 1.3: Establish the Project's Work Environment

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Integrated Product and Process Development (IPPD) Changes

IPPD material is being revised significantly

- Organization Environment for Integration PA removed and material moved to Organizational Process Definition (OPD) PA
- Integrated Teaming PA removed and material moved to Integrated Project Management (IPM) PA
- IPPD goals in the IPM PA have been consolidated
  - Goal 3: Apply IPPD Principles
- Overall material condensed and revised to be more consistent with other PAs

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Organizational Process Definition

V1.1

SG 1 – Establish Organizational Process Assets

1.1 – Establish Standard Processes

1.2 – Establish Life-Cycle Model Descriptions

1.3 – Establish Tailoring Criteria and Guidelines

1.4 – Establish the Organization's Measurement Repository

1.5 – Establish the Organization's Process

V1.2

SG1 – Establish Organizational Process Assets

1.1 – Establish Standard Processes

1.2 – Establish Life-Cycle Model Descriptions

1.3 – Establish Tailoring Criteria and Guidelines

1.4 – Establish the Organization's Measurement Repository

1.5 – Establish the Organization's Process

1.6 – Establish Work Environment Standards

New

SG2 – Enable IPPD Management

2.1 – Establish Empowerment Mechanisms

2.2 – Establish Rules and Guidelines for Integrated Teams

2.3 – Establish Guidelines to Balance Team and Home Organization Responsibilities

Consolidated from V1.1 OEI PA

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Organizational Process Definition -1

Specific Goal	Specific Practice
Establish Organizational Process Assets	**1.1 – Establish Standard Processes**
	1.2 – Establish Life-Cycle Model Descriptions
	1.3 – Establish Tailoring Criteria and Guidelines
	1.4 – Establish the Organization's Measurement Repository
	1.5 – Establish the Organization's Process Asset Library
	New **1.6 – Establish Work Environment Standards**

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Organizational Process Definition -2

IPPD Specific Goal	Specific Practice
Enable IPPD Management	**2.1 – Establish Empowerment Mechanisms**
	2.2 – Establish Rules and Guidelines for Integrated Teams
	2.3 – Establish Guidelines to Balance Team and Home Organization Responsibilities

NOTE: This Specific Goal and its associated Specific Practices are part of IPPD Addition.

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Integrated Project Management -1

V1.1	V1.2
SG1 – Use the Project's Defined Process	**SG1 – Use the Project's Defined Process**
1.1 – Establish the Project's Defined Process	1.1 – Establish the Project's Defined Process
1.2 – Use Organizational Process Assets for Planning Project Activities	1.2 – Use Organizational Process Assets for Planning Project Activities
1.3 – Integrate Plans	New: 1.3 – Establish the Project's Work Environment
1.4 – Manage the Project Using the Integrated Plans	1.4 – Integrate Plans
1.5 - Contribute to the Organizational Process Assets	1.5 – Manage the Project Using the Integrated Plans
SG2 – Coordinate and Collaborate with Relevant Stakeholder	1.6 - Contribute to the Organizational Process Assets
2.1 – Manage Stakeholder Involvement	**SG2 – Coordinate and Collaborate with Relevant Stakeholder**
2.2 – Manage Dependencies	2.1 – Manage Stakeholder Involvement
2.3 – Resolve Coordination Issues	2.2 – Manage Dependencies
	2.3 – Resolve Coordination Issues

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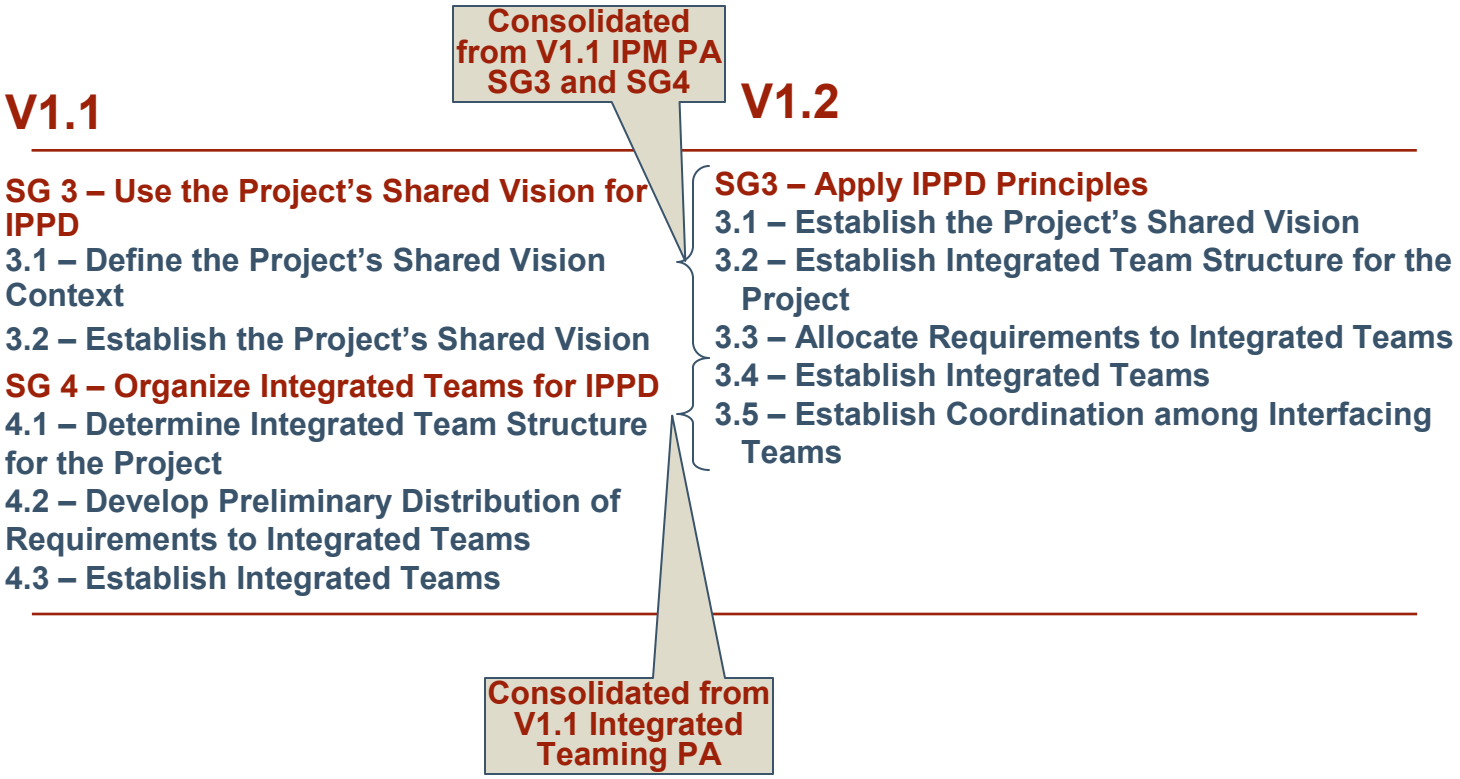
Integrated Project Management -2



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Integrated Project Management -1

Specific Goal	Specific Practice
Use the Project's Defined Process	**1.1 – Establish the Project's Defined Process**
	1.2 – Use Organizational Process Assets for Planning Project Activities
	New **1.3 – Establish the Project's Work Environment**
	1.4 – Integrate Plans
	1.5 – Manage the Project Using the Integrated Plans
	1.6 - Contribute to the Organizational Process Assets

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Integrated Project Management -2

Specific Goal	Specific Practice
Coordinate and Collaborate with Relevant Stakeholder	**2.1 – Manage Stakeholder Involvement** **2.2 – Manage Dependencies** **2.3 – Resolve Coordination Issues**
Apply IPPD Principles	**3.1 – Establish the Project's Shared Vision** **3.2 – Establish Integrated Team Structure for the Project** **3.3 – Allocate Requirements to Integrated Teams** **3.4 – Establish Integrated Teams** **3.5 Establish Coordination among Interfacing Teams**

The Specific Goal, "Apply IPPD Principles," and the associated Specific Practices are part of IPPD Addition.

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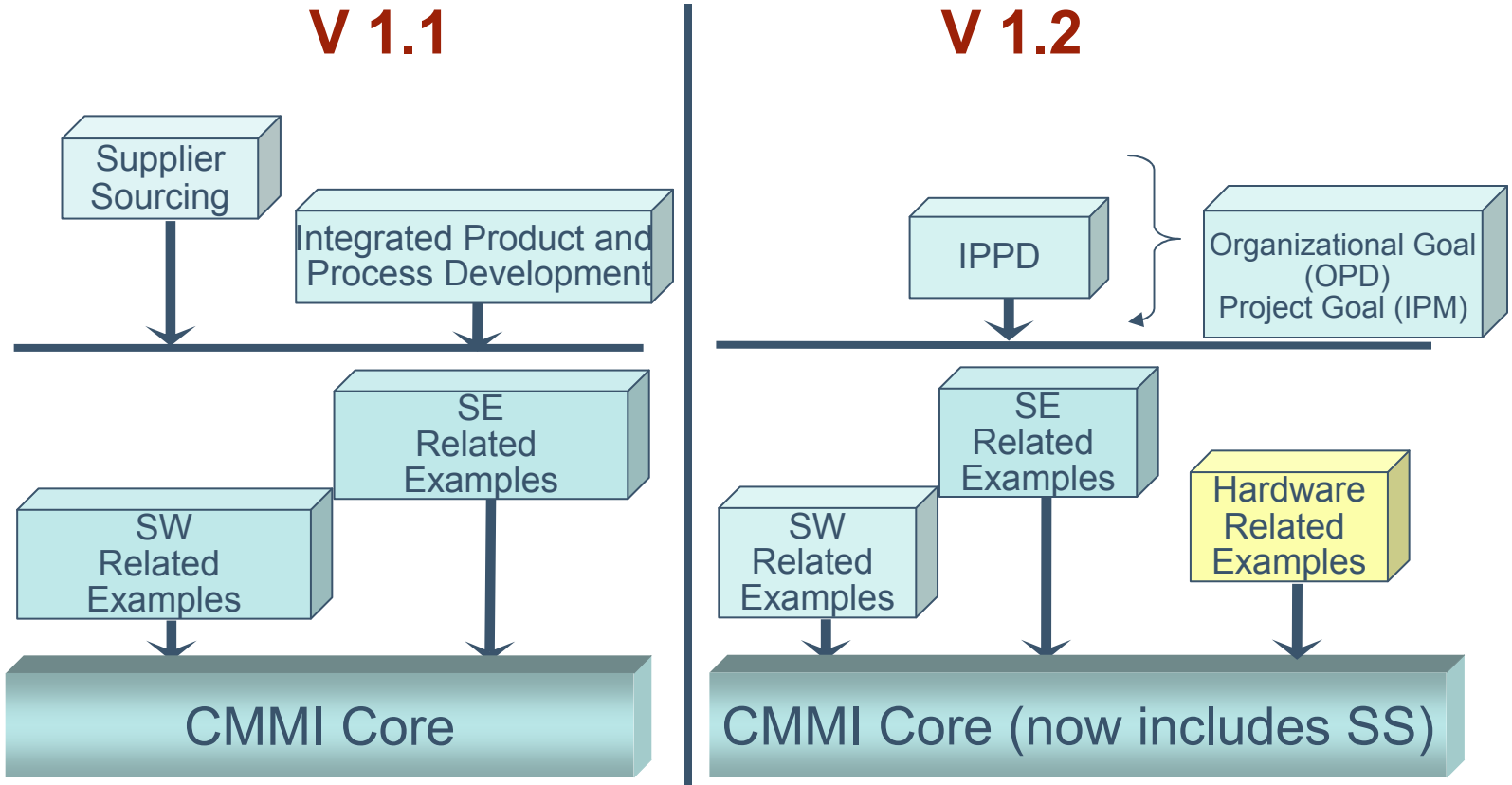
CMMI Model Combinations



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Other Specific Practice Statement Changes

Revised Practices

- OID, SP 1.4: Select process and technology improvements [not "improvement proposals"] for deployment across the organization
- OPP, SP 1.1: Select the processes or subprocesses [not "process elements"] in the organization's set of standard processes that are to be included in the organization's process performance analysis

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Other Informative Changes --

High capability practice elaborations

- Improvements being created for more significant process areas (engineering, project management)
- Continuous equivalent appraisals have shown the need…

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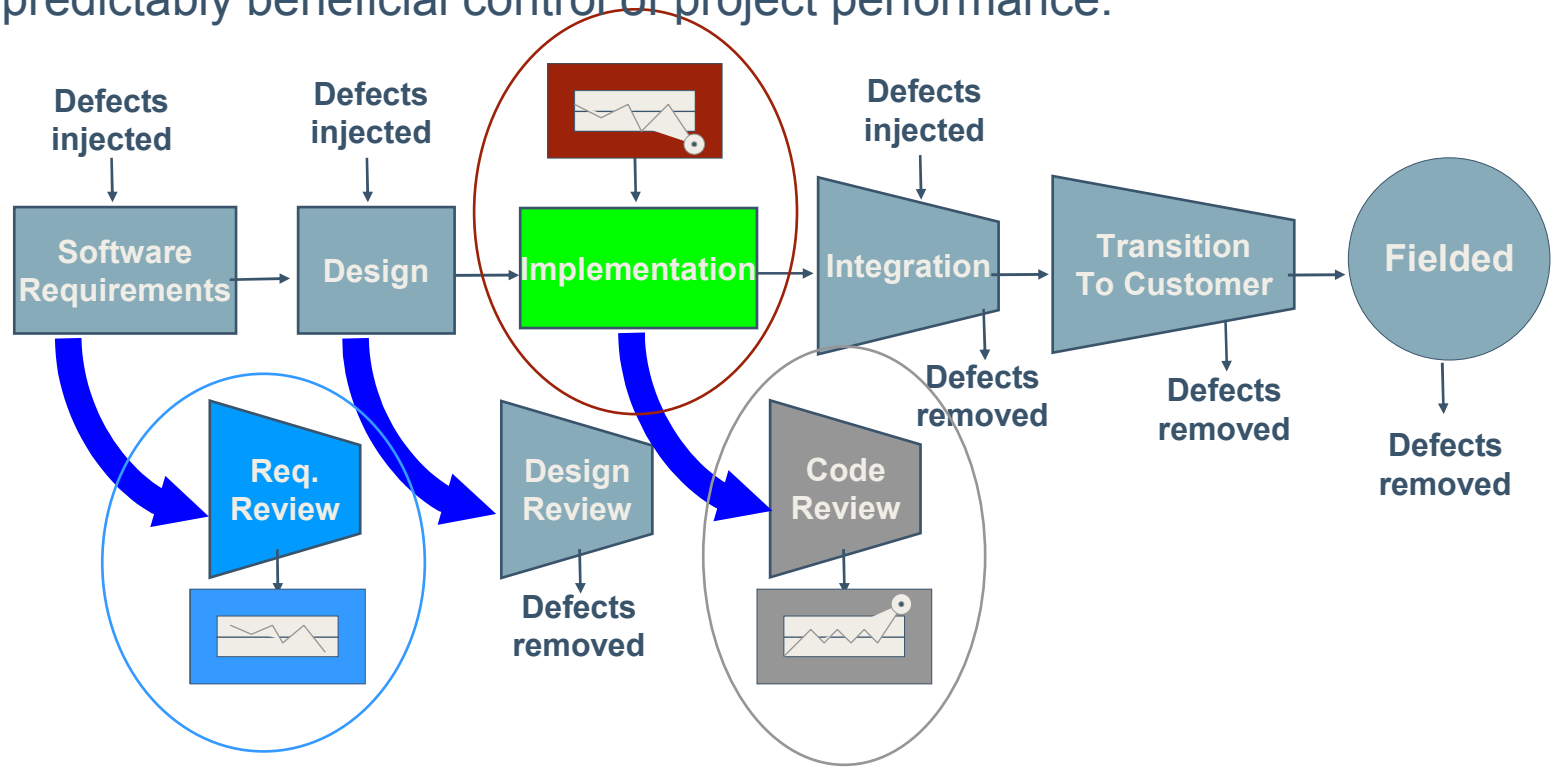
Select for Statistical Management

High-leverage elements of the constructed process are identified to provide strategic management options in order to support timely and predictably beneficial control of project performance.



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Name	Abbr	ML	CL1	CL2	CL3	CL4	CL5
Requirements Management	REQM	2	Target Profile 2				
Measurement and Analysis	MA	2					
Project Monitoring and Control	PMC	2					
Project Planning	PP	2					
Process and Product Quality Assurance	PPQA	2					
Supplier Agreement Management	SAM	2					
Configuration Management	CM	2					
Decision Analysis and Resolution	DAR	3			Target Profile 3		
Product Integration	PI	3					
Requirements Development	RD	3					
Technical Solution	TS	3					
Validation	VAL	3					
Verification	VER	3					
Organizational Process Definition	OPD	3					
Organizational Process Focus	OPF	3					
Integrated Project Management (IPPD)	IPM	3					
Risk Management	RSKM	3					
Integrated Supplier Management	ISM	3					
Organizational Training	OT	3					
Integrated Teaming	IT	3					
Organizational Environment for Integration	OEI	3					
Organizational Process Performance	OPP	4	Target Profile 4				
Quantitative Project Management	QPM	4					
Organizational Innovation and Deployment	OID	5	Target Profile 5				
Causal Analysis and Resolution	CAR	5					

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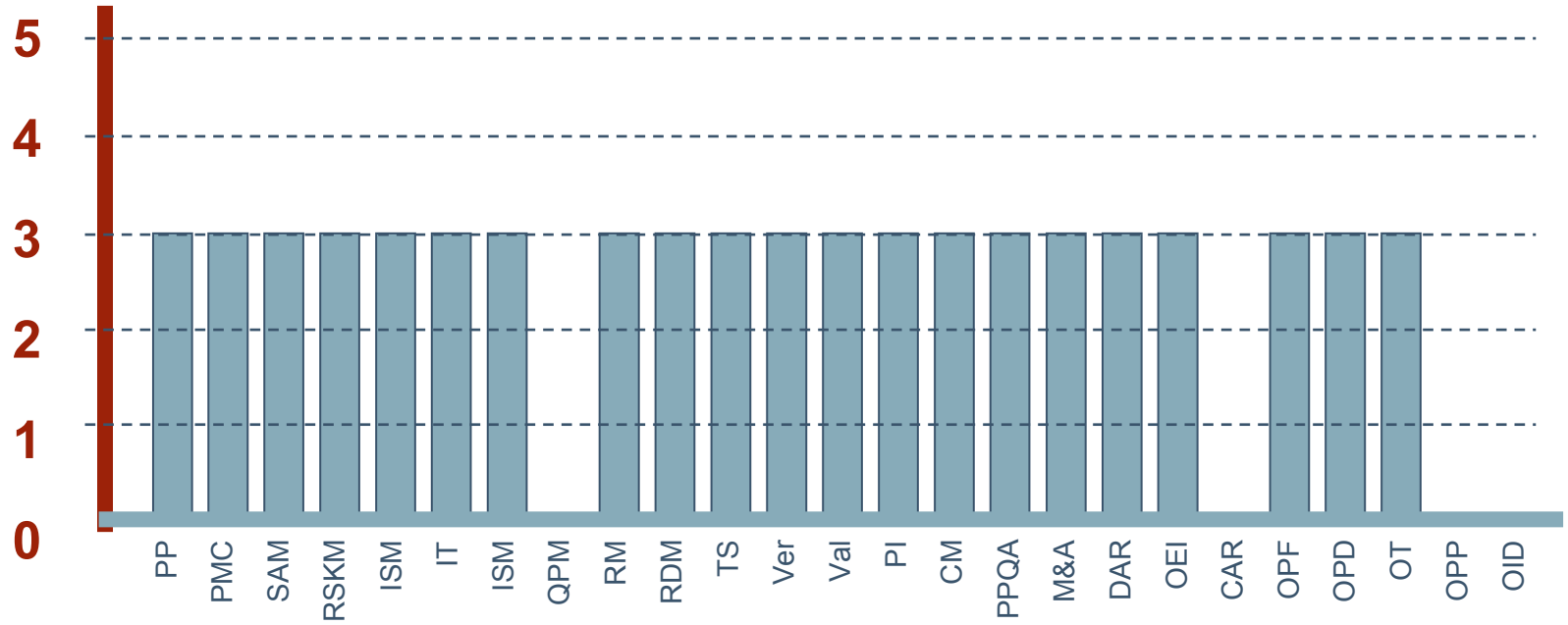
Example – Maturity Level 3

Equivalent to CMMI-SE/SW/IPPD/SS ML 3



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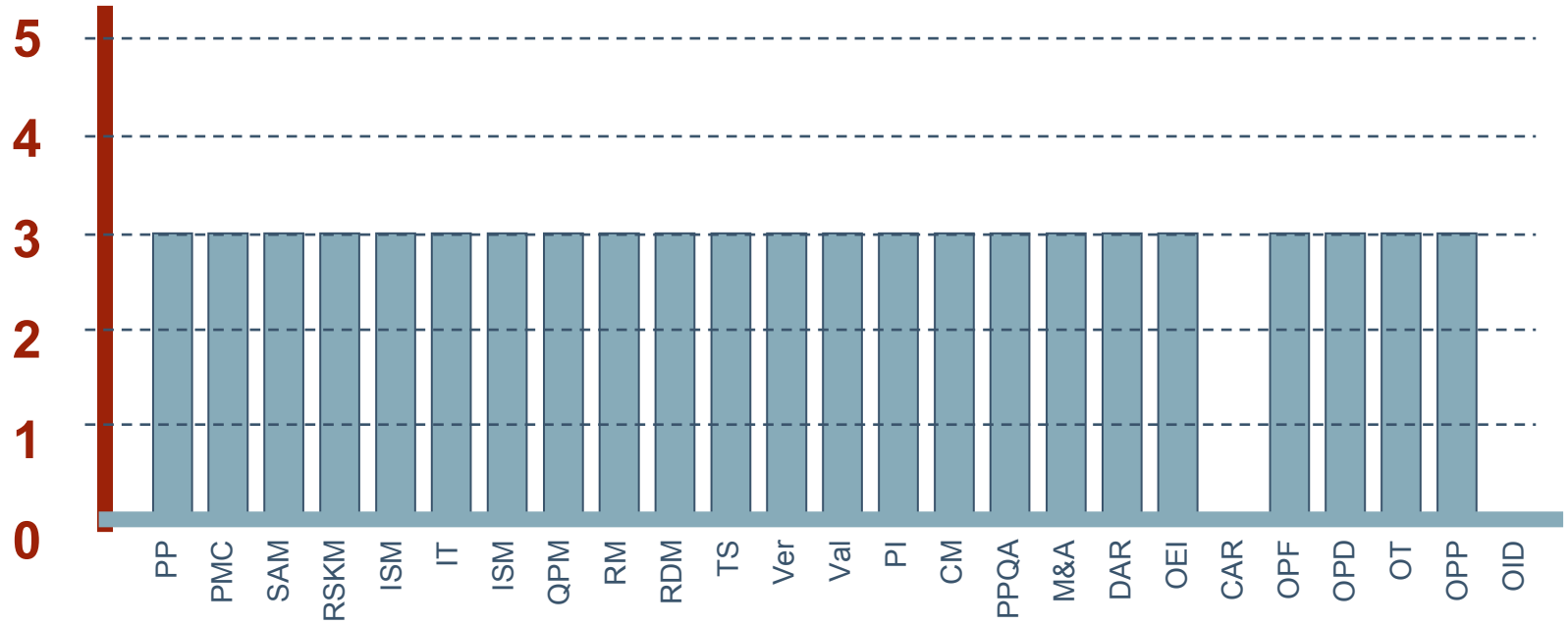
Example – Maturity Level 4

Equivalent to CMMI-SE/SW/IPPD/SS ML 4



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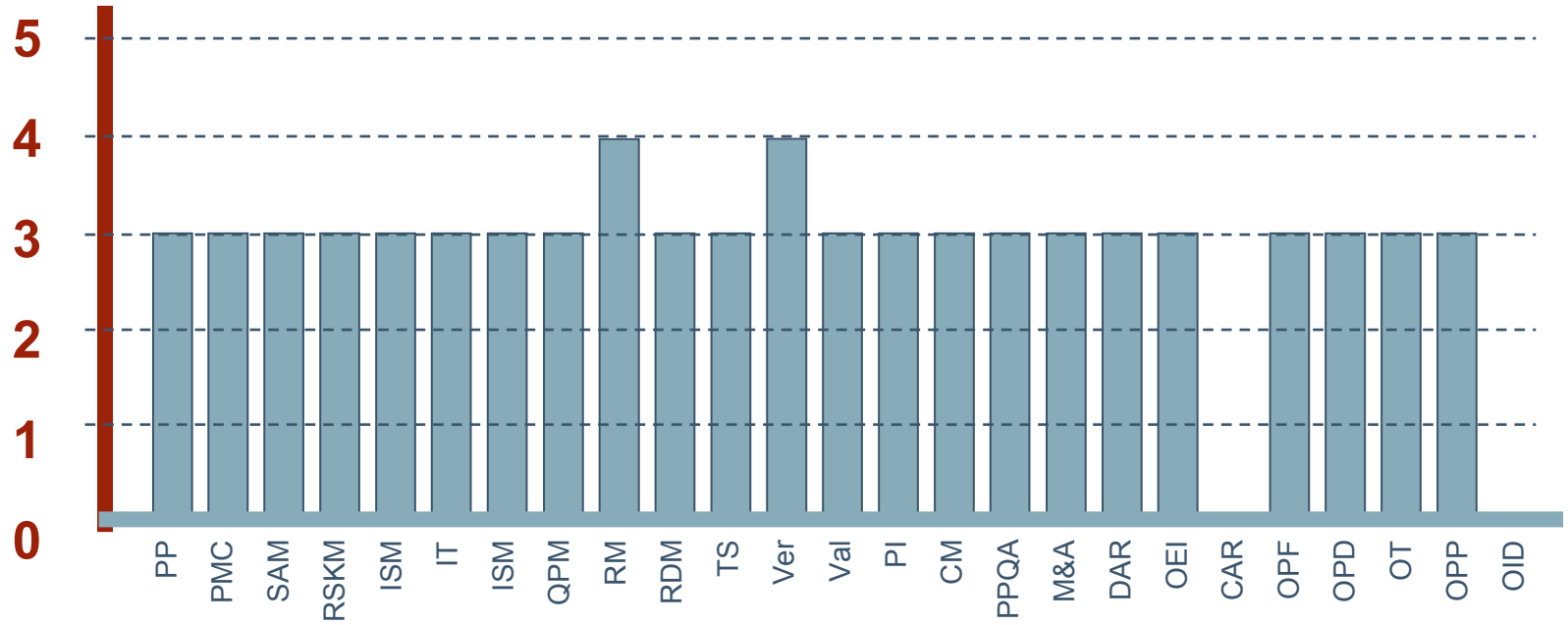
Example – Maturity Level 4

Equivalent to CMMI-SE/SW/IPPD/SS ML 4



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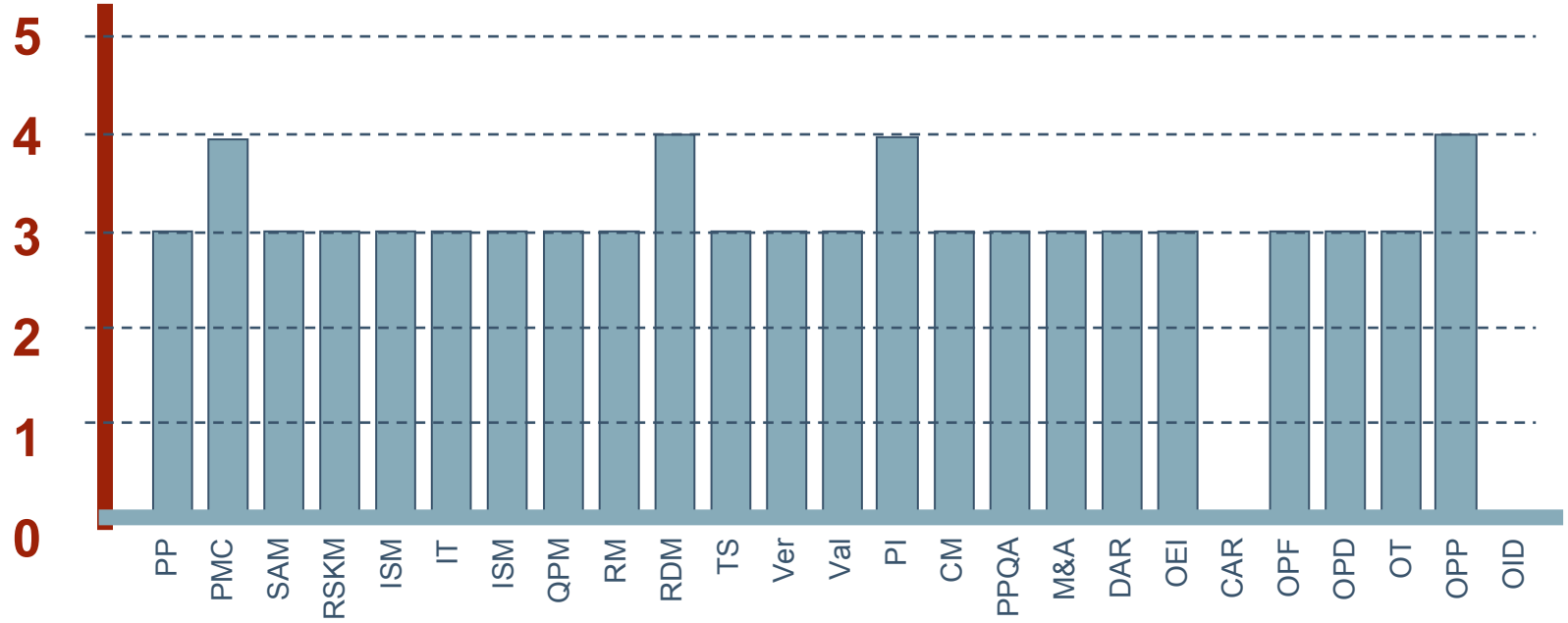
Example – Maturity Level 4

Equivalent to CMMI-SE/SW/IPPD/SS ML 4

Plus 8,388,607 other combinations!!



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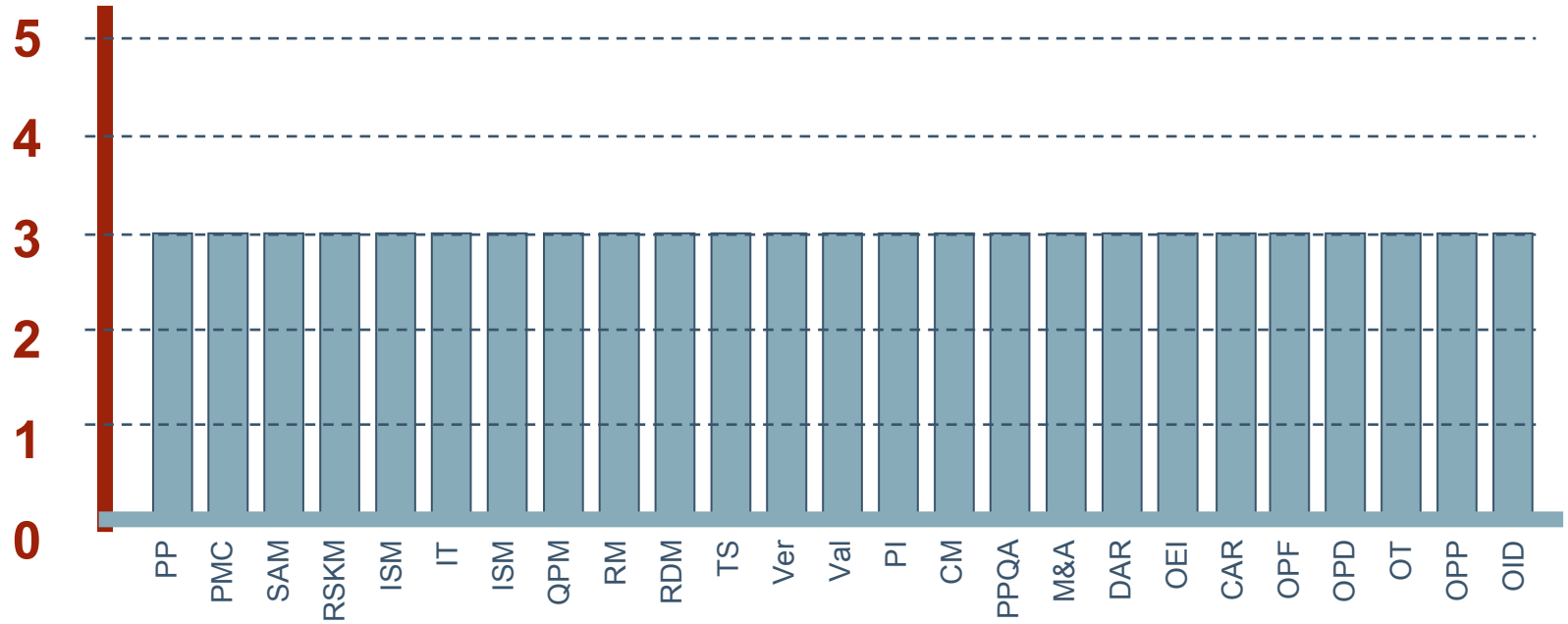
Example – Maturity Level 5

Equivalent to CMMI-SE/SW/IPPD/SS ML 5



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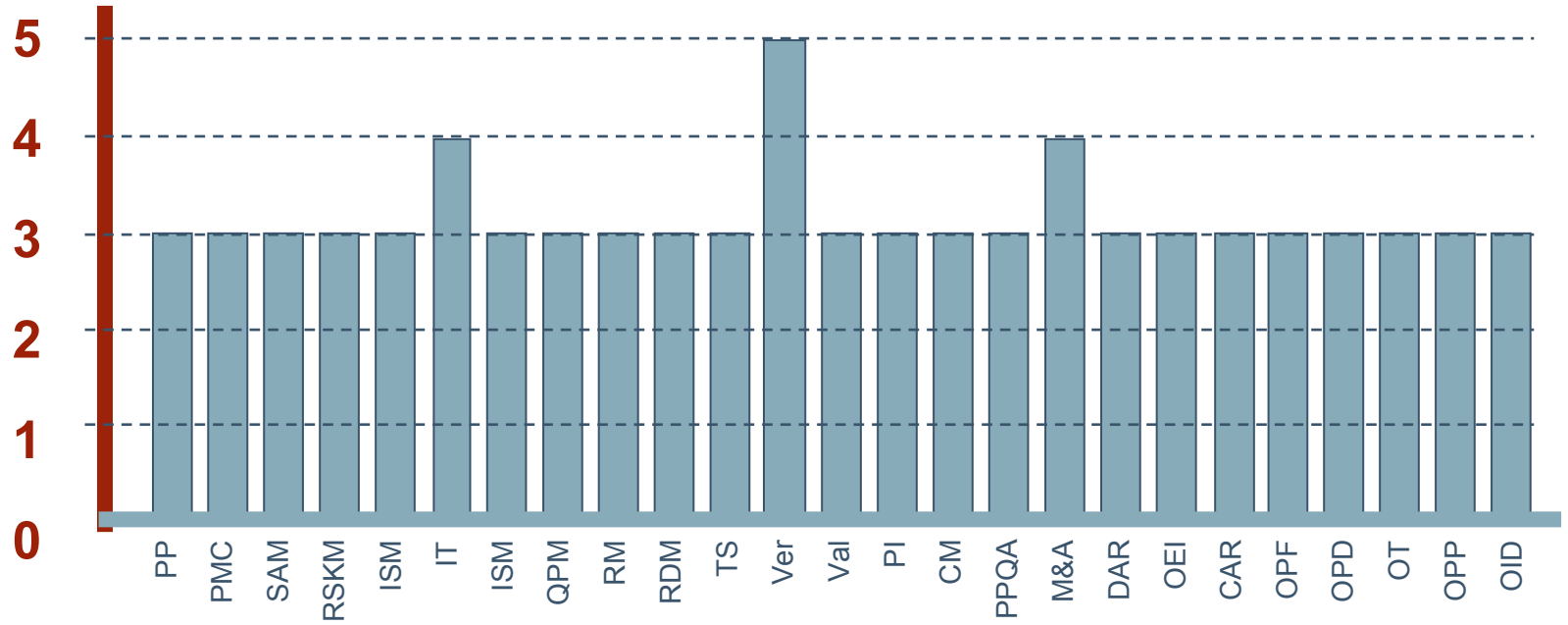
Example – Maturity Level 5

Equivalent to CMMI-SE/SW/IPPD/SS ML 5



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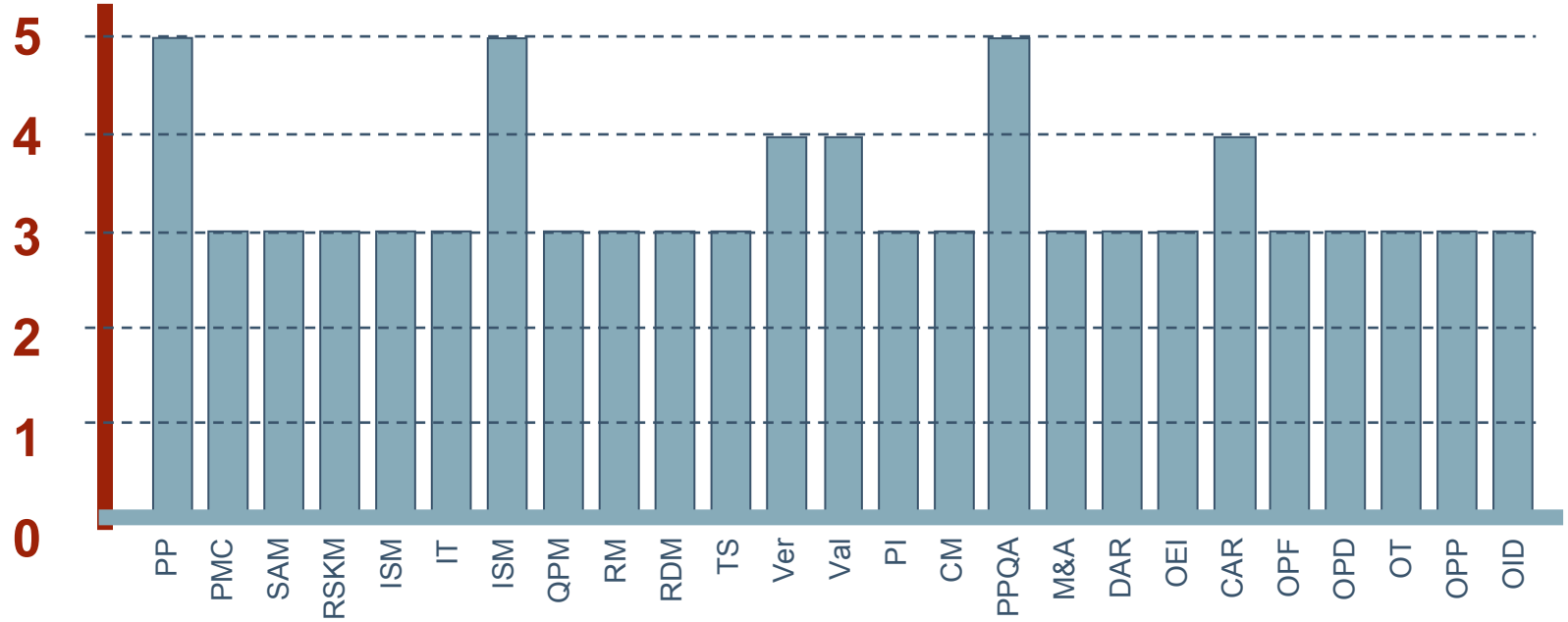
Example – Maturity Level 5

Equivalent to CMMI-SE/SW/IPPD/SS ML 5

Plus 847,288,609,442 other combinations!!



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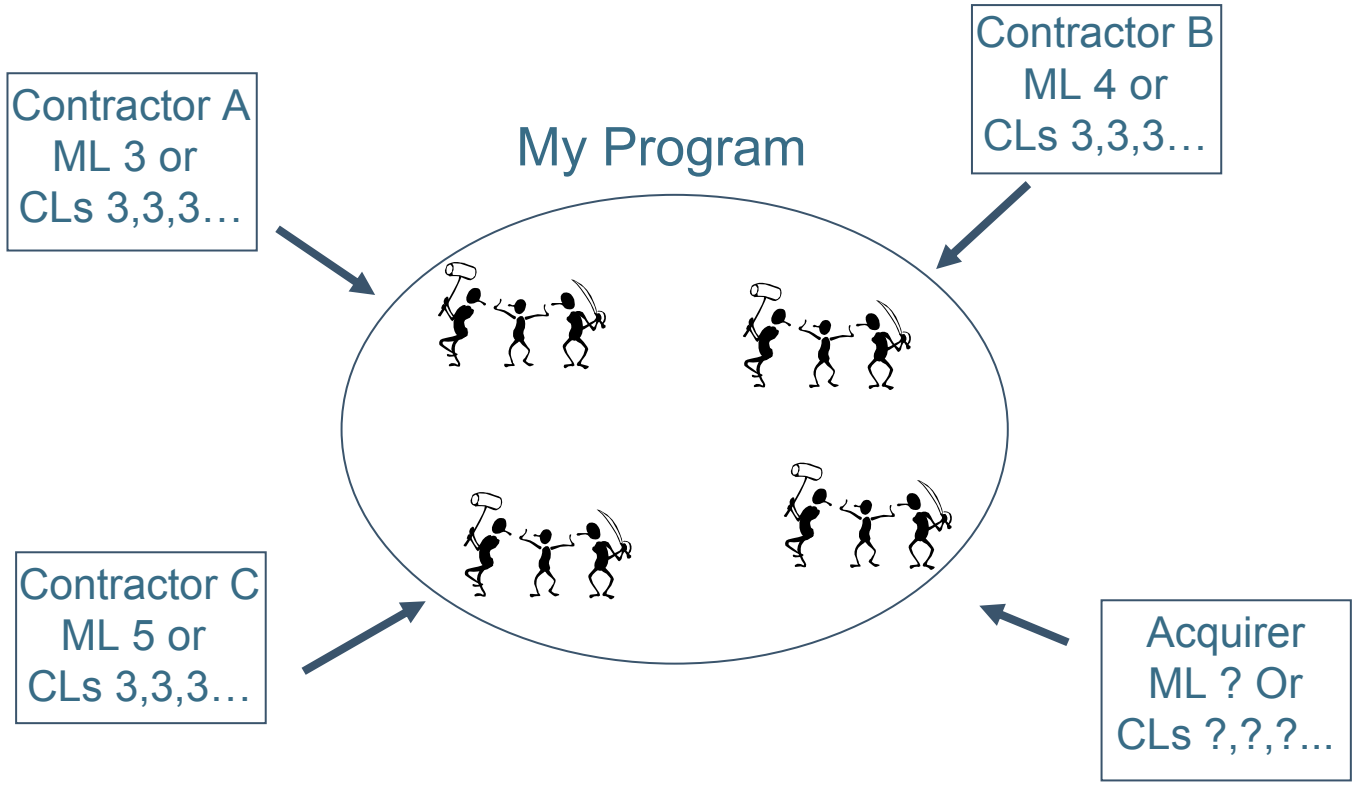
Additional Complexity



CMMI Math: 3 + 4 + 5 + ? = ?

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Version 1.2 Changes

"Not applicable" process areas (PAs) for maturity levels will be significantly constrained

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The "Not Applicable" Dilemma

The Problem

The significance of an organization being appraised to be at Maturity Level x is affected by the model scope used for the appraisal. Process areas can be classified as not applicable.

The Solution

The model core is now defined to include all components of the model except the IPPD components. For a staged appraisal only Supplier Agreement Management and Integrated Supplier Management can be classified as not applicable in the core and only then after careful analysis.

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Version 1.2 Changes

Bring ISM into baseline and incorporate into SAM

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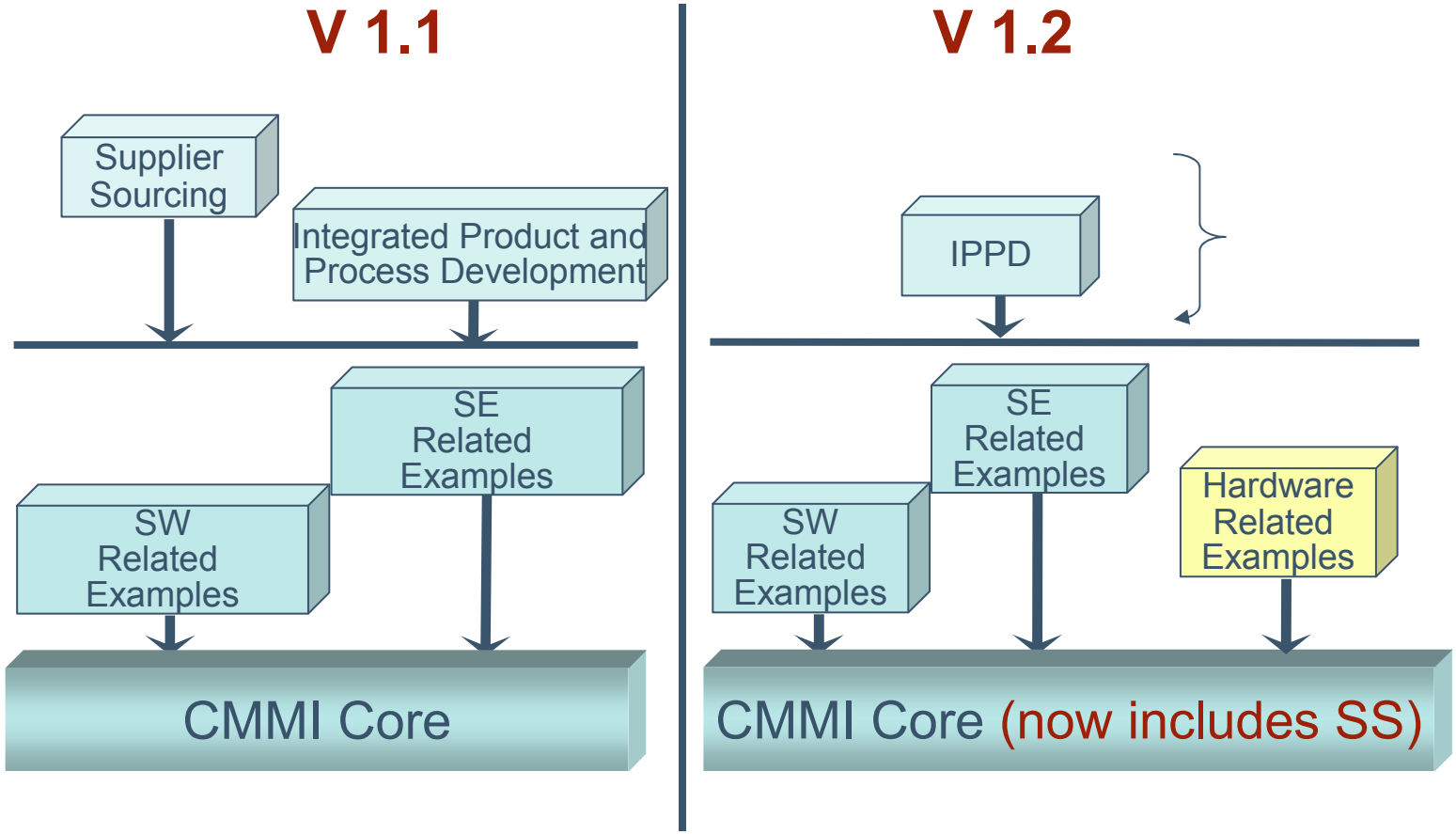
CMMI Model Combinations



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Supplier Agreement Management
(before incorporation of ISM)

Specific Goal	Specific Practice
Establish Supplier Agreements	**1.1 – Determine Acquisition Type** **1.2 – Select Suppliers** **1.3 – Establish Supplier Agreements**
Satisfy Supplier Agreements	**2.1 – Execute the Supplier Agreement** **2.2 – Accept the Acquired Product** **2.3 – Transition Products**

v1.1 SP2.1 “Review COTS Products,” was eliminated. “Identify candidate COTS products that satisfy requirements” is a new subpractice under the Technical Solutions Process Area SP1.1, “Develop Alternative Solutions and Selection Criteria.”

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Version 1.2 Changes - Recap

Major changes to expect for Version 1.2 include:

- Addison-Wesley book used as starting baseline
  - "single book" approach (CMMI-Development+IPPD)
- Hardware amplifications added
- Amplifications improved
- Common features and advanced practices eliminated
- "Not applicable" process areas (PAs) for maturity levels will be significantly constrained
- Glossary improved (e.g., higher level management, bidirectional traceability, subprocess)
- Overview text improved
- Work Environment material added to OPD and IPM
- IPPD coverage consolidated and simplified
- ISM will be brought into SAM

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Generic Practice Changes

GP 1.1: The practice title and statement changed from Perform Base Practices to Perform Specific Practices.

GP 2.2: The informative material was condensed to be more similar in size to other generic practices.

GP 2.4, Subpractice 1: “Authority” was added to stress assigning both responsibility and authority.

GP 2.6: “Levels of configuration management” was changed to “under appropriate levels of control” in the GP statement.

GP 5.2: Added informative material explaining the need for at least one quantitatively managed process.

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Translations

Japanese
- sponsored by Information-Technology Promotion Agency (IPA)
- CMMI models available
- *Introduction to CMMI* course available to authorized instructors

Traditional Chinese
- sponsored by the Institute for Information Industry (III)
- CMMI models available
- translation of *Introduction to CMMI* course underway

German Translation
- plans are being developed

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Applying CMMI in Small Settings

Where are we with our work in small settings?

- completed technical feasibility pilots in Huntsville, Alabama with two small companies in the US Army supply chain
- posted the toolkit from this pilot for review:
  - http://www.sei.cmu.edu/ttp/publications/toolkit
- chartered a project to further research in and evolve guidance for CMMI in Small Settings (CSS)

Where are we going?

- International Research Workshop for Process Improvement in Small Settings held October 19-20, 2005
- call for Interest in CSS project is posted on SEI web:
  - http://www.sei.cmu.edu/cmmi/acss/participation.html

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SCAMPI A Changes Considered for v1.2

Affirmation Clarifications
- clarify the use of “virtual” vs. “live” interviews
- change “face-to-face” affirmations to “oral” affirmations

Alternative Practice Characterization
- clarify how alternative practices are mapped and characterized

Practice Characterization Rules
- revise and clarify practice characterization rules in the SCAMPI Method Definition Document (MDD) Section 2.2.2

Incremental appraisals
- conduct appraisal in organization or model increments

Organizational unit sampling

Maturity level and capability level shelf life

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Proposed ARC V1.2 Changes

Remove requirement for instruments

- Only two types of Objective Evidence – Documents and Interviews
- Thus presentations may be either documents or interviews

Clarify “Not Rated”

- Process Areas out of the model scope are “Out of Scope”
- Process Areas that cannot be rated are “Not Rated”

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Proposed Method Definition Document (MDD) v1.2 Changes-1

Affirmation Clarifications

- clarify the use of “virtual” vs. “live” interviews
- change “face-to-face” affirmations to “oral” affirmations

Alternative Practice Characterization

- clarify how alternative practices are mapped and characterized
- described in new Appendix C

Practice Characterization Rules

- revise and clarify practice characterization rules in the SCAMPI MDD Section 2.2.2
- change “substantial” weakness to “weakness”
- make rules consistent
- add “Not Yet” characterization to table

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Practice Characterization Rules-1

Label	Meaning
Fully Implemented (FI)	•One or more direct artifacts are is present and judged to be adequate and •at least one indirect artifact and/or affirmation exists to confirm the implementation and •no weaknesses are noted.
Largely Implemented (LI)	•One or more direct artifacts are present and judged to be adequate, and •at least one indirect artifact and/or affirmation exists to confirm the implementation and •one or more weaknesses are noted.

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Practice Characterization Rules-2

Label	Meaning
Partially Implemented (PI)	•Direct artifacts are absent or are judged to be inadequate, and •one or more indirect artifacts or affirmations suggest that some aspects of the practice are implemented, and •one or more weaknesses are noted OR •one or more direct artifacts are present and judged to be adequate, and •no other evidence (indirect artifacts, affirmations) supports the direct artifact(s), and •one or more weaknesses are noted.
Not Implemented (NI)	•Direct artifacts are absent or judged to be inadequate, and •no other evidence (indirect artifacts, affirmations) supports the practice, and •one or more weaknesses are noted.
Not Yet (NY)	•The project has not yet reached the stage in the lifecycle to have implemented the practice

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Proposed Method Definition Document (MDD) v1.2 Changes-2

Incremental appraisals
- conduct appraisal in organization or model increments

Organizational unit sampling, including for Enterprise appraisals

Maturity Level and Capability Level shelf life

Require Sponsor to sign the Appraisal Disclosure Statement
- agrees that CMMI Steward may review any appraisal artifacts and conduct any audits deemed necessary

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Beyond CMMI v1.2 – Training

The SEI plans the following enhancements to CMMI training:

- update the *High Maturity with Statistics* course
- create a new course that addresses interpretation and implementation issues
- make a new course available that provides insight into using Team Software Process[SM]/Personal Software Process[SM] and CMMI

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For More Information…

For more information about CMMI

- http://www.sei.cmu.edu/cmmi/ (main CMMI site)

Other Web sites of interest include

- http://seir.sei.cmu.edu/seir/ (Software Engineering Information Repository)
- http://dtic.mil/ndia (annual CMMI Technology Conferences)
- http://seir.sei.cmu.edu/pars (publicly released SCAMPI appraisal summaries)
- https://bscw.sei.cmu.edu/pub/bscw.cgi/0/79783

Or, contact
SEI Customer Relations
Phone: 412 / 268-5800
Email: customer-relations@sei.cmu.edu

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Pittsburgh, PA 15213-3890

The ROI of CMMI: Using Process Simulation to Support Better Management Decisions

David M. Raffo, Ph.D.
Visiting Scientist, Software Engineering Institute
Associate Professor, Portland State University

Sponsored by the U.S. Department of Defense
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Acknowledgements

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Introductions and Logistics

Introductions

Workshop leader introductions

Participant introductions

- Name
- Position
- Expectations
  - What do you want to get out of the workshop?
  - Do your expectations match the workshop agenda?

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Logistics

Workshop time/duration

Rest Rooms

Breaks

Smoking Rules

Phones

Messages

Workshop Approach

Lecture/presentation

Examples

Ask questions

Participate!!!

Audience

- Executive/leaders of organizations seeking to understand
  - The costs/benefits of CMMI-based process improvement
  - How to quantify them
  - How simulation can help them achieve higher CMMI levels
- Executives/leaders seeking to benchmark their processes and performance with industry
- Process improvement/EPG personnel seeking ways to communicate more effectively to senior management about the costs/benefits of CMMI-based process improvement
- Personnel seeking to transition to the CMMI, or implement higher-maturity process areas
- Personnel working to define process and estimate performance based upon quantitative measurements.

Overview

Process simulation is a high leverage way to determine which process improvement opportunities are likely to have the best outcome

Goals of the tutorial:

- Familiarize participants with Process Simulation – What, Why, How
- Show participants how to utilize simulation ***results*** to support process improvement decisions

This tutorial will focus on one simulation method – the Process Tradeoff Analysis Method (PTAM) and will briefly touch on others

Overview

The tutorial is not intended to be comprehensive, some topics are presented at a high-level only

No knowledge of simulation or finance is assumed

Agenda

1. Introduction: What is Process Simulation?
2. Motivation: Why do Process Simulation?
3. Overview of Process Simulation Alternatives
4. How do we build process simulation models?
5. Process Tradeoff Analysis Method (PTAM)
6. Examples of Process Simulation Applications in Industry and Government.
7. Wrap-Up/ Conclusions

1 – Introduction: What is Process Simulation?

What Is a Simulation Model?

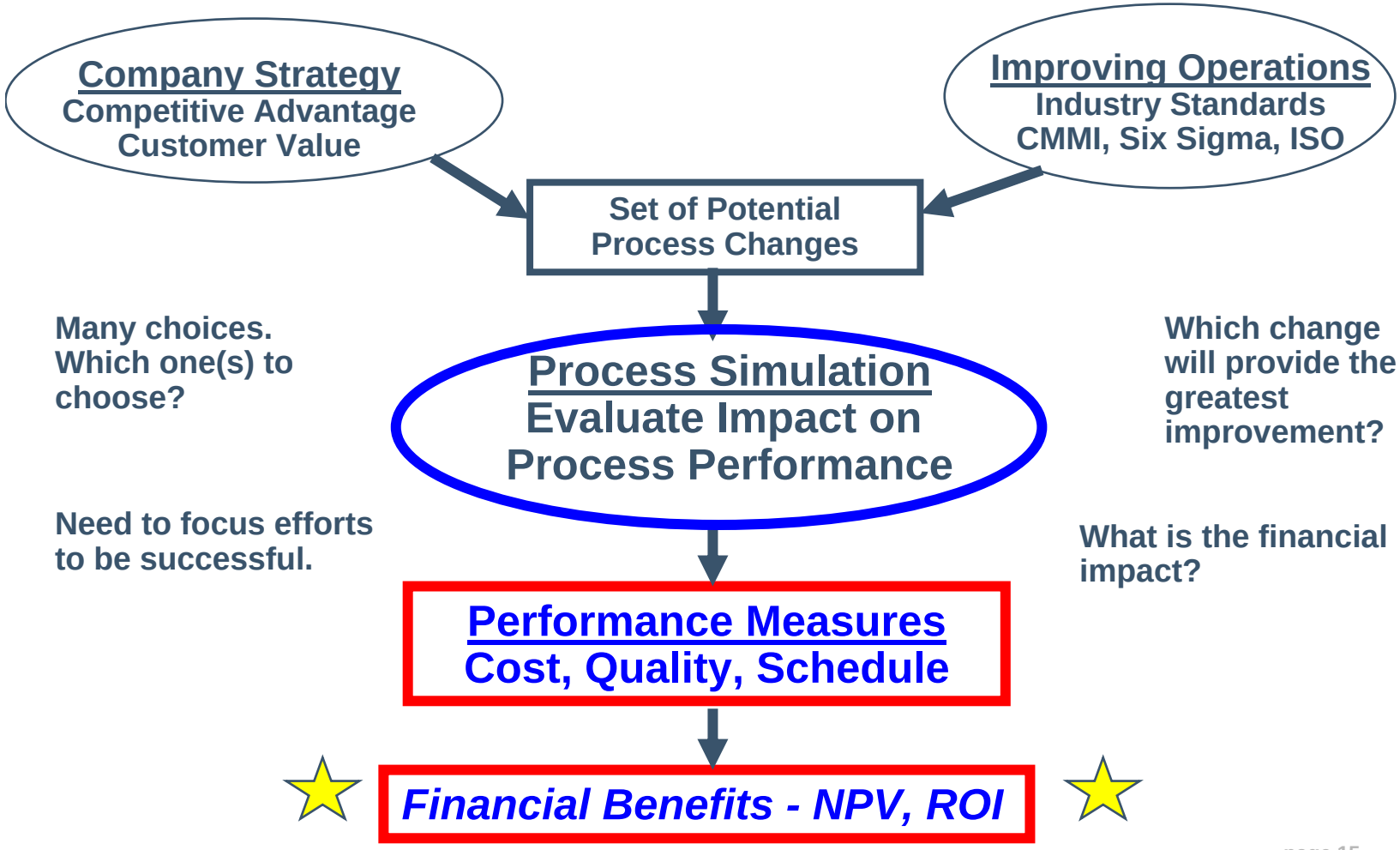
- A simulation model is a computerized model (*not a maturity model*) designed to display significant features of the dynamic system it represents.
- Simulations are generally employed when
  - behavior over time is of particular interest or significance, and
  - the economics or logistics of manipulating the system being modeled are prohibitive
- Common purposes of simulation models are:
  - to provide a basis for experimentation,
  - to predict behavior,
  - to answer “what if” questions,
  - to teach about the system being modeled.

Process Simulation Models

- Process simulation models focus on the dynamics of software and ***systems*** development, maintenance and acquisition.
- They represent the process
  - as currently implemented (as-is, as-practiced, as-documented), or
  - as planned for future implementation (to-be)
- The models represent only selected *relevant* aspects of a *defined* process.

Simulation Features

- Use Graphical interfaces
- Utilizes actual data/ metrics
- Predict performance
- Supports “What if” Analyses
- Support business case analyses
- Reduces risk


Company Strategy
Competitive Advantage
Customer Value
Improving Operations
Industry Standards
CMMI, Six Sigma, ISO
Set of Potential Process Changes
Many choices. Which one(s) to choose?
Process Simulation
Evaluate Impact on Process Performance
Which change will provide the greatest improvement?
Need to focus efforts to be successful.
What is the financial impact?
Performance Measures
Cost, Quality, Schedule
Financial Benefits - NPV, ROI

2 – Motivation: Why Do Process Simulation?

Benefits of Process Simulation

	Option	Project										
		Total Effort (PM) Dev Eff + Dev Rwk	Rework Effort Devel Defects (PM)	Project Duration *(Calendar Months)*	Projected Cost or Revenue delta due to Duration Change	Total Injected Defects	Corrected Defects	Escapted Defects	Rework Effort for Field Defects *(PM)*	Implementation Costs *($)*	NPV	ROI
0	Base Case	200	90	18	$0.00	1150	990	160	40	$0.00	n.a.	n.a.
1	Implement QFD	190	75	17.5	$0.00	1150	1020	130	30	$100,000	$165,145	15%
2	Implement VOC	185	75	17	$ 100,000	1150	1050	100	20	$120,000	$185,231	29%
3	Add QuARS Tool	175	65	16	$ 300,000	1150	1090	60	10	$ 80,000	$289,674	88%
4	Eliminate	230	130	22	$(400,000)	1150	900	250	80	$0.00	-$378,043	-129%
5	Additional Process											

Benefits of Process Simulation

- Decision Support and Tradeoff Analysis
- Sensitivity Analysis – “What if”
- Supports Industry Certification and process improvement programs including CMMI, Six Sigma, and others
- Benchmarking
- Design and Define Processes/Metrics
- Bring Lessons Learned Repositories Alive
- Can save cost, effort, and expertise
- Can be used to address project manager concerns such as….

Software Project Manager Concerns

- What development phases are essential?
- Which phases could be skipped or minimized to shorten cycle time and reduce costs without sacrificing quality?
- Are inspections worthwhile?
- What is the value of applying automated tools to support development activities?
- How do we predict the benefit associated with implementing a process change?
- How do we prioritize process changes?
- How to achieve higher levels of the CMMI?
- What is the level of Risk associated with a change?

3 – Overview of Alternative Process Simulation Approaches

Alternative Process Simulation Approaches

Modeling Paradigms

- Knowledge-Based Systems
- Agent Based
- State-Based
- Discrete Event
- System Dynamics
- Hybrid

Research Outlets

- Software Process: Improvement and Practice
- Journal of Systems and Software

- Tools
  - Arena
  - ProModel
  - Extend
  - Stella
  - VenSim
  - Research tools
- Conferences
  - Winter Simulation Conference
  - ProSim
  - SEPG
  - SSTC

Alternative Process Simulation Approaches

Knowledge Based Systems
- Person-in-the loop
- Fine level of granularity
- Supports process enactment

Agent Based Systems
- Fine level of granularity
- Supports detailed work interactions

State Based Systems
- Captures flow of control (work activities, parallelism) well
- Multi-view graphical representations
- Difficult to capture task, work package and resource details

Alternative Process Simulation Approaches

Discrete Event Simulation

- Able to represent richness of processes, work packages and resources
- Good for modeling quantitative process performance
- Good tool support

System Dynamics

- Captures feedback well
- Often used for high level qualitative issues

Hybrid

- Captures best aspects of Discrete Event and System Dynamics
- Models are complex
- Being used to predict performance of multi-site development

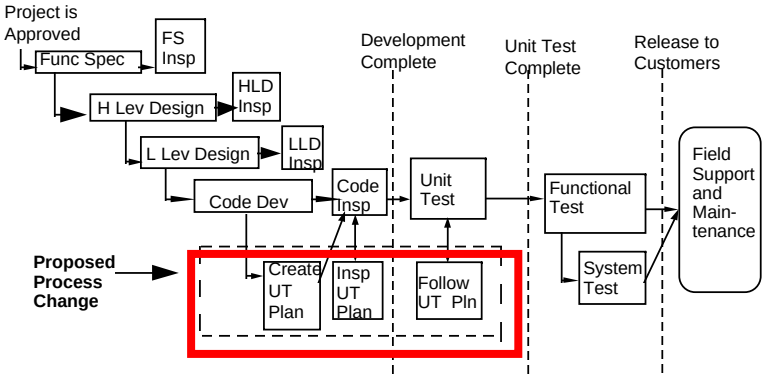
Common Applications of Each Approach

	STRAT	PLAN	MGMT	IMPR	UNDR	TRAIN
KBS					X	X
Agent Based					X	X
State-Based		X		X	X	X
Discrete Event	x	X	X	X	X	X
System Dynamic	X	x		x	X	X
Hybrid	X	X	X	X	X	X

4 –How to Build Process Simulation Models

How it works

Software Development Process



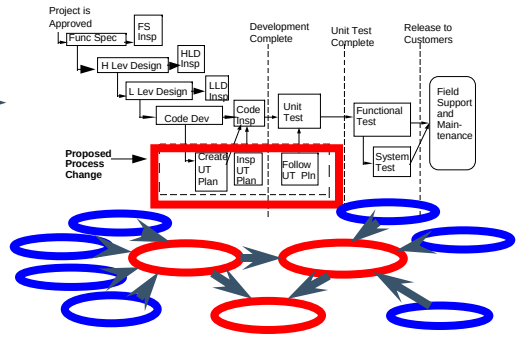
Better Process Decisions

Process Performance
Cost, Quality, Schedule

SW Process Simulation Model

Project Data
Process and Product

Model Parameters



Process Tradeoff Analysis Method (PTAM)

- **Based on extensive research** into Software Process Modeling conducted in academia, SEI and industry.
- **Graphical user interface** and models software processes
- **Integrates SEI methods** to define processes and supports CMMI PAs
- **Integrates metrics** related to cost, quality, and schedule into understandable project performance picture.
- **Predicts project-level impacts** of process improvements in terms of cost, quality and cycle time
- **Support business case analysis** of process decisions - ROI, NPV and quantitatively assessing risk.

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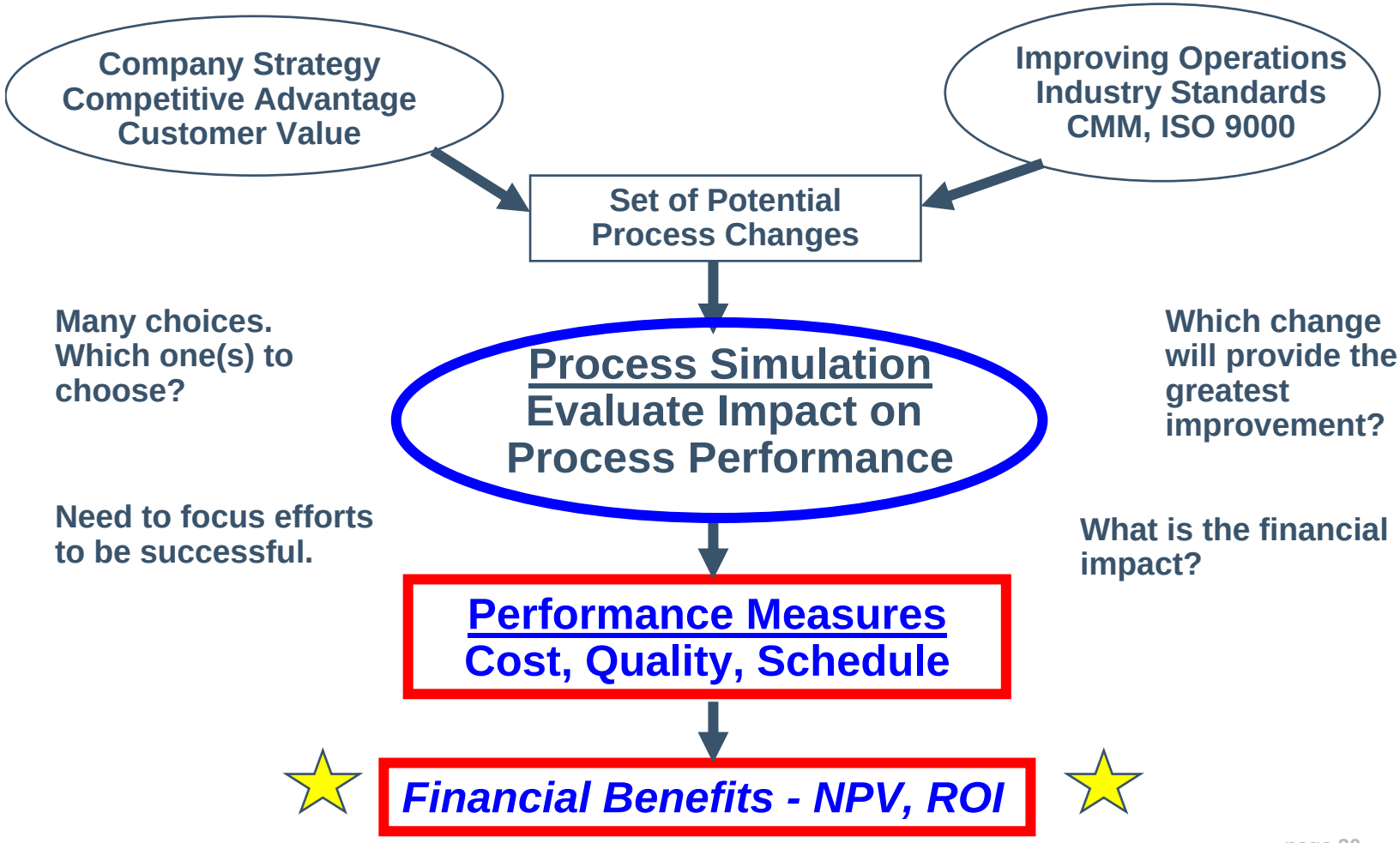
Process Tradeoff Analysis Method (PTAM)

- **Reduces risk** associated with process changes by predicting the probability of improvement
- **Saves time, effort and expertise** over other methods

5 – The Process Tradeoff Analysis Method (PTAM)

Process Tradeoff Analysis (PTA) Method



Overview of PTAM

Set-up Phase

- Set the Goal of the Modeling Effort
- Specify Questions for the Model to Address
- Define Process Performance Measures
- Identify Input Parameters

Gather Information

Modeling Phase

Analysis Phase

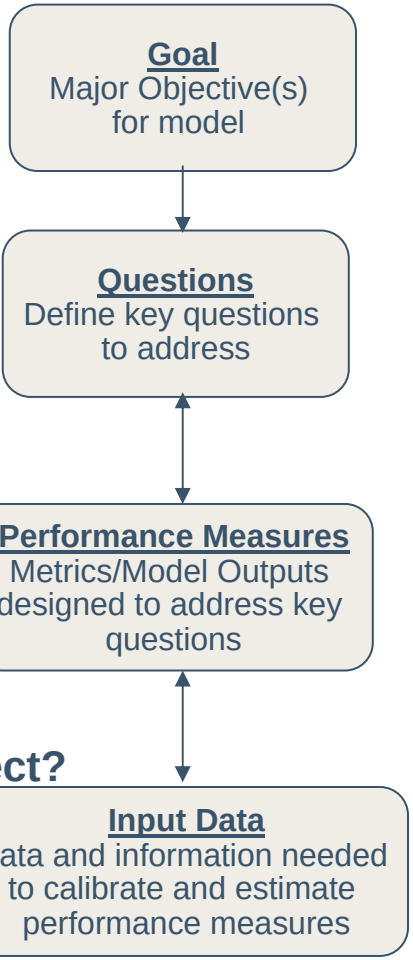
Set-up Phase

What decision(s) am I trying to make?

What questions does management have?

What do I need to know to answer the questions?

What information should we collect?



Overview of PTAM

- Set-up Phase
  - Set the Goal of the Modeling Effort
  - Specify Questions for the Model to Address
  - Define Process Performance Measures
  - Identify Input Data
- Gather Information
- Modeling Phase
- Analysis Phase

Why Simulate?

- There are a variety of reasons / purposes for undertaking process simulation.

- CMMI-Based Process Improvement
  - Strategic management
  - Planning
  - Control and operational management
  - Technology adoption
  - Understanding
  - Training and learning

CMMI Based Process Improvement

CMMI Levels 4 and 5

- Process simulation helps to fulfill PAs (OID, CAR, OPP and QPM - Sub Goals and Generic Goals)

CMMI Levels 2 and 3

- Process simulation can be used to evaluate alternative process choices (RD, TS, PI, V&V, RM, SAM, PPQA, and CM)

- Process simulation helps to fulfill PAs (OPF, OPD, OT, IPM, Risk, DAR, PP, PMA, MA, PPQA – Multiple Sub Goals and Generic Goals)

Case Study: Organizational Setting

- Leading software development firm
- Peak staffing of 60 developers on project
- Assessed at strong Level 2 of CMM/CMMI
- Experienced development staff
- 5th release of commercial project
- Data available in electronic and paper form: quantitative and qualitative; professional estimates used to fill in gaps
- Active SEPG

Case Study: Validation and Verification

- **Problem: Releasing defective products, had high schedule variance.**
- Why? Unit Test was main defect removal stage. They did it unreliably.
- Built a model of Large-Scale commercial development process
- Based on actual project data
- Predicted project performance in terms of effort, task duration and delivered defects.
- Part of a full business case analysis - determined financial performance of the process change

Process Overview - 1

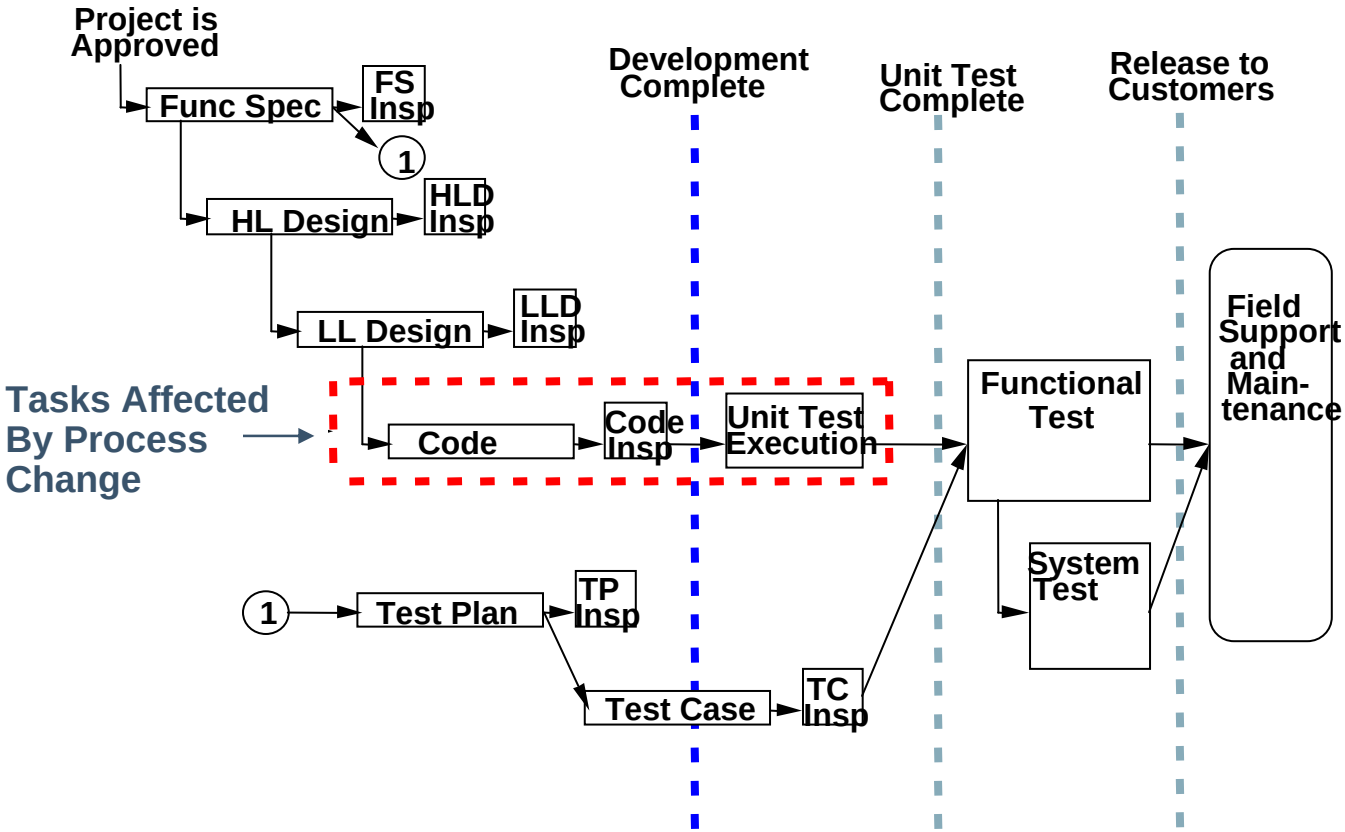
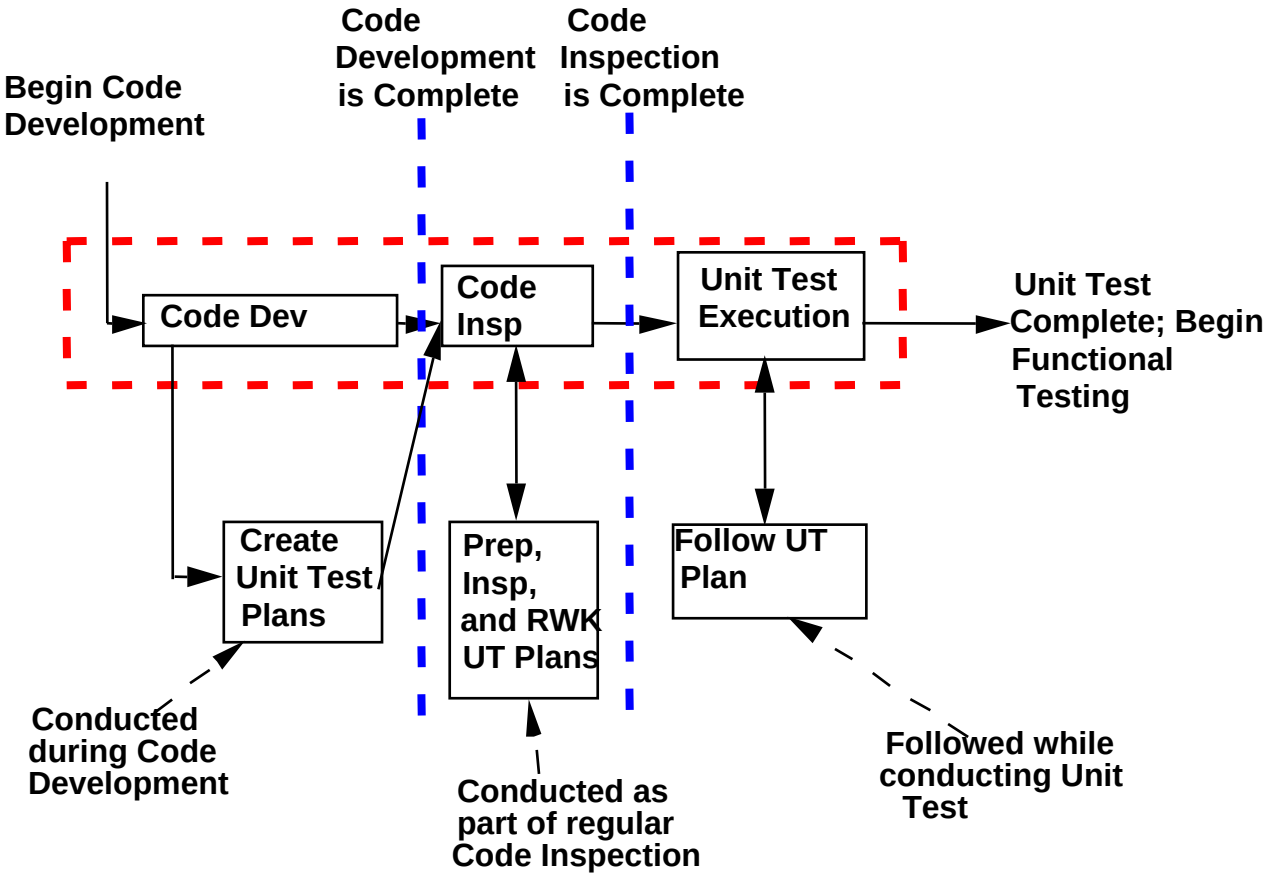


Diagram of the Field Study Life Cycle AS-IS Process

Process Overview - 2



Overview of PTAM

- Set-up Phase
  - Set the Goal of the Modeling Effort
  - Specify Questions for the Model to Address
  - Determine Organizational Scope
  - Define Process Performance Measures
  - Identify Input Data
- Gather Information
- Modeling Phase
- Analysis Phase

Specify Questions

- Based upon the goal/ purpose of the simulation model, specific management questions can be identified
- Questions should point to specific answers that management would like to obtain
- It should be recognized that the model may not be able to answer or even address all of the questions.
- The questions should document the full scope issues and information that need to be incorporated into the decision making process
- Questions document the use case

Example Questions

- What is the optimal V&V strategy for a specific project? For our organizational process?
- Would it be better to use Requirements process “A” or “B” for this new project?
- What combination(s) of V&V techniques enable us to meet or exceed the quality goals for the system? Which alternative is best?
- Given a budget of “X” dollars, what V&V activities should be conducted?
- What is the value of applying automated tools to support development activities?
- What is the level of Risk associated with a change?

Case Study: Questions Investigated

- Will the process change improve project performance?
- What is the cost the firm is currently paying by conducting Unit Tests incorrectly?
- Is partial implementation of the proposed process change possible?
- How would potential learning curve effects affect the performance of the process change?
- Would alternative process changes offer a greater improvement?
- Can the project benefit from reusing process artifacts?

Overview of PTAM

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  - Define Process Performance Measures
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- Analysis Phase

Define Process Performance Measures

- Main output measures of the simulation
- Should capture management interests and interests of engineers responsible for implementing the process changes.
- Must enable the questions to be answered
- Helps focus data collection and modeling efforts.
- Should be defined as early as possible on the project

Examples of Common Performance Measures

Typical performance measures include the following:

- effort / cost
- cycle-time (a.k.a. interval, duration, schedule)
- defect level
- staffing requirements
- staff utilization rate
- cost / benefit, return on investment
- throughput / productivity
- queue lengths (backlogs)

Case Study: Performance Measures

Cost

- Person-Months of Development, Inspection, Testing and Rework effort
- Equivalent Manpower (Staffing levels)
- Implementation costs

Quality

- Number of delivered defects by type

Schedule

- Months of Effort

Overview of PTAM

- Set-up Phase
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  - Specify Questions for the Model to Address
  - Define Process Performance Measures
  - Identify Input Data
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- Modeling Phase
- Analysis Phase

Input Data (1 of 2)

- Input data are used to predict the performance measures.

- Can be derived from the organization
  - Current baseline
  - Exemplary projects
  - Pilot data

- Can also be derived from
  - Expert opinion
  - Industry data from comparable organizations

- Best judgments to describe the state of your organization

Input Data (2 of 2)

Examples:

- process documents and assessments
- amount of incoming work
- effort based on size (and/ or other factors)
- defect detection efficiency
- effort for rework based on size and number of defects
- defect injection, detection and removal rates
- decision point outcomes; number of rework cycles
- hiring rate; staff turnover rate
- personnel capability and motivation, over time
- resource constraints
- frequency of product version releases

Case Study: Input Data

- CMM Level 2+ organization
- Process documents and assessments
- Project Size
- Productivity
- Earned Value by phase
- Total number of defects removed
- Defect injection, detection and correction rates
- Effort and schedule data
- Defect detection and rework costs

Overview of PTAM

- Set-up Phase
  - Set the Goal of the Modeling Effort
  - Specify Questions for the Model to Address
  - Define Process Performance Measures
  - Identify Input Data
- Gather Information
  - Gather qualitative and quantitative data about processes and products from variety of sources in variety of forms
- Modeling Phase
- Analysis Phase

Overview of PTAM

- Set up phase
  - Set the Goal of the Modeling Effort
  - Specify Questions for the Model to Address
  - Define Process Performance Measures
  - Identify Input Data
- Gather Information
- Modeling Phase
- Analysis Phase

Process Models

- First, create the graphical model
- Quantitative portion of the simulation model can be theoretical or data driven
  - Data driven models analyze actual data from past projects using statistical techniques such as correlation coefficients and regression.
  - Theoretical models are independent of data (relationships)
- Process simulation can incorporate many kinds of analytical models (data driven or theoretical)
  - COCOMO, SLIM
  - Reliability
  - Other Regression, Queuing and others

Case Study: Build the Graphical Model

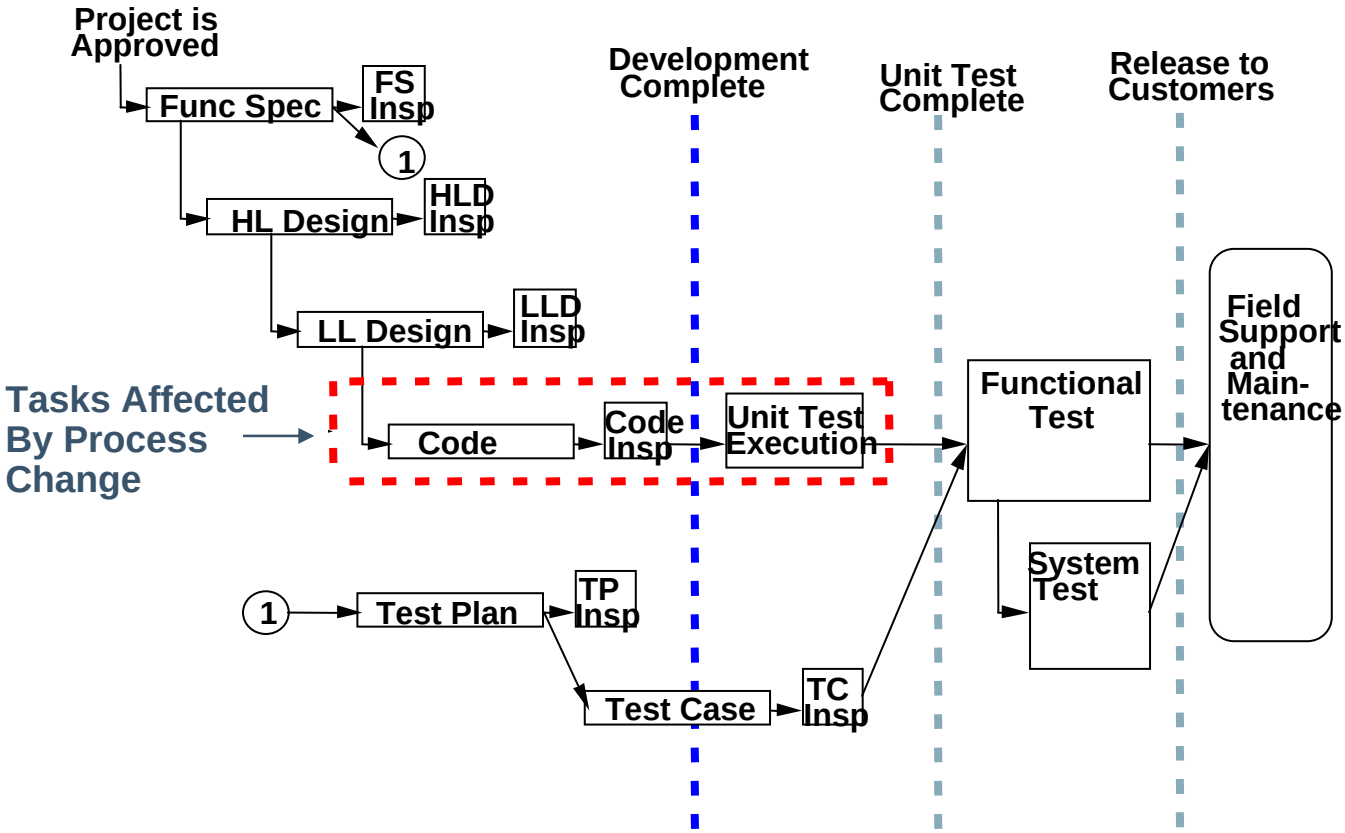
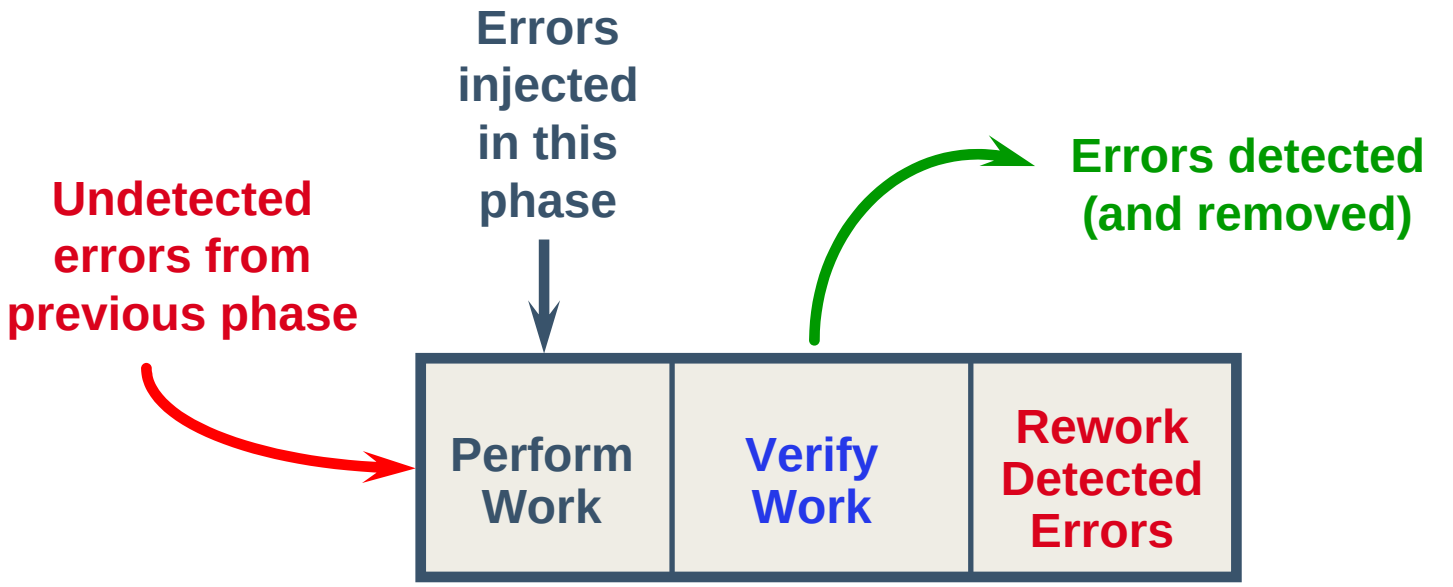


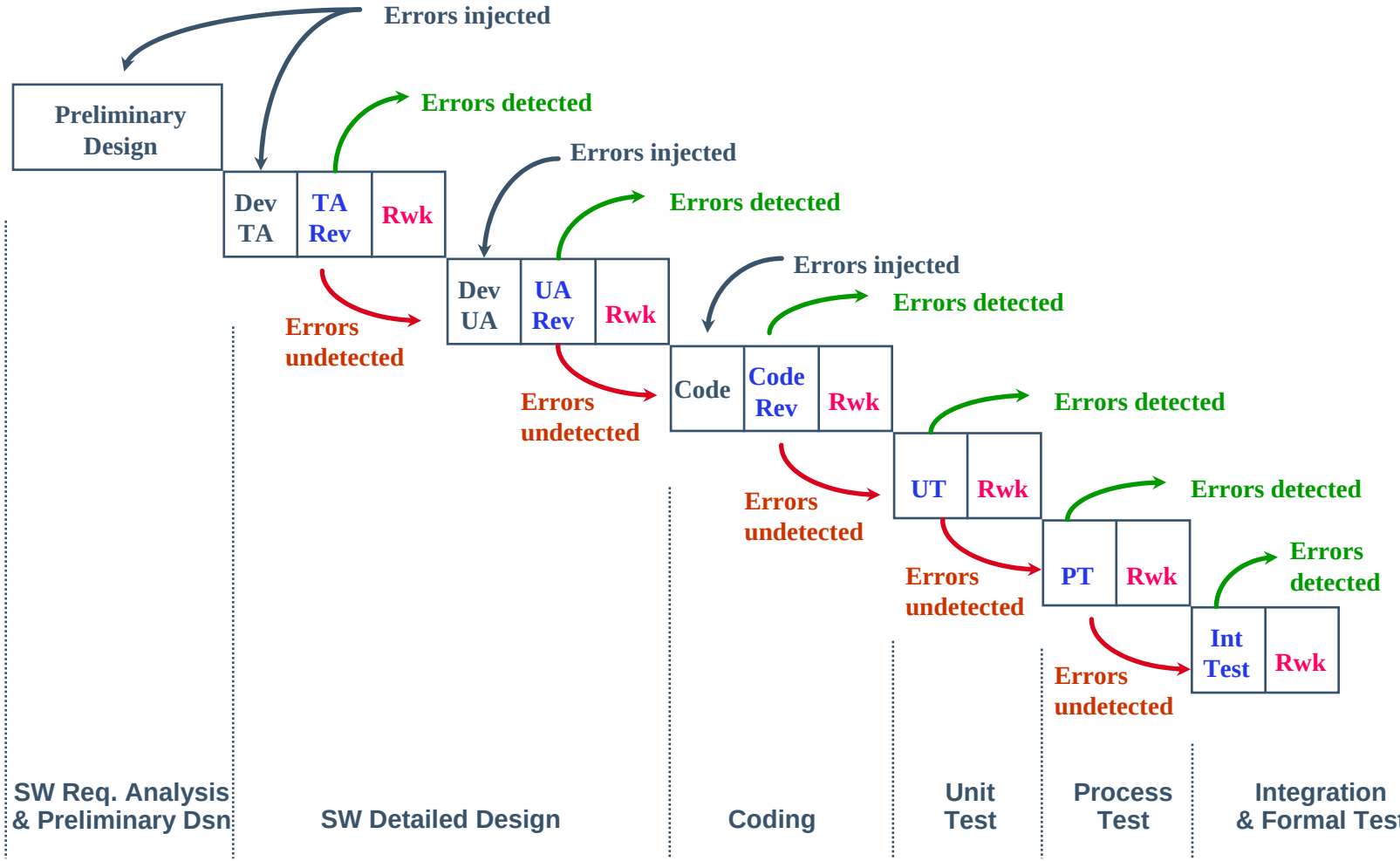
Diagram of the Field Study Life Cycle AS-IS Process

Case Study: Simplified Error Model

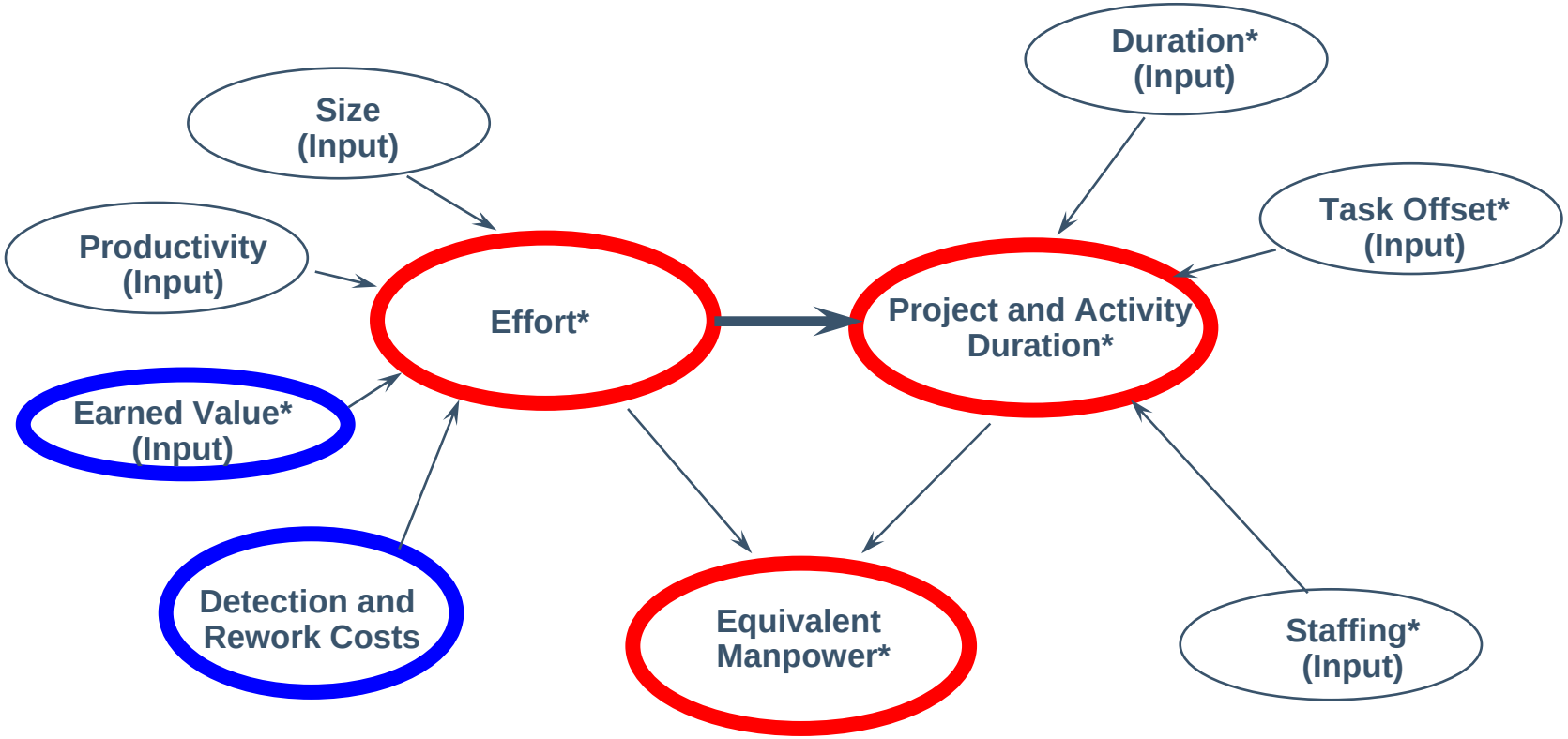


$$\text{Verification Efficiency} = \frac{\text{Errors Detected}}{\text{Total Errors Present}}$$

More Detailed Error Model



Linking Effort, Duration, and Staffing



Overview of PTAM

- Set up Phase
  - Set the Goal of the Modeling Effort
  - Specify Questions for the Model to Address
  - Define Process Performance Measures
  - Identify Input Data
- Gather Information
- Modeling Phase
- Analysis Phase

Analysis Phase

Once the model results are validated and viewed as being credible, they can be used to support decisions.

Major Steps

- Evaluate Baseline Process Alternatives
- Determine Tradeoff Rule(s)
- Conduct Sensitivity Analyses
- Select Alternative(s) for Implementation

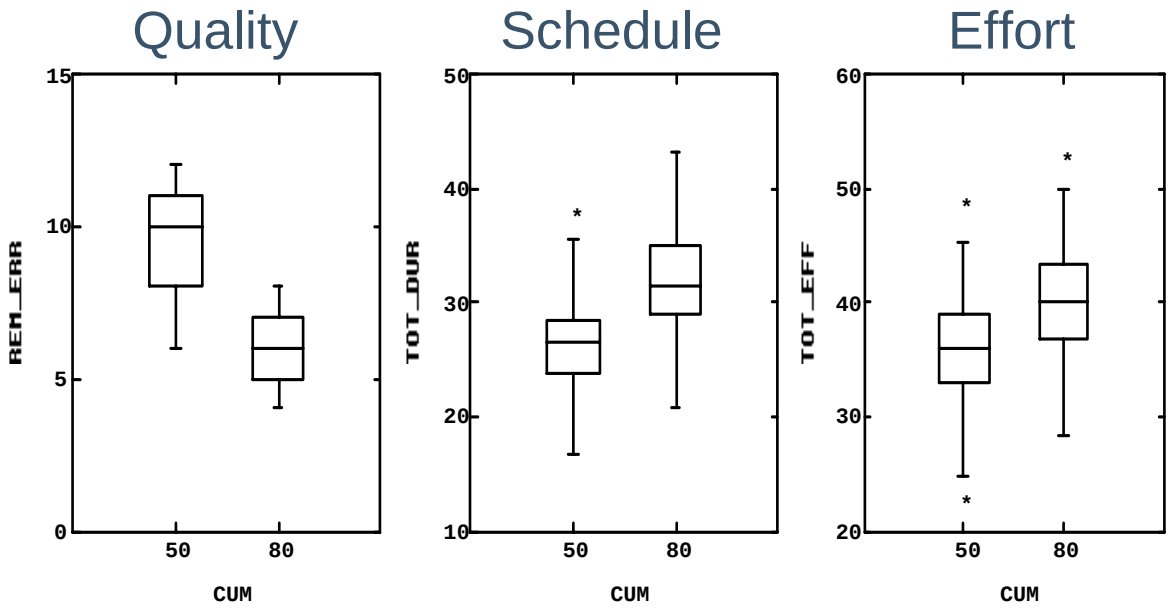
Project Level Outputs – Which Alternative to Choose?

CONFIG	Delivered Defects	Life Cycle Effort	Project Duration
W W N N	13.4	51.72	17.81
F F N N	12.6	52.83	17.26
W W N W	9.1	48.79	14.92
W W W W	6.6	47.25	12.85
F F F F	3.3	48.60	12.11

Comparison by Mean Difference

CONFIG	Reduced Defects	Reduced Effort	Reduced Duration
W W N N	0.00	0.00	0.00
F F N N	0.80	-1.11	0.55
W W N W	4.34	2.92	2.89
W W W W	6.82	4.47	4.96
F F F F	10.18	3.12	5.71

Case Study: Baseline Comparison



REM_ERR = Number of remaining errors; TOT_DUR = Total project duration (in days);
TOT_EFF = Total staff effort (in days); CUM = Cumulative error detection capability
(% of initial errors detected); 50 = "AS-IS" No Inspection Baseline; 80 = "TO-BE" Inspection Baseline

FIGURE 2 - PERFORMANCE MEASURE DISTRIBUTIONS

Analysis Phase

- Evaluate Baseline Process Alternatives
- Determine Tradeoff Rule(s)
- Conduct Sensitivity Analyses
- Select Alternative(s) for Implementation

Determine Tradeoff Rule(s)

Which alternative is best?

Need to reduce multiple performance measures to one decision statistic that can be used to rank process alternatives.

Possible Options

- Utility functions
- Financial measures (e.g. Net Present Value (NPV), Internal Rate of Return (IRR aka ROI), etc.)
- Optimization techniques (e.g. Data Envelopment Analysis (DEA))
- Analytic Hierarchy Process (AHP)
- Combination

Financial Measures of Performance

- Gets management interest (and excitement)
- Supports building a business case
- Trick is to convert performance measures to cash equivalents
- Examples:
  - Net present value (NPV)
  - Internal rate of return (IRR aka ROI), etc.
  - Discounted Payback period

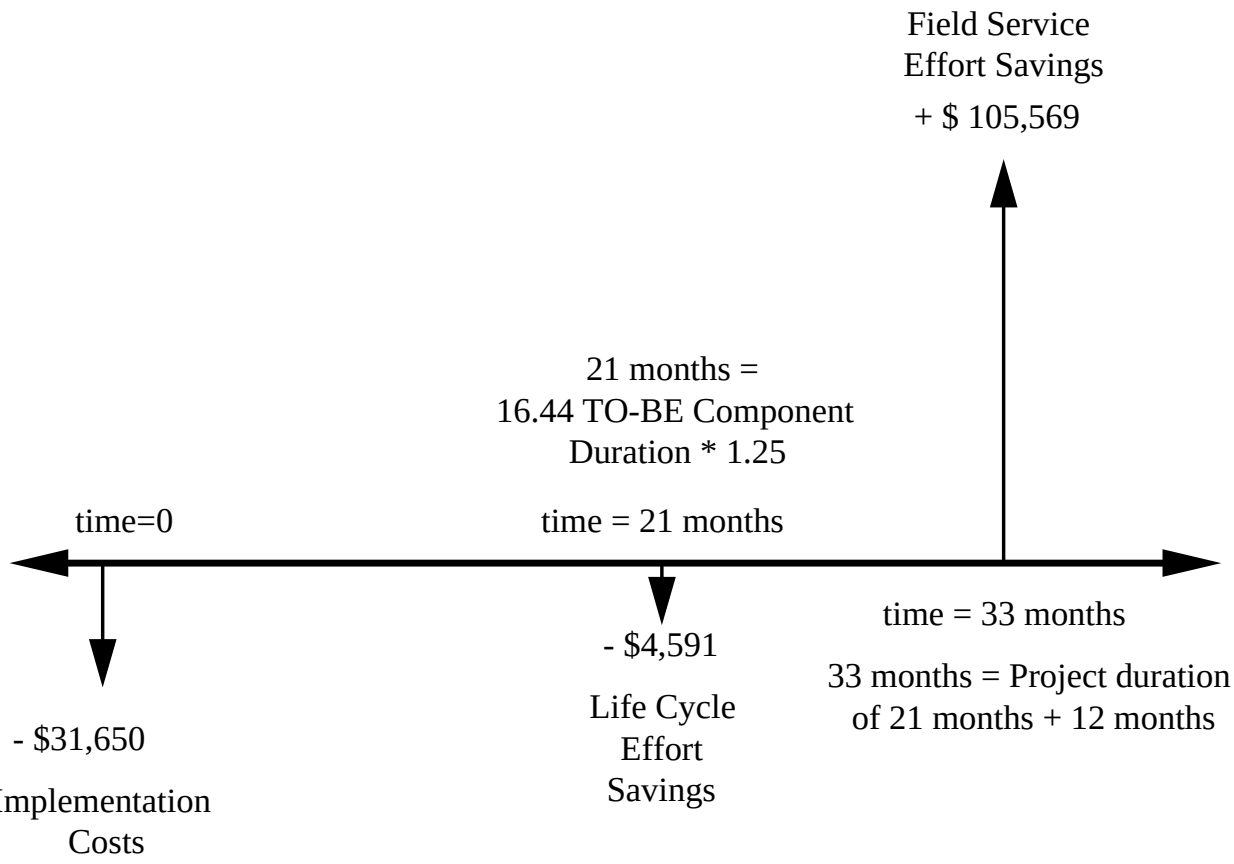
Determining Financial Benefits

- Need to reduce all benefits to cash equivalents
- Implementation costs are easy to include
- Effort is a straight forward conversion
- Some measures can be converted to effort (e.g. number of customer defects are converted to the effort to correct them)
- Other measures (e.g. time to market) can be difficult to convert.

Ranking by Financial Performance

Rank	CONFIG	NPV(15%) Mean	NPV(15%) STDev	PR(NPV<0) (Risk)
1	F F F F	$362,291.35	$118,344.45	0.11%
2	W W W W	$253,041.92	$68,513.12	0.08%
3	W W N W	$157,874.18	$44,518.84	0.09%
4	F F N N	$27,836.80	$26,910.00	15.15%
5	W W N N	$0.00	NA	NA

Case Study: Cash Flows



Case Study: Results

- The process change offered significant reductions in remaining defects, staff effort to correct field detected defects, and project duration. The expected ROI was 56% for a typical 30 KLOC release.

- Pilot implementations indicated that the process change provided a 37% ROI even under worst case conditions.

Analysis Phase

- Evaluate Baseline Process Alternatives
- Determine Tradeoff Rule(s)
- Conduct Sensitivity Analyses
- Select Alternative(s) for Implementation

Conduct Sensitivity Analyses

- "What if" analyses allow managers to apply the model to evaluate the proposed process change(s) under different business conditions and assumptions.

- Provides added insight and confidence into the potential process change

Case Study: Questions Investigated

- Will the process change improve project performance?
- What is the cost the firm is currently paying by conducting Unit Tests incorrectly?
- Is partial implementation of the proposed process change possible?
- How would potential learning curve effects affect the performance of the process change?
- Would alternative process changes offer a greater improvement?
- Can the project benefit from reusing process artifacts?

Case Study: Results Obtained

- Compressing Unit Test causes significant increases in schedule (+18%) and effort costs (+8%) during the later testing phases and reduces overall product quality(+48% increase in defects).
- Partial implementation of the process change is possible for complex portions of the code. Estimated ROI is 72%.
- Potential learning curve effects significantly enhance the performance of the process change. Expected ROI of 72% assuming only moderate improvements.

Case Study: Results Obtained

- Improving inspections would be a more effective process improvement than the Creating Unit Test Plans process change.

- Reusing the Unit Test Plans on the next development cycle provided an overall ROI of 73% (compared to 56% expected improvement without reuse)

Analysis Phase

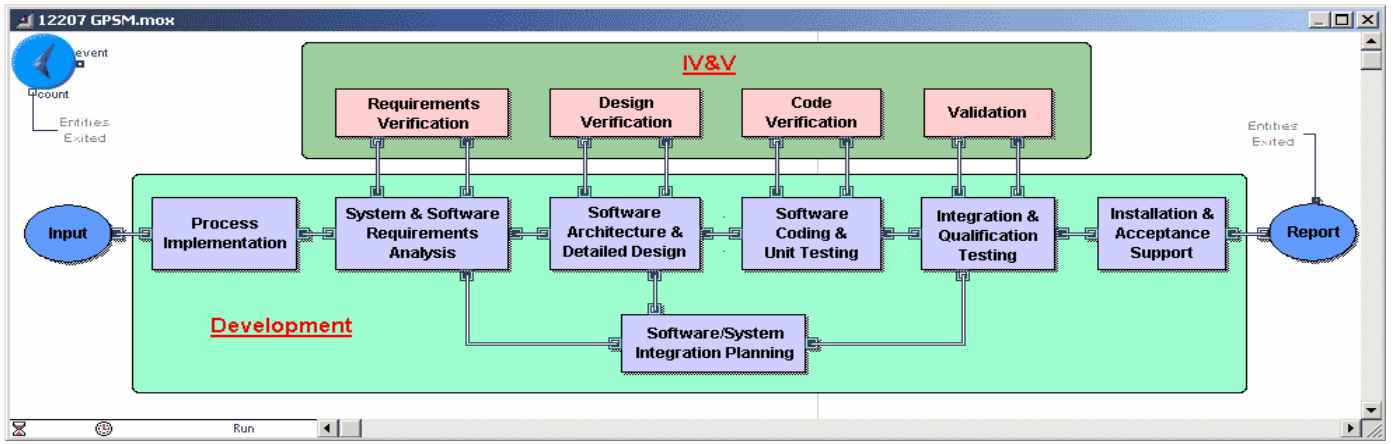
- Evaluate Baseline Process Alternatives
- Select Evaluation Method and Criteria
- Conduct Sensitivity Analyses
- Select Alternative(s) for Implementation

Select Alternative(s) for Implementation

- Process simulation can be used to estimate the ROI and risk
- Results are traded-off with other factors not included in the model such as budget and political considerations
- Utilize all the information at hand (quantitative and qualitative) to choose the best alternative

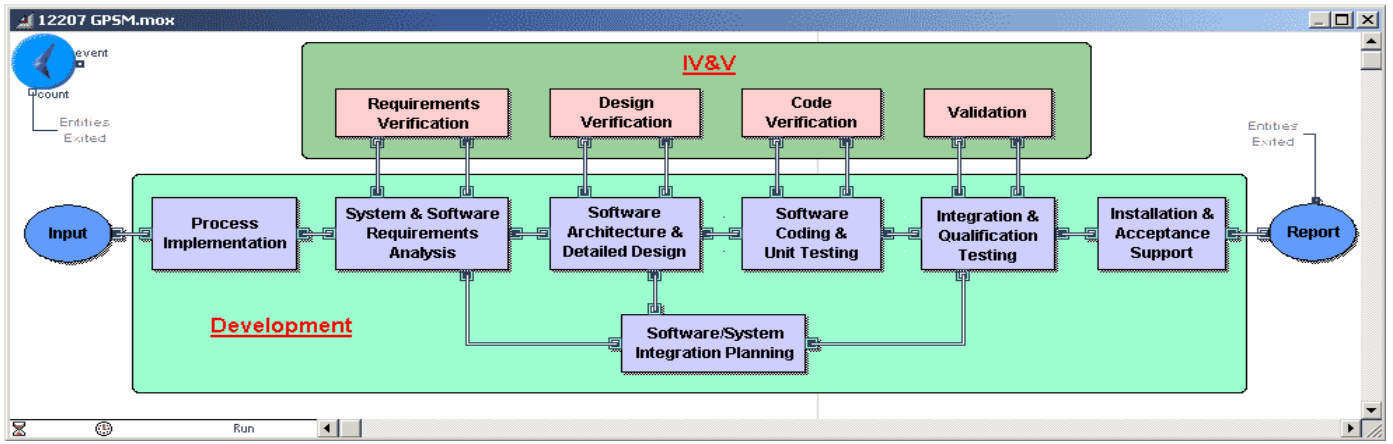
6 – Examples of Process Simulation Applications in Industry and Government

NASA IV&V



- Mission: To independently verify and validate software on all missions that are life critical or have significant vehicle cost involved.
- Problem: Limited resources to conduct IV&V. Critical need to deploy IV&V in most effective manner possible (biggest return on investment)
- Goal to optimize IV&V within a project and across projects.

NASA IV&V



Description of Model

- Based on IEEE 12207 Software Development Process
- Tuned for large-scale NASA projects (Size >100 KSLOC) (uses actual data)
- 8 major life cycle phases; 86 process steps
- Includes IV&V Layer
- Compares alternative IV&V configurations (ROI)

NASA IV&V

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Description of Model

- Based on IEEE 12207 Software Development Process
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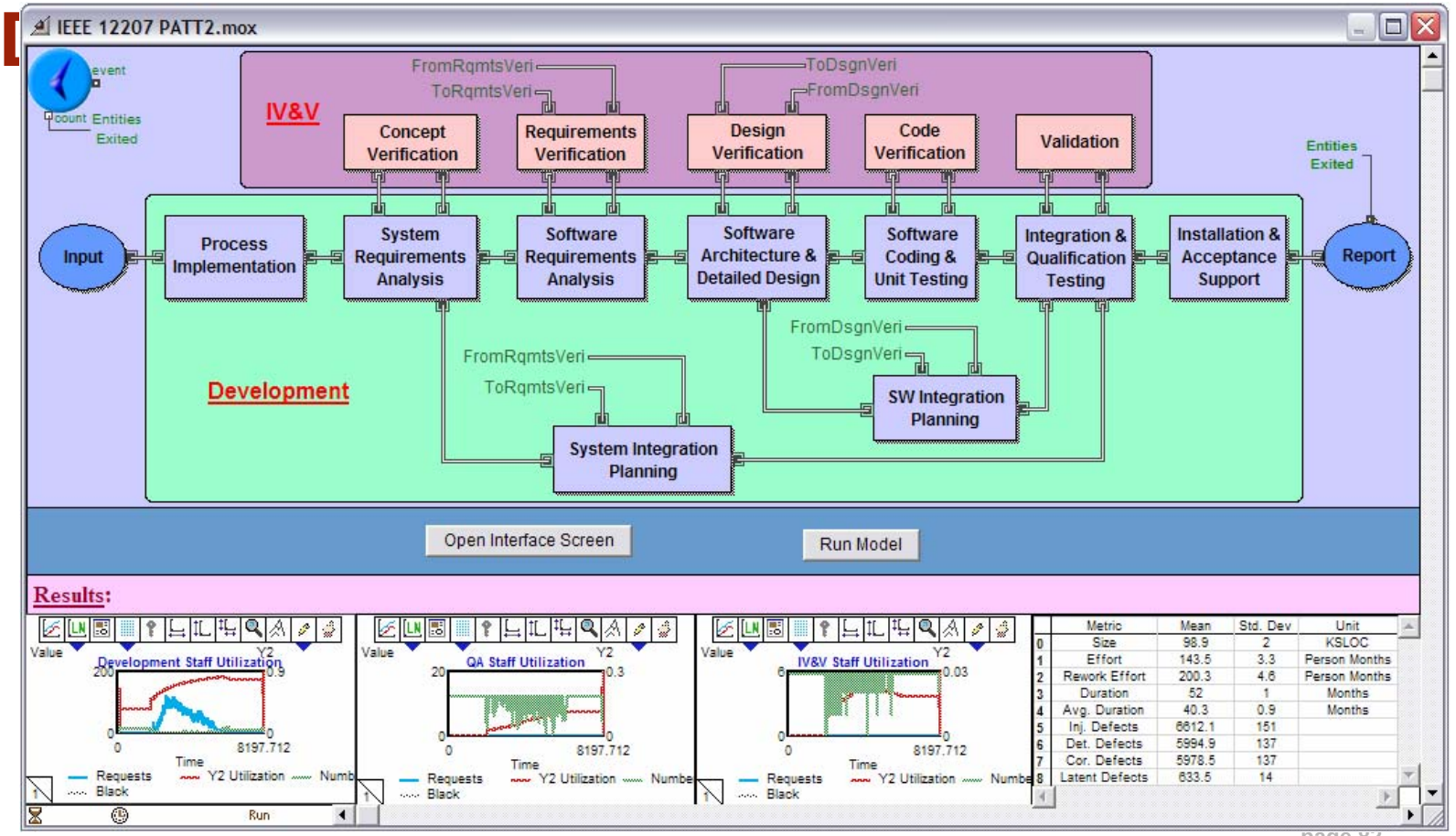
- 8 major life cycle phases; 86 process steps
- Includes IV&V Layer
- Compares alternative IV&V configurations (ROI)

NASA Model – Includes IV&V Layer with IEEE 12207 Software

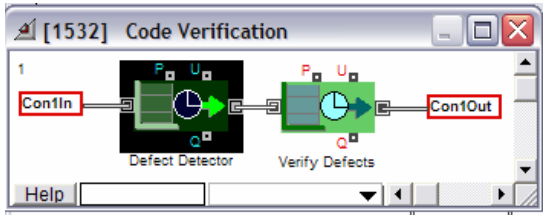


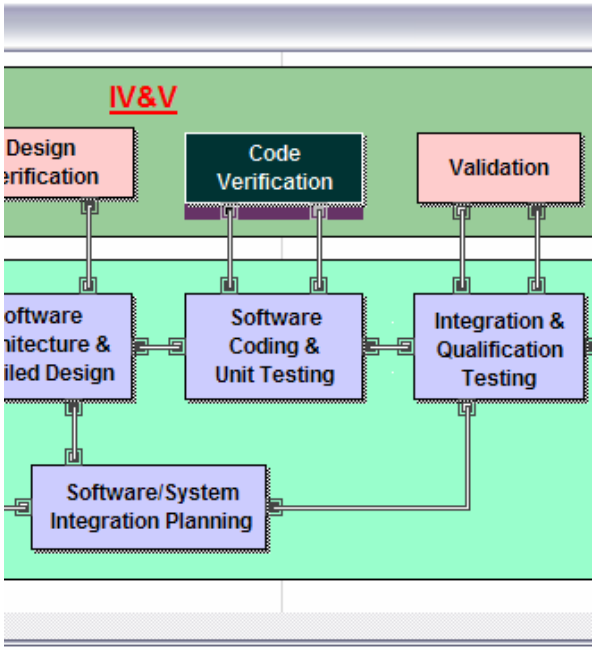
IV&V Layer – Select Criticality Levels for IV&V Techniques using pull-down

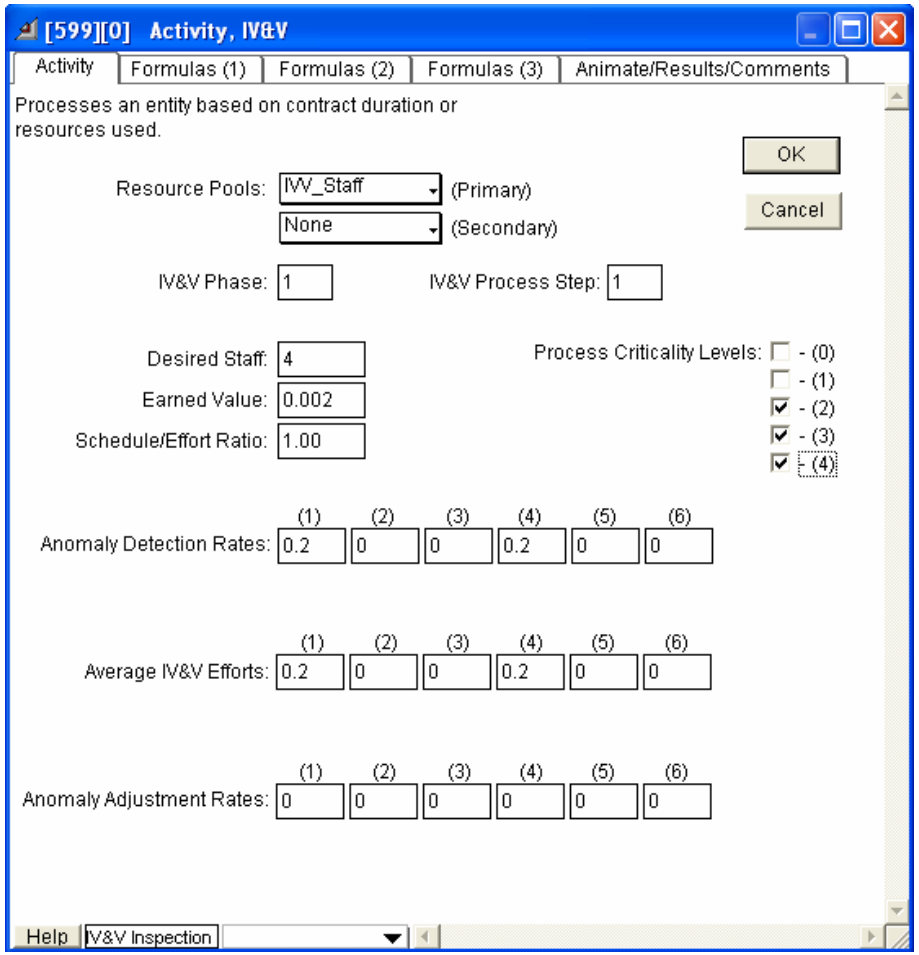
Notebook - IEEE 12207 PATT2.mox

		Concept Verification		Requirements Verification		Design Verification		Code Verification		Validation	
ID	IV&V Technique	Consequence	Error Potential	Consequence	Error Potential	Consequence	Error Potential	Consequence	Error Potential	Consequence	Error Potential
1.1	Management and Planning of Independent Verification and Validation	None	None	None	None	None	None	None	None	None	None
1.2	Issue and Risk Tracking	None	None	None	None	None	None	None	None	None	None
1.3	Final Report Generation	None	None	None	None	None	None	None	None	None	None
1.4	IV&V Tool Support	None	None	None	None	None	None	None	None	None	None
1.5	Management and Technical Review Support	None	None	None	None	None	None	None	None	None	None
1.6	Criticality Analysis	None	None	None	None	None	None	None	None	None	None
1.7	Identify Process Improvement Opportunities in the Conduct of IV&V	None	None	None	None	None	None	None	None	None	None
2.1	Reuse Analysis	None	None								
2.2	Software Architecture Assessment	None	None								
2.3	System Requirements Review	None	None								
3.1	Traceability Analysis – Requirements			None	None						
3.2	Software Requirements Evaluation			None	None						
3.3	Interface Analysis – Requirements			None	None						
3.4	System Test Plan Analysis			None	None						
4.1	Traceability Analysis – Design					None	None				

A Look Inside the Model…







What is IV&V?

- IV&V = Independent Verification and Validation
- Performed by one or more independent groups
- Can be employed at any phase with different levels of coverage

IV&V Techniques

- Traceability Analysis
- Software Design Evaluation
- Interface Analysis
- Criticality Analysis
- Component Test Plan Verification
- V&V Test Design Verification
- Hazard Analysis
- And etc.

Importance/Benefits – Enduring Needs

IV&V Level

- IV&V New Business Planning (Independent Bottoms-Up Cost Estimation for NASA Projects and for IV&V)
- IV&V Policy Research (IV&V strategies for alternative NASA Project types)
- IV&V Services Contract Bid Support
- IV&V Services Replanning
- Cost/Benefit Evaluation of new technologies and tools
- Space Science Data Mining

Macro IV&V Questions

- What is the optimal IV&V strategy for a given NASA project or NASA project type?
- What combination(s) of IV&V techniques enable us to meet or exceed the quality assurance goals for the system?
- Given a budget of “X” dollars, what IV&V activities should be conducted?
- What if the complexity or defect profiles for a particular project were different than expected?
- How is the duration of the IV&V effort impacted by the overall staffing level for the project?

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Preliminary Study

- Use the model to quantitatively assess the benefits of performing IV&V on software development projects

- Comparing benefit of applying IV&V activities at different phases and in combination

Impact of IV&V at Different Points in the Development Process

Result Comparison

Case	Configuration	Total Effort Mean (Person Months)	Rework Effort Mean (Person Months)	Duration Mean (Months)	Corrected Defects Mean (Number of Defects)	Latent Defects Mean (Number of Defects)
1	Baseline	346.26	201.65	58.42	6,038.26	629.48
2	IV&V at Validation	355.35	210.75	59.95	6,113.79	574.17
3	IV&V at Code	334.13	189.53	57.38	6,134.84	573.49
4	IV&V at Design	327.93	183.33	56.56	6,123.11	581.27
5	IV&V at Requirements	326.82	182.21	56.40	6,078.87	600.04

% Improvement Compared to the Baseline

Case	Configuration	Total Effort Mean	Rework Effort Mean	Duration Mean	Corrected Defects Mean	Latent Defects Mean
1	Baseline					
2	IV&V at Validation	-2.63%*	-4.51%*	-2.63%*	+1.25%	+8.79%*
3	IV&V at Code	+3.50%*	+6.01%*	+1.77%	+1.60%	+8.90%*
4	IV&V at Design	+5.29%*	+9.09%*	+3.17%*	+1.41%	+7.66%*
5	IV&V at Requirements	+5.62%*	+9.64%*	+3.46%*	+0.67%	+4.68%*

Impact of IV&V Techniques in Combination

Result Comparison

Case	Configuration	Total Effort Mean (Person Months)	Rework Effort Mean (Person Months)	Duration Mean (Months)	Corrected Defects Mean (Number of Defects)	Latent Defects Mean (Number of Defects)
1	Baseline	346.26	201.65	58.42	6,038.26	629.48
6	IV&V at Code and Validation	342.14	197.54	58.78	6,203.66	524.96
7	IV&V at Req and Code	316.15	171.55	54.41	6,170.94	547.74
8	Two IV&V Techniques at Code	327.10	182.50	57.54	6,180.22	540.60

% Improvement Compared to the Baseline

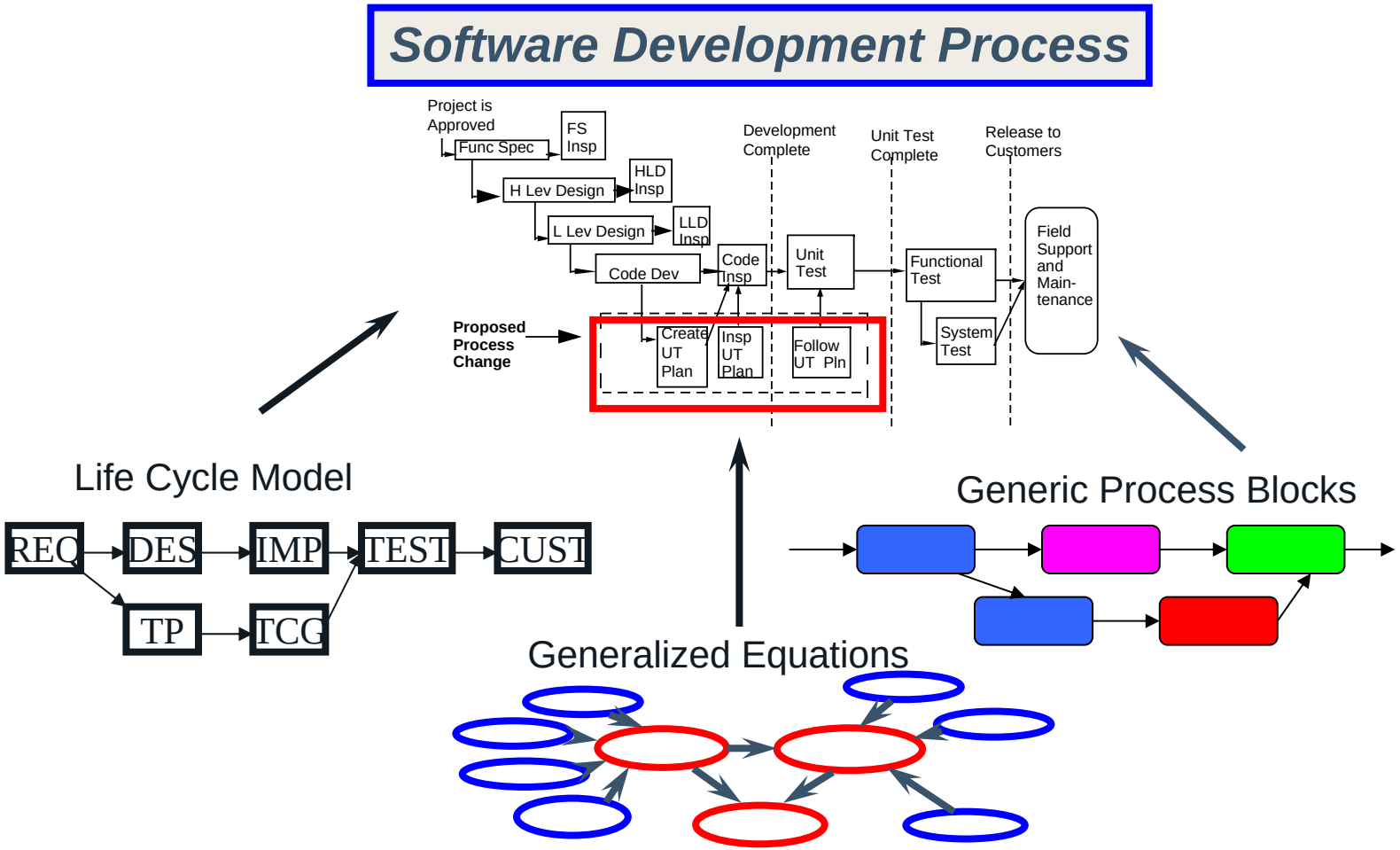
Case	Configuration	Total Effort Mean	Rework Effort Mean	Duration Mean	Corrected Defects Mean	Latent Defects Mean
1	Baseline					
6	IV&V at Code and Validation	+1.19%	+2.04%	-0.63%	+2.74%	+16.60%*
7	IV&V at Req and Code	+8.69%*	+14.93%*	+6.86%*	+2.20%	+12.99%*
8	Two IV&V Techniques at Code	+5.53%*	+9.50%*	+1.50%	+2.35%	+14.12%*

Rapidly Deployable Software Process Simulation Models and Training

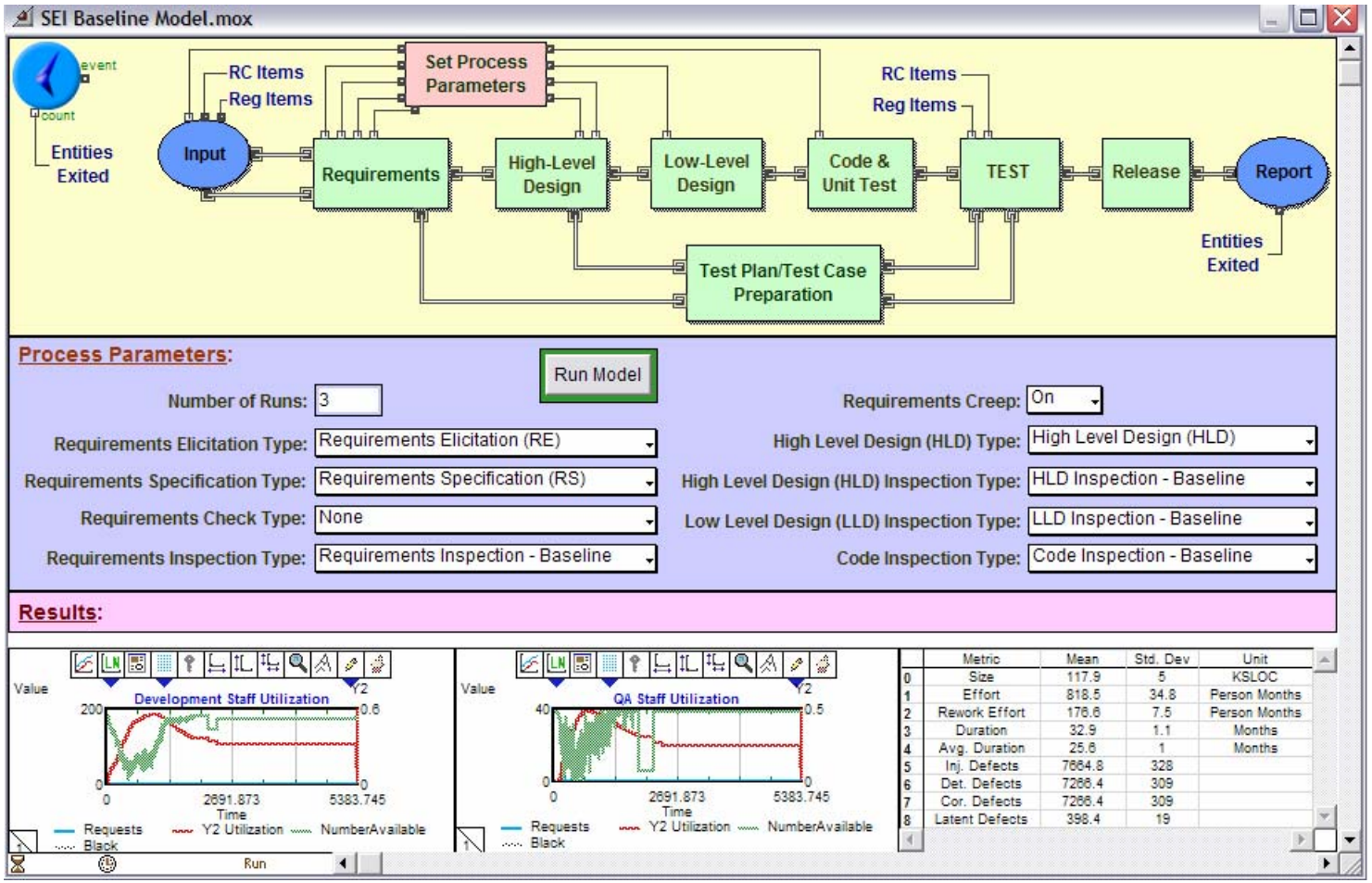
- Goal: To create a flexible decision support tool that can be easily used to support better project management, planning and tracking by quantitatively assessing the economic benefit of proposed process alternatives.

- **Motivation: Companies need to get useful results from simulation models quickly.**

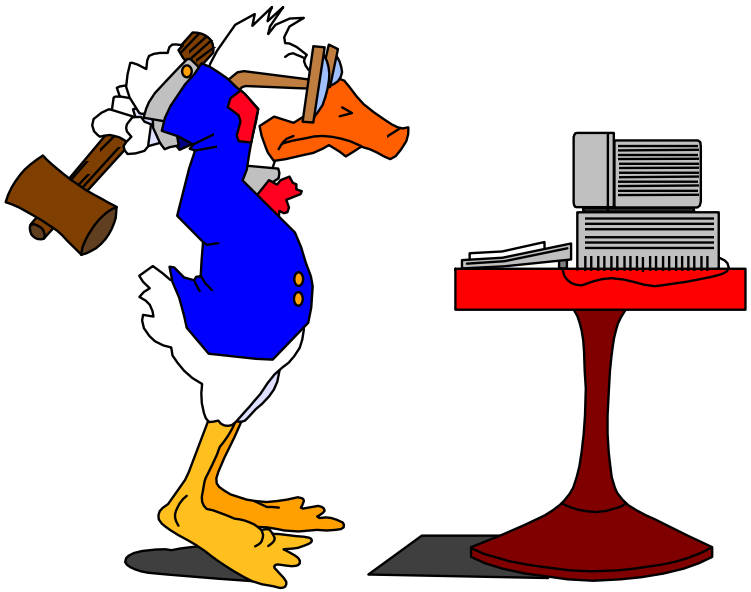
Rapidly Deployable Process Models



Simulation Dashboard



Demonstration



7 – Wrap up/ Conclusions

Conclusions

Process simulation modeling has been used successfully to quantitatively address a variety of issues from strategic management to process understanding.

Key benefits include:

- Decision Support and Tradeoff Analysis
- Sensitivity Analysis – “What if”
- Supports Industry Certification and process improvement programs including CMMI, Six Sigma, and others
- Supports CMMI at all levels 2 through 5
- Design and Define Processes
- Benchmarking
- Can address project manager concerns
- Supports project management and control

Conclusions

Process Tradeoff Analysis Method (PTAM) provides a tested approach for developing models and utilizing the results

Not a silver bullet

Focus on RAPID DEPLOYMENT

- ***Reducing costs and time to develop models***
- ***Making models easier to use – No simulation expert needed***

The End

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Calculating CMMI-Based ROI
Why, When, What, and How?

Rolf W. Reitzig – cognence, inc.

with contributions from:
Dennis R. Goldenson - SEI
Diane Gibson – SEI
Mark R. Cavanaugh - IBM

5th Annual CMMI Technology Conference & User Group
November 14, 2005
Denver, CO

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Agenda

1. **Introductions and Logistics**
2. **Why?**
   Why should an organization attempt to calculate the ROI of CMMI-based efforts? Is ROI the right way to show financial value?
3. **When?**
   When should these ROI calculations be performed? When can you compare ROI results across organizations?
4. **What?**
   What information is needed in order to calculate ROI? What information is inappropriate?
5. **How?**
   How do organizations calculate ROI? How can they do it better?
6. **Wrap-Up**

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1 - Introductions and Logistics

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How often have you heard this....?

What is the value of process improvement to our organization?

Why CMMI?

What should we focus on?

How much is this going to cost?

What's in it for me?

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Overview

This tutorial is intended to be a basic introduction to calculating the costs and benefits of CMMI-based process improvement

We'll discuss estimating, tracking, and validating ROI over the course of a CMMI improvement effort

You'll be introduced to several ways to calculate ROI, and the pros and cons of each

Implementation approaches, hints and tricks will be introduced to help you really make this work!

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Logistics

Workshop Time/Duration

Rest Rooms

Breaks

Smoking Rules

Phones

Messages

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ROI can be calculated many ways

There is no single, official “definition” of ROI – it can be calculated in many ways.

Some of these include:

- Benefit/Cost ratio (typically considered ROI)
- Net Present Value (NPV)
- Internal Rate of Return (IRR)
- Payback Period (PP)/Break Even Point (BEP)

A <u>complete</u> ROI analysis includes all of the above.

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The Value of CMMI Improvement

Average software organizations spend 65% or more of their engineering dollars addressing quality problems!

This means that only 1/3 of the organization is actually creating something.

Leading software organizations can reduce this Cost of Quality to 40% or less, resulting in 50% or more gains in productivity.

Numerous CMM case studies conclusively demonstrate the value that can be achieved.

A rapidly growing number of CMMI case studies are duplicating & exceeding these results.

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Examples

Reduced cost of poor quality from over 45% to under 30%
- 2:1 ROI over 3 years (Siemens Information Systems Ltd, India)

$2.1 Million in savings in hardware engineering processes
(Reported under non disclosure)

Reduced software defects per million delivered SLOC by over 50% compared to defects prior to CMMI
(Lockheed Martin Systems Integration)

Reduced defect rate at CMMI ML5 approximately one third compared to performance at SW-CMM ML5
(Lockheed Martin Maritime Systems & Sensors – Undersea Systems)

Avoided $3.72M in costs due to better cost performance
- As the organization improved from SW-CMM level 4 to CMMI level 5 (Raytheon North Texas Software Engineering)

2.5:1 ROI over 1st year, with benefits amortized over less than 6 months (reported under non disclosure)

Some Caveats!

No financial or accounting knowledge is assumed

The tutorial is not intended to be comprehensive, some topics are presented at a high-level only

In some cases, nuances of financial accounting and ROI determination are not addressed

We'll do our best to get you started without burying you in details!

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Audience

Executive/leaders of organizations seeking to understand the costs/benefits of CMMI-based process improvement and how to quantify them

Process improvement/EPG personnel seeking ways to communicate more effectively to senior management about the costs/benefits of CMMI-based process improvement

Personnel in organizations starting down a CMMI-based process improvement path

Project managers and engineers who need information to make better decisions about their project work.

Personnel in higher-maturity organizations seeking to transition to the CMMI, or implement higher-maturity process areas

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Introductions

Tutorial leader introductions

Participant introductions

- Name
- Company
- Position
- Expectations
  - What do you want to get out of the tutorial?
  - Do your expectations match the tutorial agenda?
  - How can we best address your concerns?

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Tutorial Approach

Interactive Presentation

Examples

Exercises

Questions and Answers

Participate!!!

2 – Why?

i. To develop the business case for process improvement
ii. Need to communicate to decision makers who understand the language of money, not CMMI
iii. ROI is the only way to show financial value

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Business Context

The first question to answer is “what is the business context in which we’re undertaking a CMMI effort?” Is it because we want to:

- Do things better, faster, cheaper?
- Increase contract award fees?
- Secure more contracts?
- Improve product quality?

We’re going to focus on the quality, project management, and productivity implications of CMMI process improvement

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System Development Costs

Costs incurred to develop the product

Examples:

- Requirements development
- Design
- Product development + unit test
- Project management
- Engineering infrastructure
- Purchased components

What isn't on this list?

Cost of Quality (CoQ) Concept

Developed by J.M. Juran and applied successfully by companies like Toyota Motor Corporation to achieve competitive advantages through the development of better quality products

CoQ represents *all costs associated with poor quality*

Source: Juran's Quality Handbook

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Cost of Quality Appraisal Objectives

- Quantify quality costs in the language management understands – money
- Identify major opportunities for quality cost reduction
- Identify opportunities for reducing customer dissatisfaction and threats to product saleability
- Expand budgetary and cost controls
- Stimulate improvement through publication
- Improve ability to deliver more to the business/market
- Reduce the functionality gap versus the competition
- Provide executives with reasons to invest in engineering improvement
- **CoQ appraisals are an easy way to understand where money is spent and to gauge the effectiveness of an organization**

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Internal Failure Costs

Costs associated with defects that are found prior to transfer of the product to the customer

Examples:

- Design corrective action
- Design re-reviews
- Purchased component corrective action
- Purchased component re-test
- Defect reporting/tracking
- Defect fixing
- 2nd and subsequent integration testing iterations
- 2nd and subsequent system testing iterations

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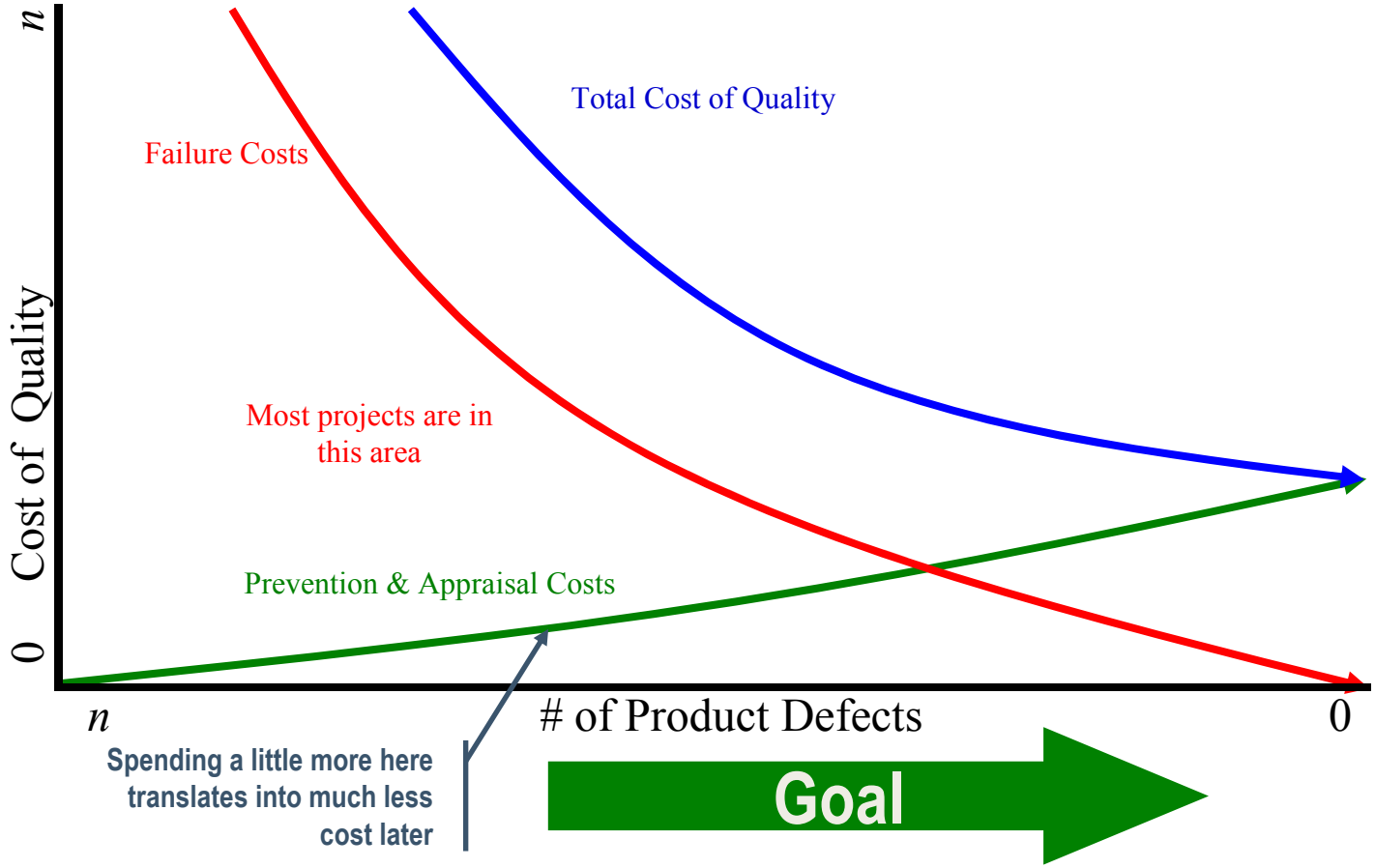
External Failure Costs

Costs associated with defects that are found after the product is shipped to the customer

Examples:

- Next release defect rework (maintenance)
- “Re-engineering”
- Technical support personnel
- Product returns
- Lawsuits
- Contract penalties
- Lost customers
- Lower marketplace perception
- Loss of pricing power
- Lost sales

Graphical Representation of CoQ



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Prevention Costs

Costs incurred to keep failure and (product) appraisal costs to a minimum

Examples:

- Quality planning
- Quality assurance
- Configuration management
- Supplier capability assessments
- Quality training
- Component/software reuse
- Requirements reviews
- Design reviews
- Code reviews
- CM tools
- External process appraisals/audits (CMMI, ISO, SPICE, etc)
- Process improvement efforts

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(Product) Appraisal Costs

Costs incurred to determine the degree of conformance to quality requirements

Examples:

- Purchased component testing
- Defect reporting/tracking
- Test automation systems/software
- First iteration integration testing
- First iteration system testing
- User acceptance testing

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Relating CoQ to Productivity

Decreasing an engineering organization's Cost of Quality directly impacts productivity:

- Fewer defects mean less time testing and reworking the product
- Less time testing means a shorter cycle time
- Shorter cycle time means more products can be developed in similar time frames
- Fewer defects also mean a smaller customer support staff – these resources can be applied to new product development

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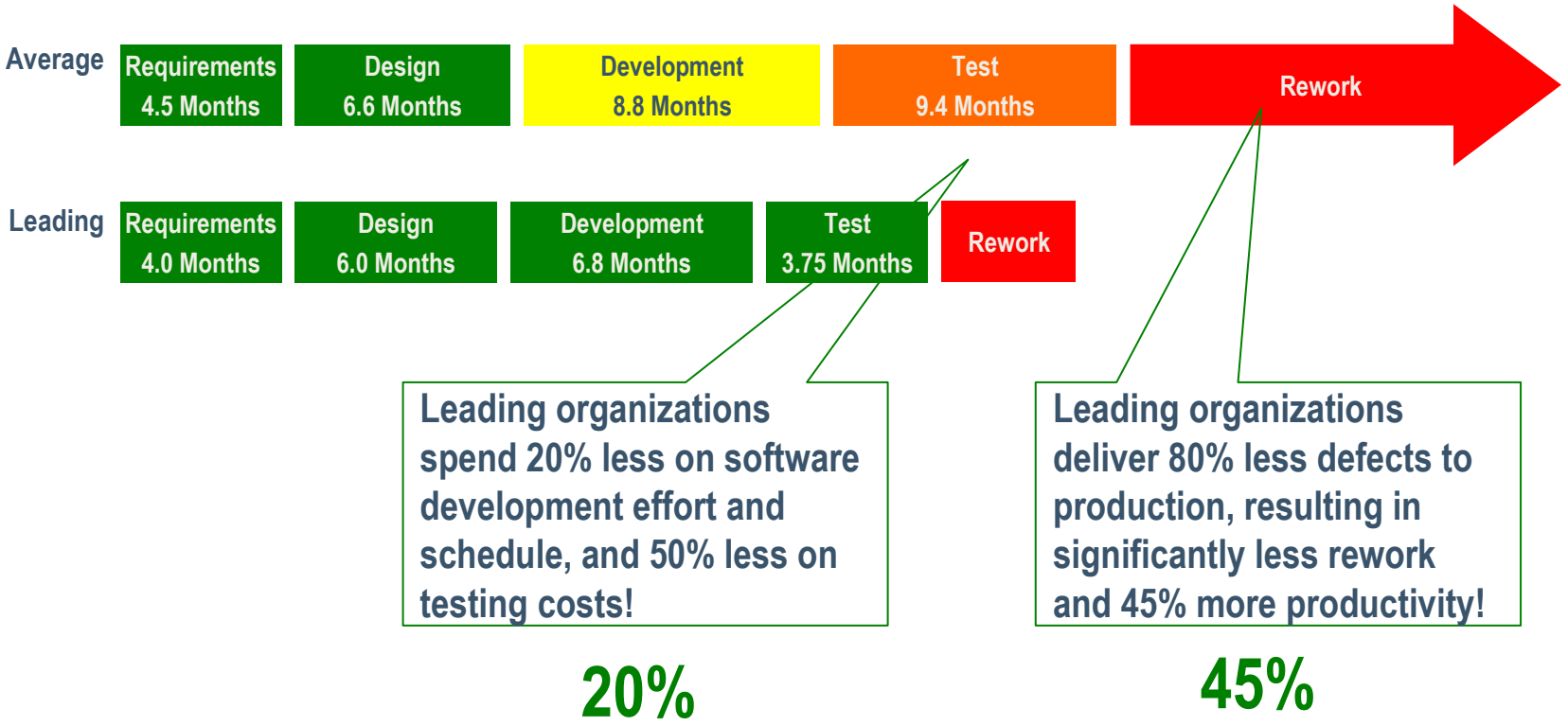
SW Example: 65% More Productivity



Average organizations spend 30% of project resources on testing, leading organizations spend 15%

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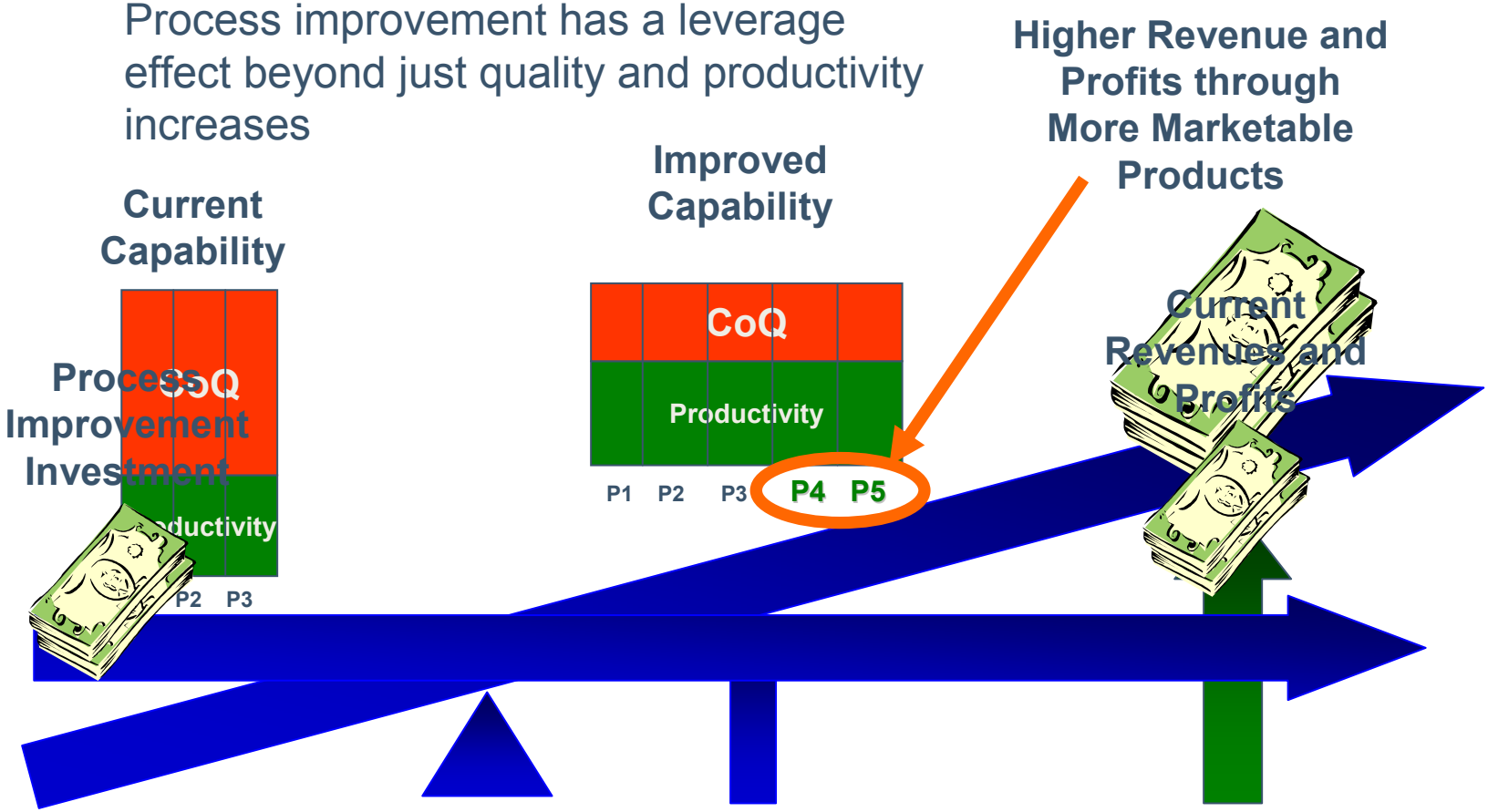
Leverage

Process improvement has a leverage effect beyond just quality and productivity increases



Communication

Executives, senior management, and other decision makers don't use CMMI language

- $ **Their language is money**
- $ Decision making is done in the context of money

  so.....
- $ Communicating the importance and effectiveness of CMM-based process improvement
- $ Champions must communicate in the language of executives – money

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Business Case

- Resources are scarce (especially $money$)
- It is impossible to execute on all opportunities available to the organization
- Executives want an “apples-to-apples” comparison of the various investment options available

Incorporating ROI analysis into a proposed or existing CMMI effort allows for comparison of efforts across seemingly disparate projects

And, the ROI of CMMI can be quite high

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Provide Focus and Tracking Capability

Performing an ROI analysis up-front (estimation) can

- focus the organization on concrete business objectives for CMMI process improvement,
- clarify how improvement efforts map to corporate objectives,
- establish expectations about results
- establish a baseline to track performance

Multi-year process improvement efforts need to maintain the business focus by continuously tracking

- $ the associated actual costs
- $ the related benefits

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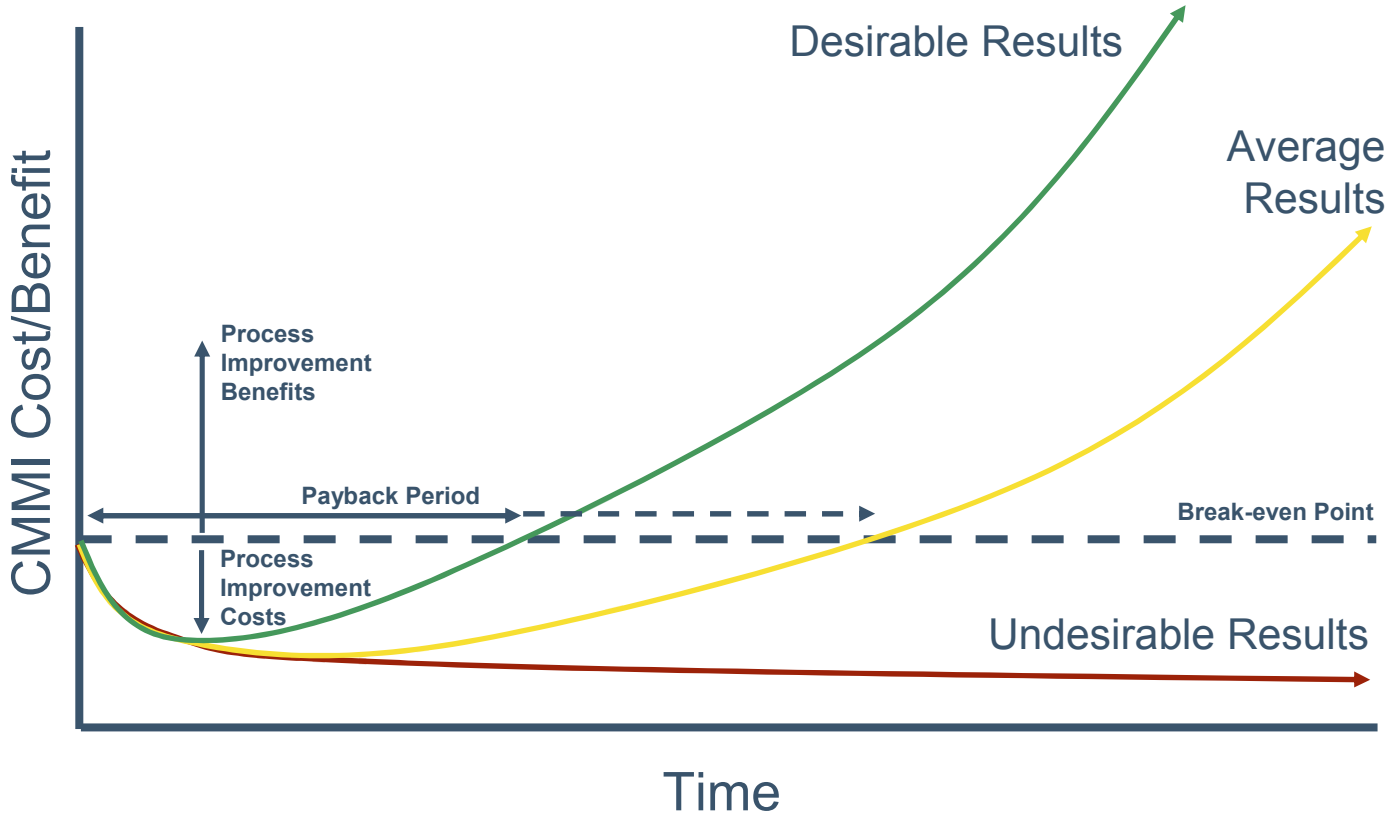
Drive Better Results



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Difficulties in Using ROI

Differing perceptions of ROI

Buy-In

Access to Data

Calculating benefits is tough

Consistently measuring ROI over time is tough

Organizations are resistant to measurement

Discussion

What other difficulties have you experienced in determining CMMI ROI? How did you overcome them?

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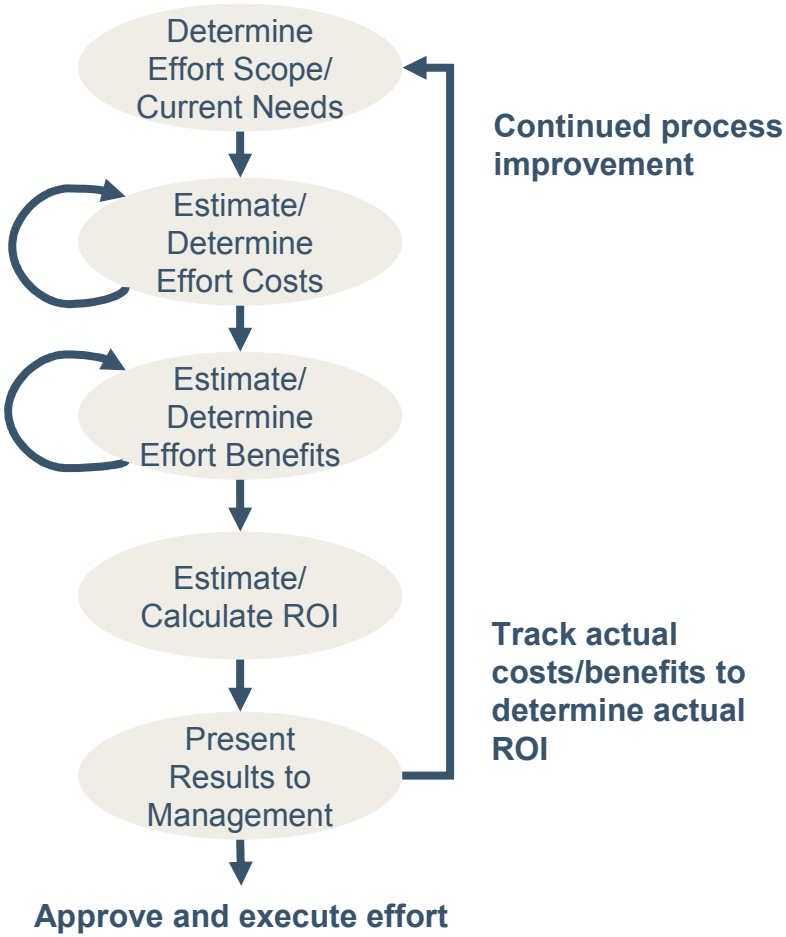
A Process for Determining ROI



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3 – When?

i. Before
ii. During
iii. After

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Before

Initially, it is VERY important to understand the potential value of a CMMI-based improvement effort to:

- Clearly understand the estimated costs associated with the effort
- Demonstrate the potential business value
- Provide a comparison against competing projects
- Establish a baseline for ongoing tracking and oversight
- Establish the expectations that benefits require time to develop, particularly for senior management
- Communicate with decision makers

At this time, other organizational indicators such as quality measurements, schedule adherence, customer satisfaction, etc. should be baselined.

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During

In order to track and maintain visibility, ROI should be tracked on an ongoing basis (perhaps every 6-12 months)

At the same time, intermediate indicators such as quality measurements, customer satisfactions surveys, etc. are tracked to determine the impact of improvement activities

Doing so demonstrates that the effort is on track from a cost perspective, and continues to keep the focus on the effort.

Additionally, early wins are communicated unambiguously in financial terms – something executives like to see.

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After

After a particular effort is completed, the ROI should be calculated to fully understand the true value of the effort.

This is needed to evaluate the financial effectiveness of the effort, create lessons learned, and set the stage for driving continuous improvement and institutionalization.

This forms the basis for the implementation of higher maturity process areas that support fact-based decision making.

In other words....

continuously,
throughout the entire effort!

Implementation of the Measurement and Analysis process area early in your adoption effort will facilitate this. It will also support your organization's comparison to applicable benchmarks as well as modeling and simulation.

4 – What?

i. All applicable direct costs should be identified
ii. As well, all direct benefits should be accounted for
iii. Indirect costs and benefits shouldn't be part of the analysis as they are difficult to attribute solely to the effort

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What information is needed.....

In its most basic definition ROI = A comparison of the costs and benefits of a process improvement effort across a specific organizational scope and time span.

You need to understand:

- Scope of the analysis
- Appropriate time horizon for analysis
- Relevant costs
- Financially quantifiable benefits

Remember, for a proper ROI analysis, all cost and benefit information needs to be calculated in terms of dollars and cents.

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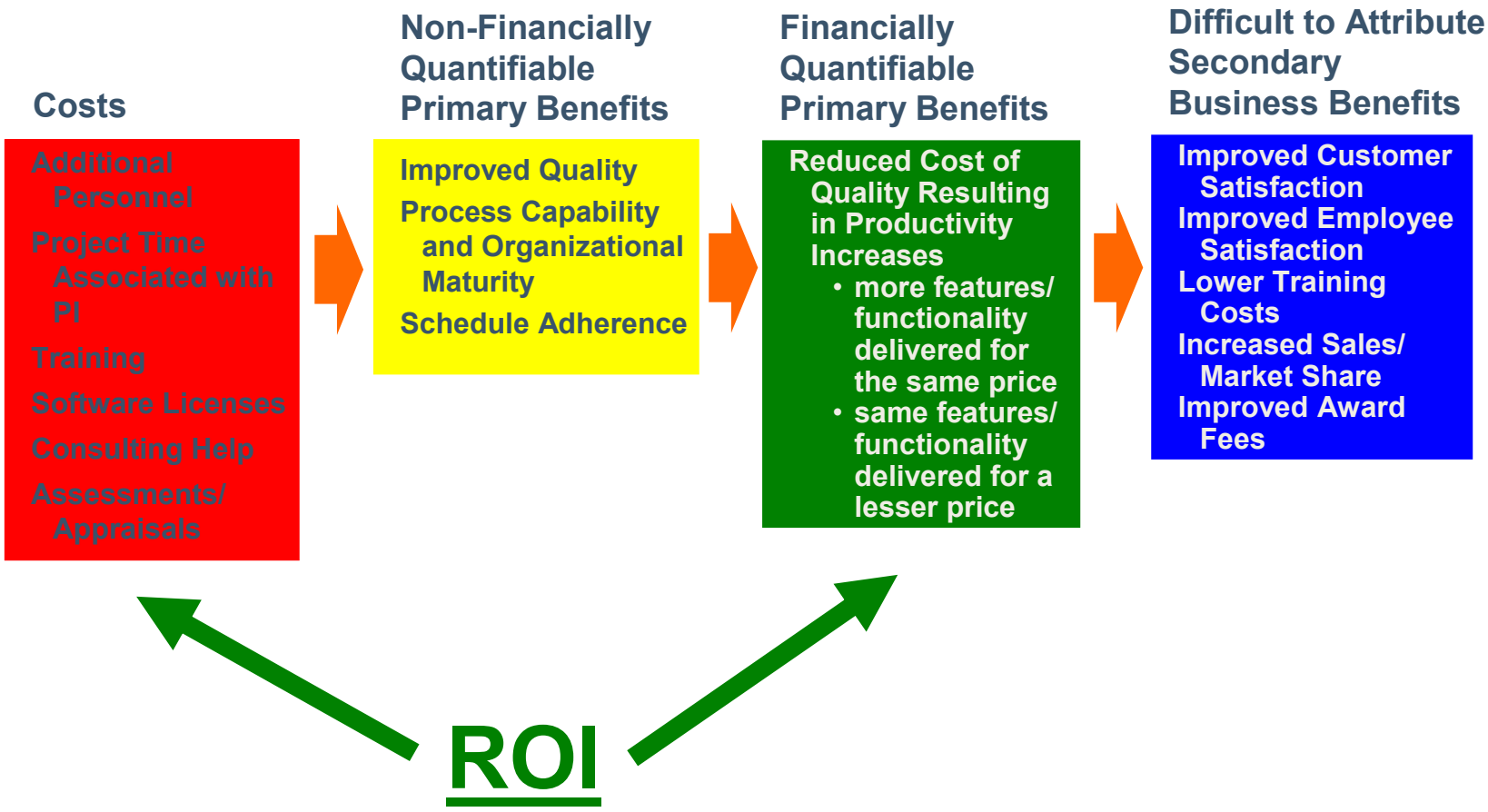
Process Improvement ROI Model



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Scope of Analysis

There are many ways to scope an ROI analysis.

- At the:
  - Organizational level
  - Project level
  - Process level
- Examples include:
  - Moving from CMM to CMMI
  - Introducing all practices associated with a particular PA
  - Implementing specific practices
  - Achieving a specific maturity or capability level
- **ROI calculations/equations won't change due to scope.**

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Time Horizon

Over how much time should an ROI analysis be performed?

Organizational - Generally, organizational efforts must show net value over a 2-3 year time period and unambiguous incremental value in shorter time frames.

Project/process - must show value in a shorter period of time.

It is probably unrealistic in most circumstances to demonstrate meaningful and measurable benefit in less than 3 months time due to:

- Need to develop/implement processes
- Train organizational units
- Institutionalize the improved processes

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Scope: Exercise

At this point, we'll begin working though our fictitious example of:

- Organizational CMMI improvement effort
- 150 person engineering organization at maturity level 1
- Looking to reach maturity level 2 in 18 months
- No EPG or QA in place
- Experiencing a Cost of Quality of 65%

In the exercise, we'll utilize an ROI calculation worksheet that guides the type of information we need to consider.

First off, we need to define the scope of the effort

What Costs and Benefits?

What **costs** do you need to track?

What **benefits** are you expecting to realize?

When will costs and benefits be incurred?

How will these come together to generate **ROI**?

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Key Factors

Generating Cost & Benefit Data, you need to be aware of:

- Consistency
  - in gathering over time
  - in matching costs and benefits
- Clear & detailed operational definitions
- Clearly understanding **incremental** costs and benefits
- Costs and benefits defined in financial terms

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Direct People Costs of CMMI Improvement

Costs of Process Definition / Improvement	
Process definition & documentation	Interviews, meetings
MSG, EPG, TWGs	Attendance in training
Management of the effort	Process implementation
Consulting	Process institutionalization
Additional personnel	Process adherence
Project team diversion	Assessments/appraisals
Communication	Rewards and recognition

Generally counted as salary & benefit costs associated with people's time

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Direct Non-People Costs of CMMI Improvement

Costs of Process Definition / Improvement	
Tools	PAL, Measurement Repository
Training	

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Indirect Costs of CMMI Improvement

Costs of Process Definition / Improvement	
Loss of organizational/project team productivity	

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Other Costs to Think About

Rework due to poor quality • Prior to shipping • After shipping
Poor project cycle time
Lack of schedule predictability

Rather than consider these expenses on the "cost" side of the ROI analysis, we'll consider improving them to be part of the "benefits" side.

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Costs: Exercise

- Organizational CMMI improvement effort
- 150 person engineering organization
- Looking to reach maturity level 2 in 18 months
- No EPG or QA in place
- Experiencing a Cost of Quality of 65%

Which costs should we plan and account for?

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Direct Benefits

Reductions in:	Improvements in:
Defects	Process adherence
Rework	Quality
Effort/overtime	Product features
Schedule cycle time	
Product costs	
Production costs	
Support costs	

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Indirect Benefits

Reductions in:	Improvements in:
Training costs	Employee satisfaction/retention
	Customer satisfaction/retention
	Revenue
	Award fees
	Market share

Discussion

Most direct process improvement benefits can be financially quantified in terms of productivity increases

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So, How Do We Measure Productivity?

The definition of Productivity is the number of outputs delivered for a certain number of inputs.

For systems engineering, the inputs are typically people-related.

The outputs however, can vary significantly, and are difficult to compare against each other:

- Missile system
- Copy machine
- Cell phone
- Function points or SLOC (for software)

The easiest way to help understand the notion of productivity in an engineering organization is Juran's Cost of Quality concept.

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Measuring Non-Financial Benefits

As discussed, there are many non-financial benefits with different ways to measure them.

It is important to measure non-financial benefits on an ongoing basis as part of the effort in order to keep focus on other indicators of progress or value.

Keep in mind that measuring these in non-financial terms doesn't directly impact the ROI calculation.

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Using Benchmarks to Estimate

To aid in determining what costs and benefits may be expected, consider the use of industry benchmarks. For example:

- Gartner research shows software organizations spend 3% - 5% on CMMI process improvement efforts
- CMM maturity level 1 organizations typically experience a Cost of Quality of 65%
- CMM maturity level 3 organizations typically experience a Cost of Quality of 40%

Baselining the organization and using benchmarks to compare against helps in building a credible ROI calculation.

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Using Simulation to Estimate

Engineering process simulation models focus on the dynamics of engineering development and maintenance.

Modeling and simulation of the significant features of engineering processes facilitates experimentation, answer "what-if" questions, and perform sensitivity analysis.

By modeling an organization's current engineering processes and simulating improvements to them, costs and benefits can be better estimated and determined.

Example: would the cost of source code inspections add value if the input source code had an abnormally high degree of errors?

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Benefits: Exercise

- Organizational CMMI improvement effort
- 150 person engineering organization
- Looking to reach maturity level 2 in 18 months
- No EPG or QA in place
- Experiencing a Cost of Quality of 65%

Benchmarks indicate that an organization operating at maturity level 2 can reduce its Cost of Quality to 50%

How can we quantify these benefits?

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Levels of Data Fidelity

The level of detail you go to in an ROI analysis will depend on the size of the effort

Multi-million dollar CMMI efforts in larger organizations will most likely require a greater degree of data fidelity than a smaller, more tactical solution on just one project.

Understand the level of fidelity needed to make a **credible** ROI analysis. Don't blow your chance with a shallow case if decision makers are expecting more details.

"Test run" your assumptions and analysis with peers and other managers before presenting the final results.

5 – How?

i. There are several ways to calculate ROI

ii. Using multiple methods provides for a multi-faceted view and allows for better decision making

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ROI can be calculated many ways

There is no single, official “definition” of ROI – it can be calculated in many ways.

Some of these include:

- Benefit/Cost ratio (typically considered ROI)
- Net Present Value (NPV)
- Internal Rate of Return (IRR)
- Payback Period (PP)/Break Even Point (BEP)

A <u>complete</u> ROI analysis includes all of the above

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Match Cash Flows and Don't Double Count

Costs must align appropriately with benefits

- Don't include costs or benefits that don't relate to each other
- Beware of "one-time" costs that should really be incurred over the entire ROI analysis time period
- Don't scope the effort's costs to a specific project but count benefits organizationally

No double counting

- For example, you can't count the value of an avoided defect *and* the productivity that's improved as a result

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Benefit/Cost Ratio

Benefit/Cost Ratio (typically considered to be ROI) is simply the ratio of benefits enjoyed by a certain effort divided by the costs incurred. i.e. 150%

Pros

- Fairly easy to compute
- Provides a “one number” method of comparing projects

Cons

- Doesn’t incorporate the Time Value of Money (TVM)
- No way to know the dollar magnitude of the return
- Don’t know how long the return took to achieve

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Benefit/Cost Ratio

	Year 0	Year 1	Year 2	Total
Costs	$300	$100	$100	**$500**
Benefits	$0	$500	$500	**$1000**
Return	-$300	$400	$400	$500

Benefit/Cost Ratio in this example would be 2:1 or 200%

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Time Value of Money (TVM)

Benefit/Cost ratio, while valuable, doesn't take into account the concept of the Time Value of Money (TVM).

Simply stated, the value of a dollar is less in the future than it is now.

Question: If risk-free interest rates are 10%, how much would you pay me now for $100 in 3 years?

Time Value of Money (TVM)

Answer: $75.13

	Year 0	Year 1	Year 2
Principal	**$75.13**	$82.64	$90.91
Interest	$7.51	$8.26	$9.09
Total	$82.64	$90.91	$100

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Discounted Cash Flow (DCF)

To aid in corporate decision-making, the TVM is captured in Discounted Cash Flow (DCF) analysis.

In DCF analysis, future cash flows are discounted using either:

- The company's weighted average cost of capital (WACC)
- A "hurdle rate" consisting of the company's cost of capital adjusted by a risk premium appropriate for the type of project being analyzed

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Discounted Cash Flow (DCF)

This risk premium can be significant (30%+) in some cases!

	Year 0	Year 1	Year 2
Principal	**$45.52**	$59.17	$76.92
Interest	$13.65	$17.75	$23.08
Total	$59.17	$76.92	$100

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Net Present Value (NPV)

Net Present Value (NPV) takes both cost and benefit cash flows and discounts them appropriately using the company's cost of capital or hurdle rate.

NPV is described as a dollar value, allowing for seemingly dissimilar projects to be compared against each other.

Pros

- Articulates the dollar magnitude of the return
- Provides a "one number" method of comparing projects
- Incorporates TVM

Cons

- Not as easy to compute
- Don't know how long the return took to achieve

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Net Present Value (NPV)

With a 10% hurdle rate, our example looks like:

	Year 0	Year 1	Year 2	Total
Costs	$300	$100	$100	$500
Benefits	$0	$500	$500	$1000
Return	-$300	$400	$400	$500
Disc Return (NPV)	-$300	$363.63	$330.58	**$393.94**

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Internal Rate of Return (IRR)

IRR determines the intrinsic interest rate that summarizes the value of a series of cash flows. 0% indicates "break-even", positive percentage indicates a positive return while a negative percentage indicates a negative return.

Essentially determines the discount rate that results in NPV=0

Pros

- Provides a "one number" method of comparing projects that is independent of the company's WACC or hurdle rate

Cons

- No way to know the dollar magnitude of the return
- Don't know how long the return took to achieve
- In unusual cases, may provide multiple answers
- Not as easy to compute

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Internal Rate of Return (IRR)

In our example, the **IRR is 100%**

	Year 0	Year 1	Year 2	Total
Costs	$300	$100	$100	$500
Benefits	$0	$500	$500	$1000
Return	-$300	$400	$400	$500
Disc Return	**-$300**	**$200**	**$100**	**$0**

Payback Period/Break Even Point

Determines the amount of time it takes for cash inflows to equal cash outflows, resulting in the *break even point*

Pros

- Indicates how quickly a project turns profitable

Cons

- No way to know the dollar magnitude of the return
- In unusual cases, may provide multiple answers

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Payback Period/Break Even Point

In our example, the PP/BEP is Year 1

	Year 0	Year 1	Year 2	Total
Costs	$300	$100	$100	$500
Benefits	$0	$500	$500	$1000
Return	-$300	$400	$400	$500
Net Return	-$300	**$100**	$500	$500

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Exercise

- Organizational CMMI improvement effort
- 150 person engineering organization at maturity level 1
- Looking to reach maturity level 2 in 18 months
- No EPG or QA in place
- Experiencing a Cost of Quality of 65%

How do the various ROI calculations turn out for our exercise?

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6 – Wrap-up

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Implementation Issues

ROI analysis won't necessarily improve a CMMI effort's results – you still have to execute!

In any process improvement effort, you should find ways to leverage organizational change best practices to overcome resistance to change.

Determining and tracking ROI as well as other measurements keeps the focus of the effort on the **business benefits**

Use the Measurement and Analysis process area early to put the focus on the business benefits from the start

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Discussion

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What Did You Learn?

1. Why?

i. To develop the business case for process improvement
ii. Need to communicate to decision makers who understand the language of money, not CMMI
iii. ROI is the only way to show financial value

2. When?

i. Before, During, and After

3. What?

i. All applicable direct costs should be identified
ii. As well, all direct benefits should be accounted for
iii. Indirect costs and benefits shouldn't be part of the analysis as they are difficult to attribute solely to the effort

4. How?

i. There are several ways to calculate ROI
ii. Using multiple methods provides for a multi-faceted view and allows for better decision making

5. Case Study

We went through a case-study where we estimated CMMI-based process improvement costs and returns over a 3 year time period, and explored the various ways of calculating the value of the effort over the 3 years.

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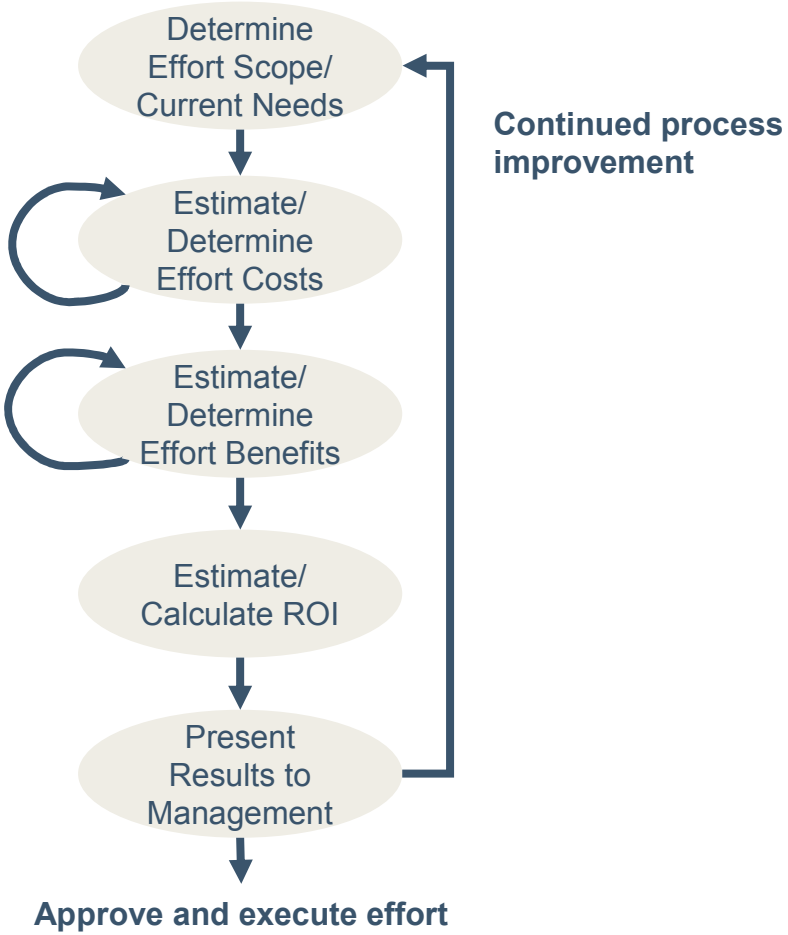
A Process for Determining ROI



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Parting thoughts: What's Next for You?!

Determining the monetary value of CMMI-based process improvement may appear to be difficult.

But it's not that hard.

- It does take disciplined effort
- You may have to build or buy the necessary organizational capabilities & resource capacities

And it's extremely important.

- Making informed decisions about how to invest scarce resources
- Sustaining commitment for disciplined process improvement

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Thank You!

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