BAE SYSTEMS

The Key Ingredients

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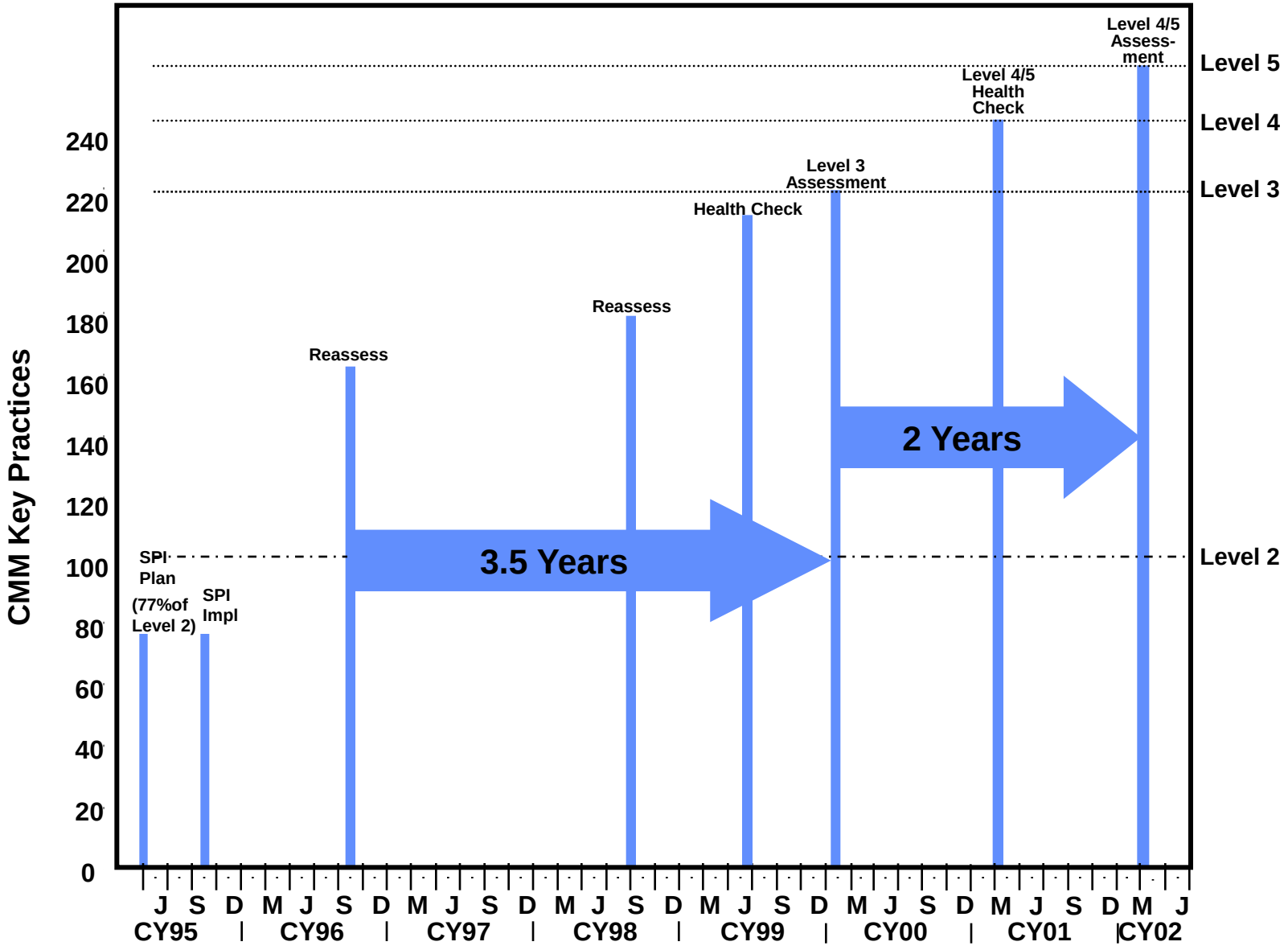
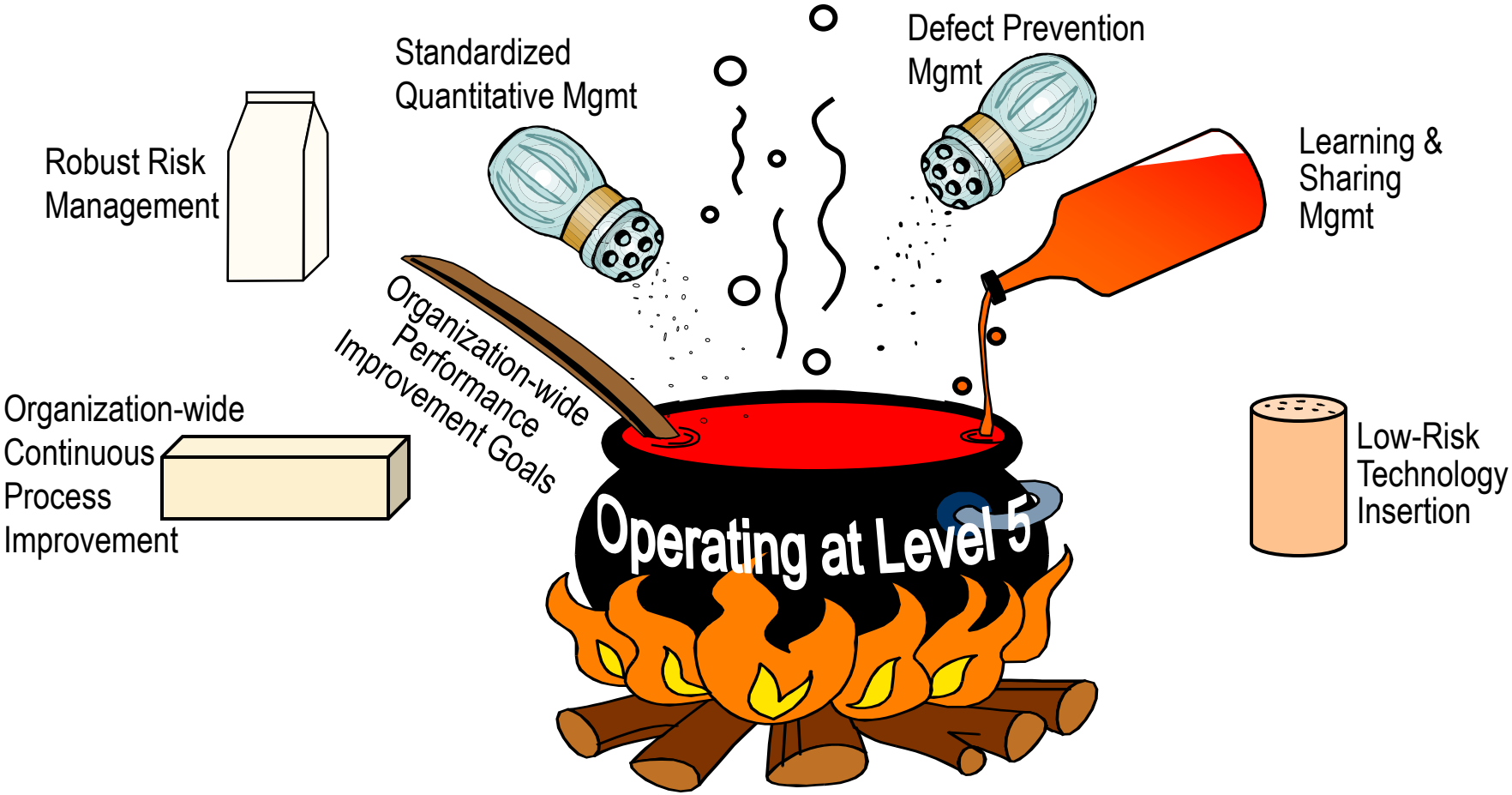
05 June 2003

Acknowledgement & Scope

- **This presentation is a shortened version of a keynote presentation Pete Howard – CNIR's Director of Software Engineering –presented at the European SEPG Conference**
- **Although the slides focus on software and the SW-CMM model, the principles are easily extendible to other engineering disciplines and the CMMI**

A Worthwhile Journey to Improve Software Capability

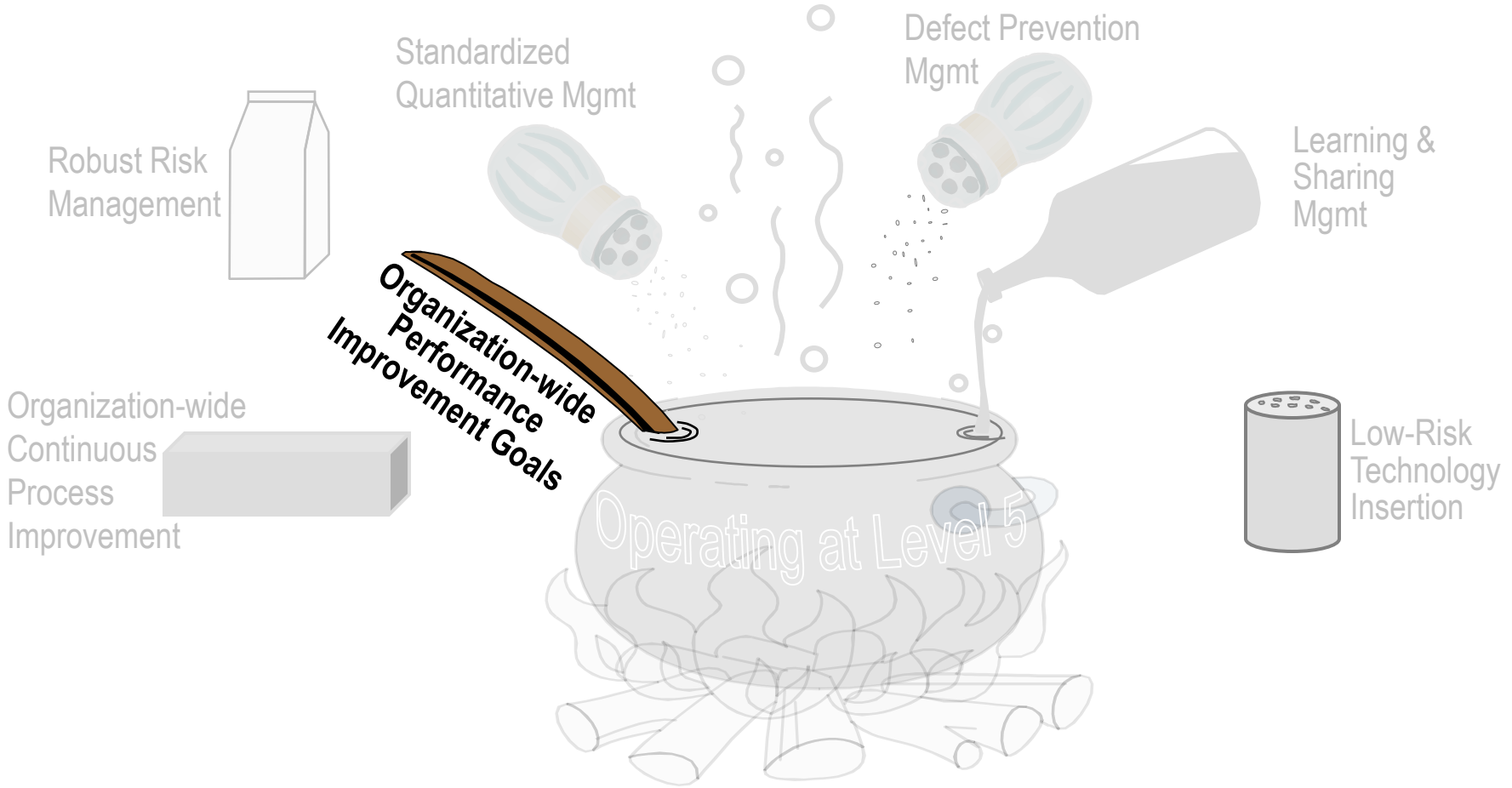




Improved Customer Satisfaction & Recognition

Improved Employee Satisfaction

Improved Results



Improved Customer
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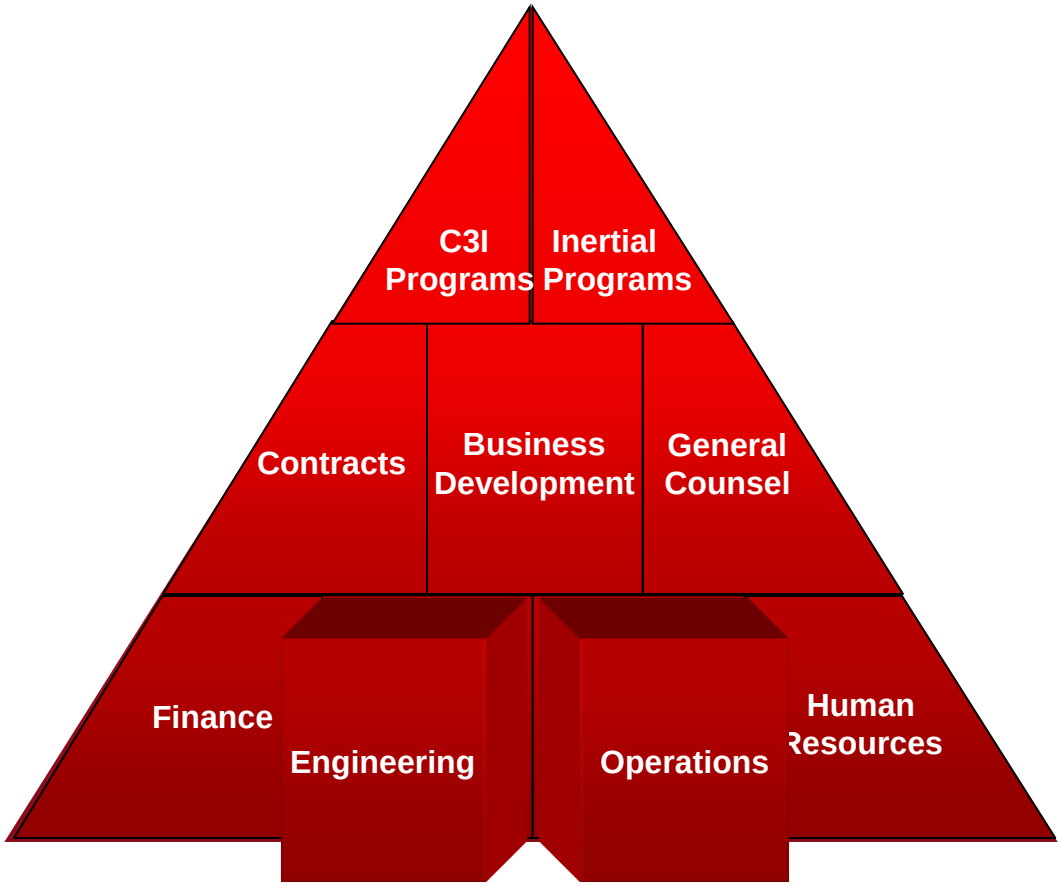
CNI Defect Reduction Improvement 9%



- Capture 70% defects, by phase, prior to test
- Reduce design review action item closure time and number of items
- Achieve 5.35 Sigma workmanship

Cycle Time Improvement 9%

2003 Engineering Goal	2003 Software Engineering Goal
1) For Systems/Hardware CT – propose methods for baseline, measurement, and reduction. Goal is to improve 9% 2) Reduce the number of systems undefined requirements at time of system review. Goal is to achieve < 5%. 3) Reduce number of unfunded requirements. Goal is to achieve zero.	1) Reduce software development cost by 6% in 2003, and another 6% in 2004 through the implementation of continuous process improvement activities. 2) Have no customer unfunded project requirements.

Defect Reduction Improvement 9%

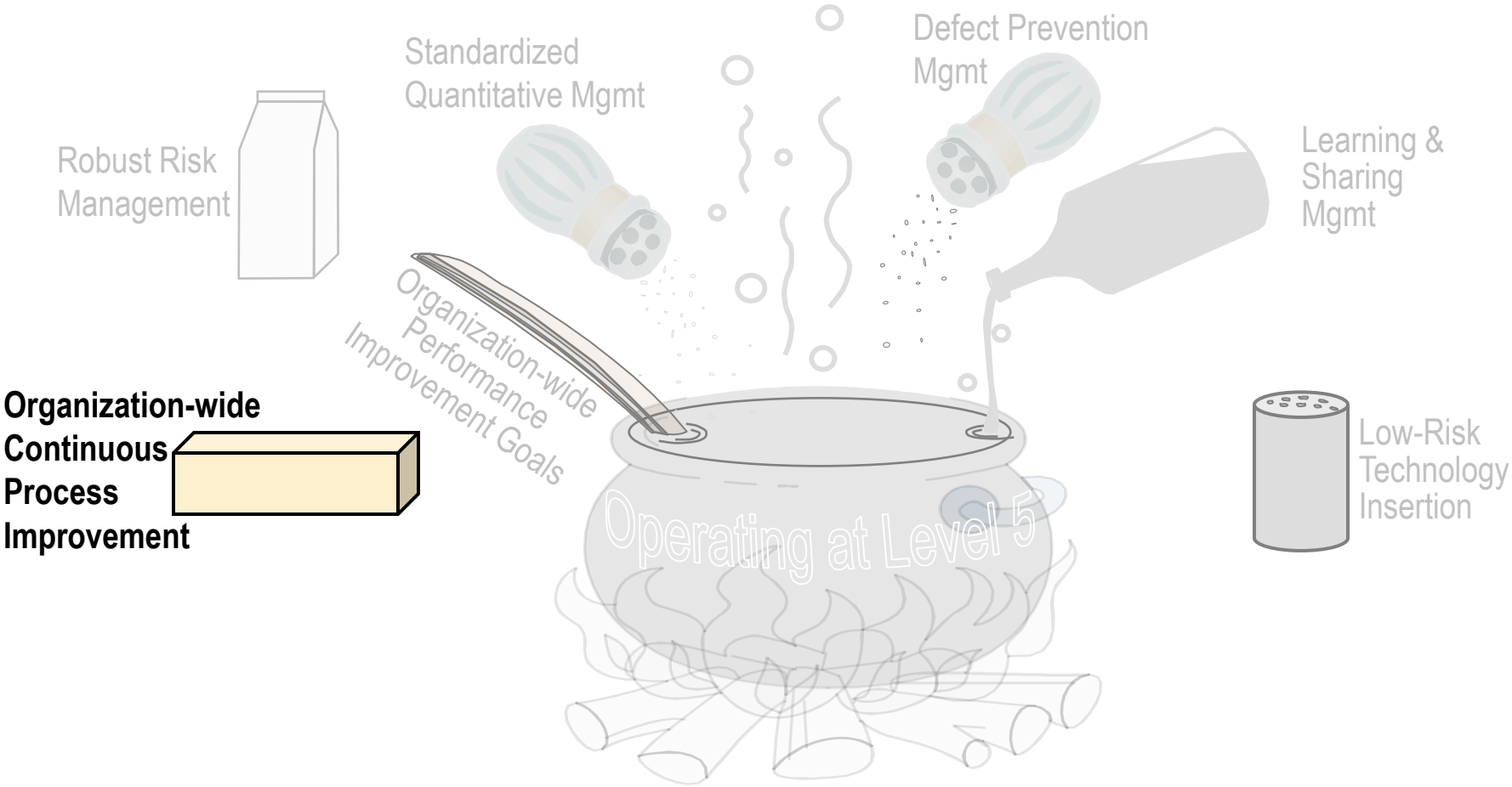
2003 Engineering Goal	2003 Software Engineering Goal
1) For requirements and design reviews, reduce the number of action items and reduce AI closure time to within 30 days, while achieving best balance with program schedule and cost. 2) Reduce the number of hardware design changes and improve escaping defect profile (systems requirements, design, build, test phases) to capture defects earlier in the life cycle. Goal is to detect 70% of defects prior to test. 3) Eliminate 80% of the software defects prior to software integration test. 4) Reduce number of software defects via root cause analysis. 5) Reduce number of post-delivery design defects. Goal is zero defects.	1) Maintain number of post delivery defects to < 0.5 defects/1000 SLOC. 2) Detect 80% of defects prior to software integration test.

Customer Satisfaction Improvement 3%

2003 Engineering Goal	2003 Software Engineering Goal
1) For Internal Customer Satisfaction: a) Reduce the corrective action closure time to 30 days. b) Reduce the number of corrective actions by 10%. 2) Improve percentage of Customer deliveries accomplished on time. Goal is 100%. 3) Perform within 5% of cost estimates (CPI).	1) Maintain on-time deliveries at 95% or higher. 2) Achieve Internal Customer Satisfaction Report (ICSR) Rating of 4.2 and close all Corrective Action Requests (CARs) within 30 days. 3) Perform within +/-5% of cost estimates. 4) Maintain average of 40 hours of training per software engineer.

Double the 9% Annual Growth Rate Through Strategic Initiatives

2003 Engineering Goal	2003 Software Engineering Goal
1) Leverage IRAD over multi programs for 25% savings through technical synergy and common investment. 2) Increased number of technical pursuit leads to support initiatives. 3) Show increased coupling of CRAD to IRAD investment. 4) Identify at least 3 advantages using other BAE technology. 5) Conduct SEI CMMI L3 in 2003. 6) Maintain SEI CMM Level 5 throughout 2003.	1) Develop DO-178B capability to support future Avionics Programs. 2) Maintain SEI CMM Level 5 3) Leverage Link-16 OOA/OOD IRAD activity into New Business opportunities. 4) Grow C4ISR business opportunities. 5) Develop additional supervisory capability and new business project leads in software engineering 6) Support SEI CMMI L3 in 2003.



Improved Customer Satisfaction & Recognition

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Improved Results

BAE SYSTEMS

Organization-Wide Continuous Process Improvement Coordinated by the Executive Staff

- Organization performance improvement goals established for all disciplines and flowed down into the organization
- Connection between Organization Improvement Goals and Project Improvement Goals and individual goals
- PACE Board is the Performance / Process Improvement focal point and coordinating body for the Executive Staff
- Multi-disciplined Management Steering Groups in all disciplines
- All personnel at all levels participate in continuous improvement
- Monthly review of Process Improvement Initiatives, Current Business and New Business connects improvement goals to project performance

PACE Board

- **Function**
- **Performance / Process Improvement focal point and coordinating body for the Executive Staff**
  - Comprised of senior level cross functional members
- **Ensure that continuous improvement methodologies are implemented across all business processes.**
- **Ensure coordination and cooperation across functional boundaries for all improvement initiatives.**
- **Monthly PACE Reviews by the Executive Staff**
  - Agenda reviews organizational progress against performance improvement goals

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Standardized Quantitative Management

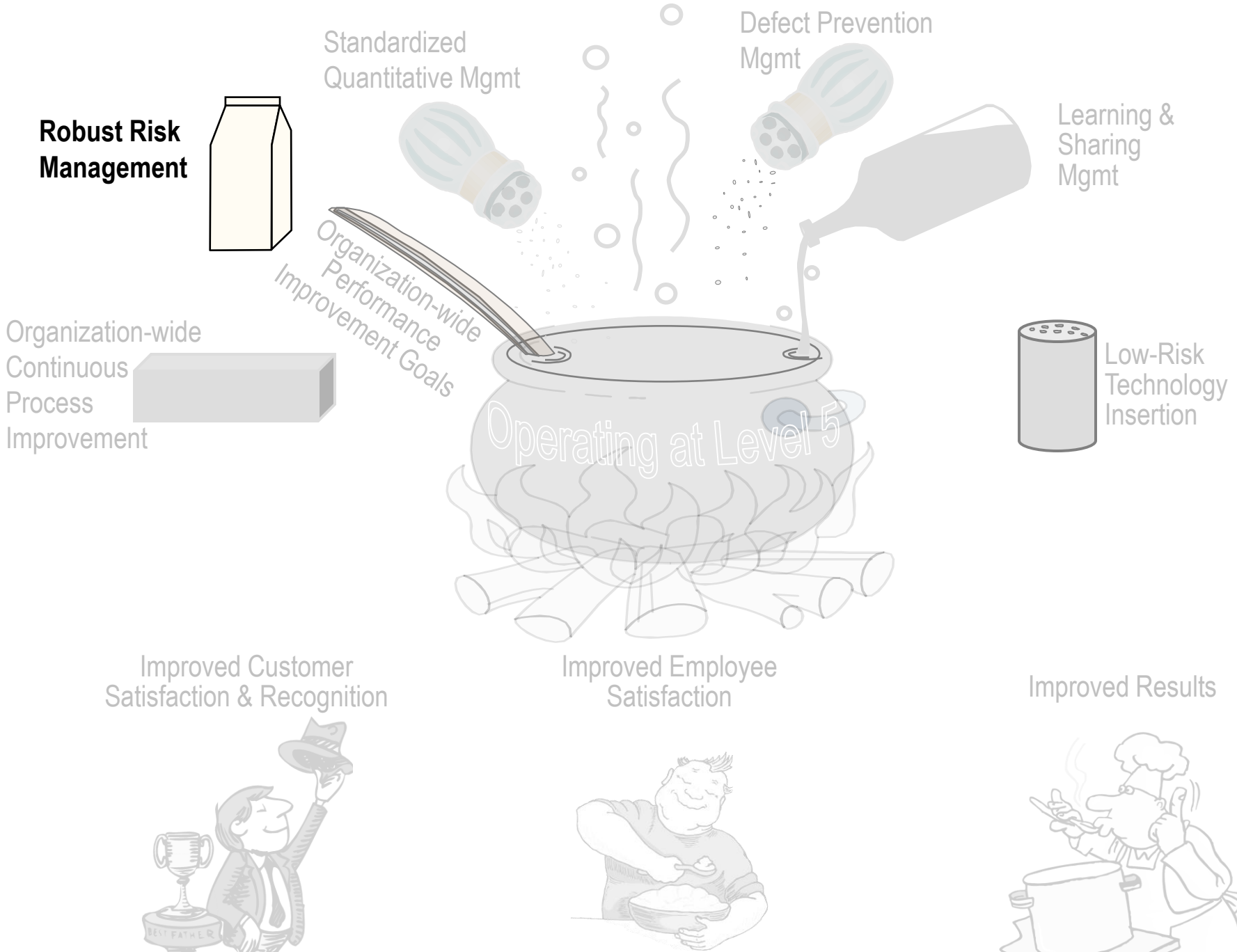
- **Linked to organizational goals**
- **Project and Process measurements**
- **Provides accurate quantitative knowledge of organizational capabilities**
  - Accurate estimates on future opportunities
  - Quantitative insight to areas of improvement (i.e., via training, process, or technology)

Project Measurements

- Cost Performance Indicator (CPI) cumulative
- Schedule Performance Indicator (SPI) cumulative
- Source Lines of Code (SLOC) growth cumulative
- Estimate at Completion (EAC) stability
- EAC vs Budget
- CPI vs To Complete Performance Index (TCPI)
- SLOC growth current
- Requirements Stability
- Peer Review number held vs planned
- Defect Density for Code Peer Review (Fagan inspection)
- RAM usage projected vs. budget
- ROM usage projected vs. budget
- CPU usage projected vs. budget

Process Measurements

- **Fagan Inspection Effectiveness**
  - Defects per inspection
- **Escaping defects profiles**
- **Productivity**
- **% Defects Detected Prior to Test**
- **Training Hours per Employee**
- **Internal and External Customer Satisfaction**
- **Employee Satisfaction**
- **OSSP Software Update Requests**
- **Defect Prevention Causal Analysis Status**
- **Technology Change Management Status**
- **Quality Process Audits**


Robust Risk Management
Standardized Quantitative Mgmt
Defect Prevention Mgmt
Learning & Sharing Mgmt
Organization-wide Performance Improvement Goals
Organization-wide Continuous Process Improvement
Operating at Level 5
Low-Risk Technology Insertion
Improved Customer Satisfaction & Recognition
Improved Employee Satisfaction
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Robust Risk Management Process

- **Pervasive use of Early Warning Indicators (EWIs) by:**
  - Programs
  - Systems Engineering
  - Software Engineering
- **Avoids missed deliveries via early risk mitigation**
- **Augments risk identification / mitigation processes**

EWIs - Programs

	1	2	3	4	5	6	7	8	9
Project									
CPI	G	G	Y						
SPI	Y	G	R						
Margin	G	B	R						
Contingency	Y	B	B						
Sales (Cum-to-date)	G	B	G						
Sales (Forcast/Year)	G	B	B						
Risk	G	B	B						
Opportunity	Y	B							
Technical	G	G	B						
Contracts	G	G	B	B	G	G	G	G	G
Customer Satisfaction	G	B	B	B	G	G	B	B	G
Improvement Goals	G	B	G	Y	G	G	G	G	G
Process									
IPT	P	B	G	G	G	G	G	G	Y
Phase Review	Y	G	G	G	G		Y	Y	Y
EWI	N/A	G	G	G	B	G	G	G	Y
Defects			G	Y		G	G	G	G
Inspection	G		G	G		G	G	G	Y
Test Yields	Y	B	G	Y	B		G	G	Y
Prevention			G	Y		G	G	G	G
Cycle-time	G	B		G	G		G	G	Y
EVMS	G	G	G	G	G	G	G	G	G
Proposals	B	N/A	N/A	G	N/A	G	G	G	G

Monthly program review integrates project performance, process adherence, and organizational improvement goals

EWIs - Systems Engineering

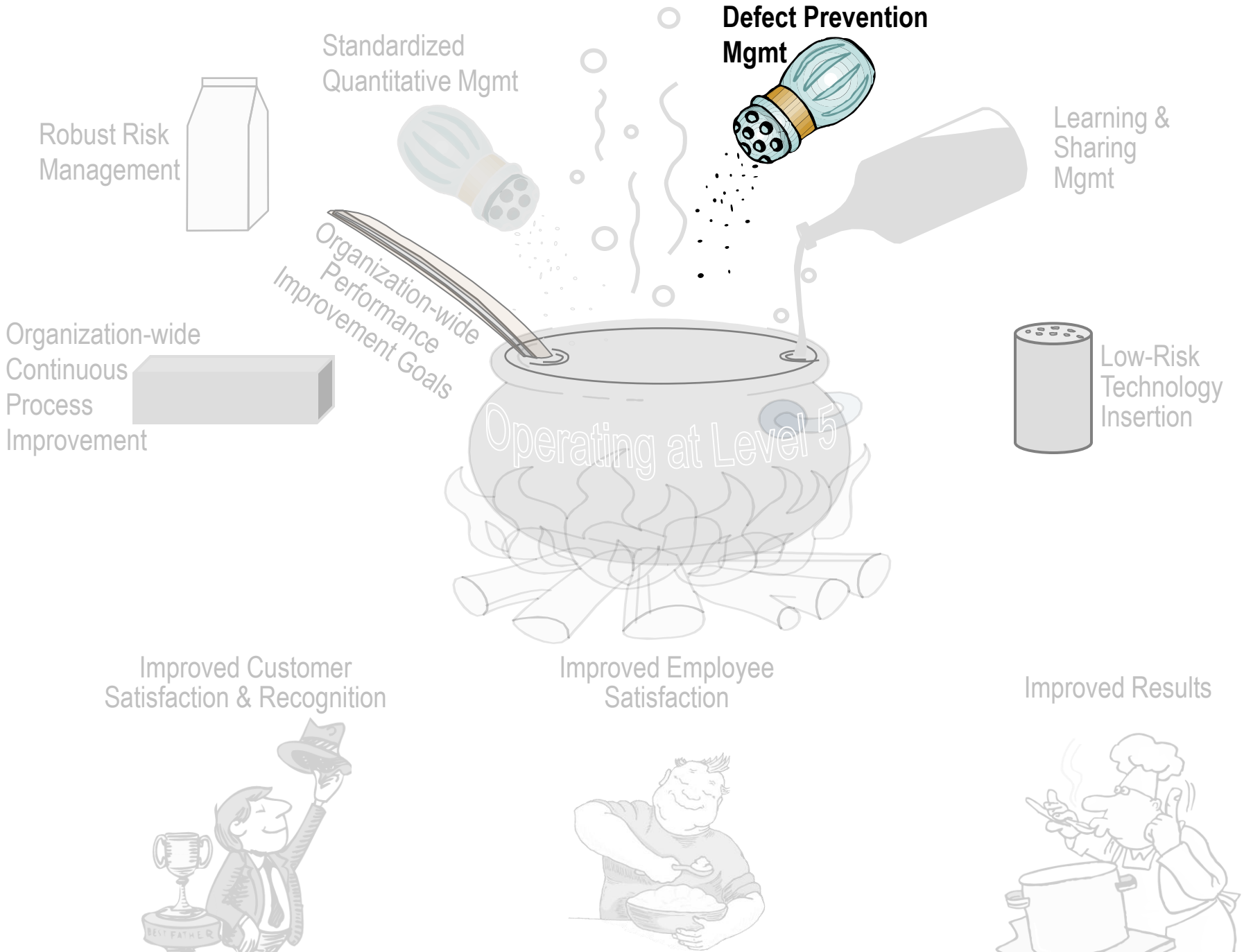
System Early Warning Indicators	Current Status	Previous Status
CPI cumulative* (Project Current Month)		w
EAC versus budget in %* (100* EAC/Budget)		n
SPI cumulative* (Project Current Month)		w
EAC Stability *. No growth in (EAC-Budget) ov		
Percent planned staffing, and project related experience in place.	Blue	Red
Status of resources relative to plan.	Green	Yellow
Percent of all system requirements defined todate	Green	Yellow
Percent of acceptance criteria defined todate	Green	Yellow
Requirements/Acceptance criteria impact to Cost and Schedule	Green	Yellow
How well does current system design meet all system requirements?	Green	Green
Percent of added, deleted, clarified/modified requirements since SR	Blue	Blue
Percent of total non funded changes in requirements	Blue	Blue
DPI current estimate	Green	Green
DPI projected at project completion	Green	Green
Total number of Design, Fagan. Peer reviews held versus planned.	Green	Green
How well do current product DPI projections meet product plan?	Green	Green

Systems indicators are derived from the standardized project metrics

EWIs - Software Engineering

Critical Factors	Current Status	Previous Status	Comments
CPI cumulative	Yellow	Yellow	Contract mods to include additional functionality
SPI cumulative	Yell		
SLOC growth: cumulative	Gre		
EAC Stability: No growth in EAC over previous months	Gre		
EAC versus Budget	Yellow	Yellow	nality in process; will return to green in 2 months.
CPI versus TCPI	Blue	Blue	CPI current period = 1.31
SLOC growth: current period	Green	Green	
Percent of total unfunded changes in requirements	Green	Green	
Plan for Early Detection of Defects	Green	Green	
Defect Tracking (defect detection and coverage)	Yellow	Red	Recovering inspection schedule via replanning and focusing on highest complexity code.
RAM usage: projected versus budget	Blue	Blue	Estimated 21% usage vs 50% requirement
ROM usage: projected versus budget	Blue	Blue	Estimated 25% usage vs 50% requirement
CPU usage: projected versus budget	Blue	Blue	Estimated 57% usage vs 75% requirement
Quantitative Management Status	Blue	Blue	No Quantitative Management issues
Defect Prevention Activity Status	Blue	Green	Root cause analysis meetings and resulting actions are being conducted according to plan.

Software indicators are derived from the standardized project metrics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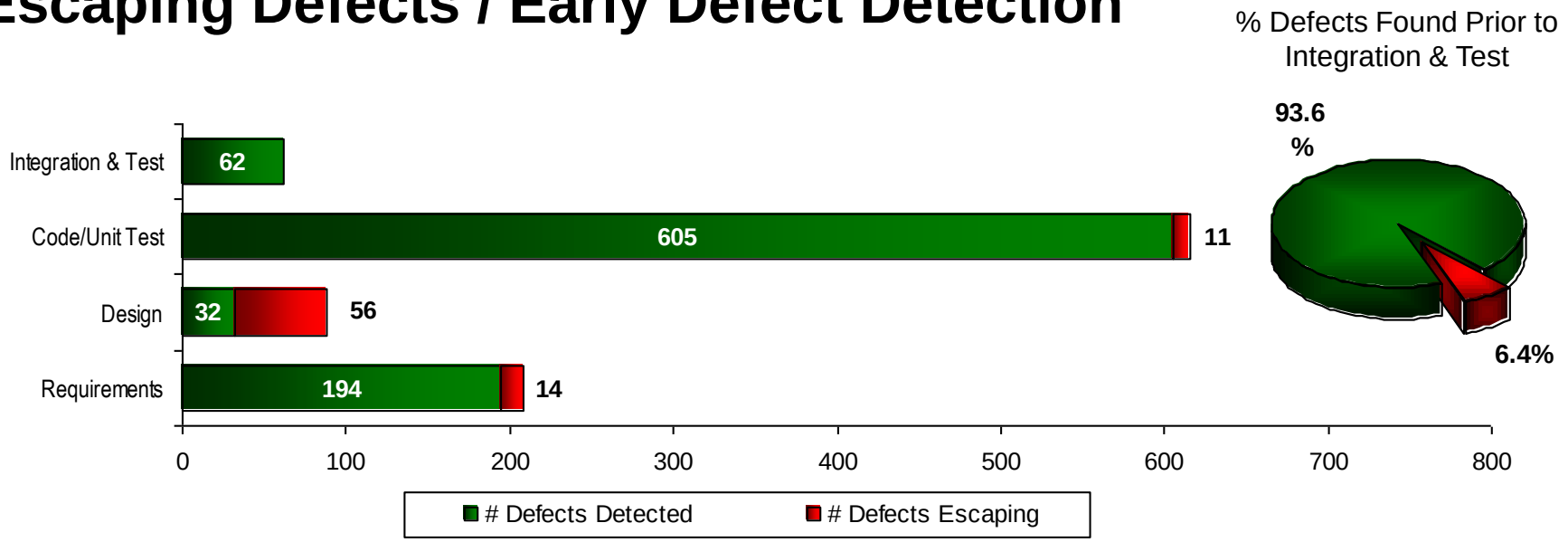
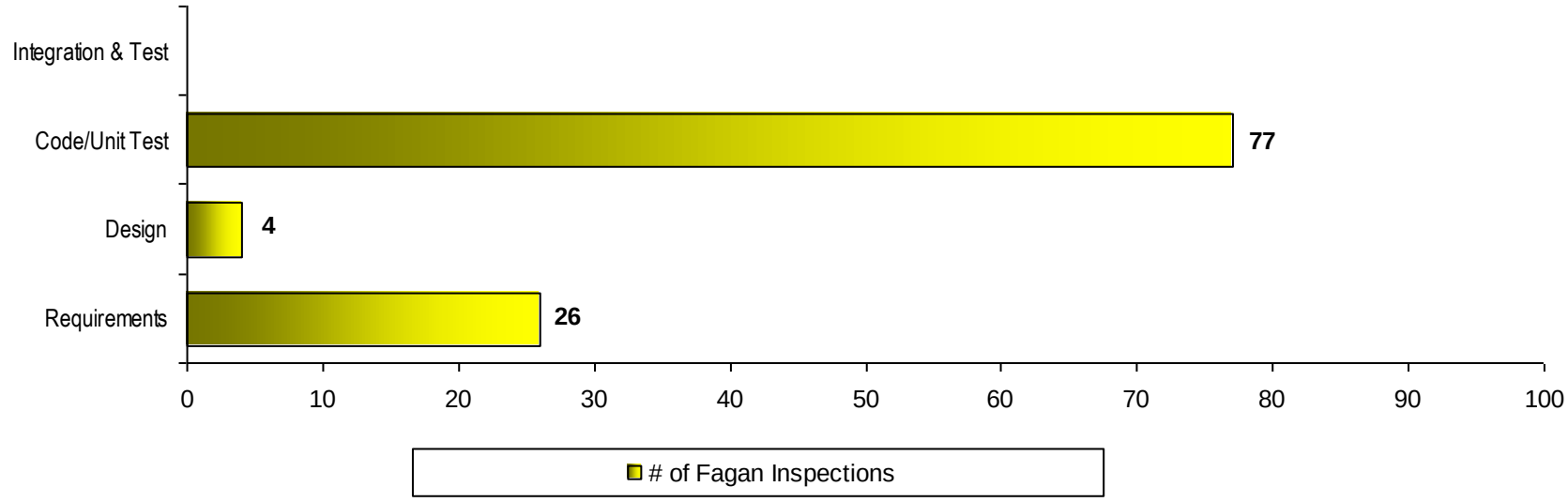
Defect Prevention Management

- **Reduced defect insertion and early “left-shift” detection**
  - Fagan Inspection Process in all phases
- **Root-Cause Analysis and corrective action**
- **Reduced costs and avoidance of repeating mistakes**

Escaping Defects / Early Defect Detection





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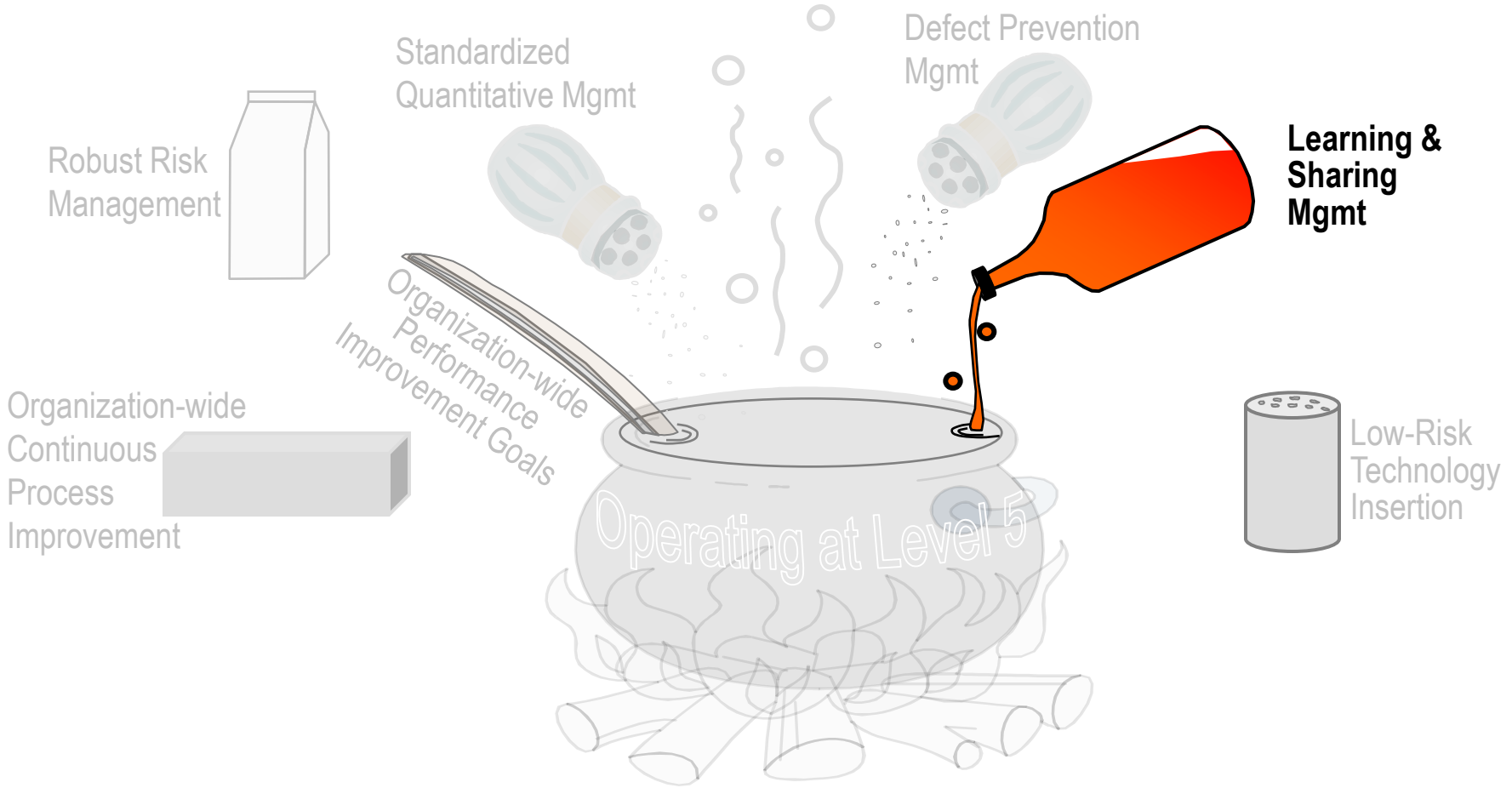
Low Risk Technology Insertion

- **On-going technology evaluations and pilots result in low risk technology insertion**
- **Technology Insertion Review Board**
  - Multi-disciplined team including: Software, Systems, Programs, & Operations
  - Coordinate & draft Software Technology Insertion Plan based on MSG, Engineering Technology Board, & Strategic Business Plan input.
  - Facilitate the identification, evaluation, & introduction of new technologies which improve quality, increase productivity and/or decrease cycle time.
  - Maintain a Technology Change Management (TCM) database & library.
  - Serve as focal point for coordination of software technology change & insertion activities with other BAE SYSTEMS' companies.
  - Conducts pilots & issues technology reports; issues monthly technology newsletter; evaluates entries for Lessons Learned.

TCM Examples

- **Selection of PC-lint as code analysis tool**
  - CodeWizard to enforce coding conventions
- **Evaluation of Insure++ for memory leakage detection**
- **Initiated introduction of DOORS, DocExpress.**
  - Connecting with PVCS
- **Introduced NT version & web-based PVCS**
- **Generation of 20 pilot plans for various tools and operating systems**
- **Evaluation of COTS OS vendors**



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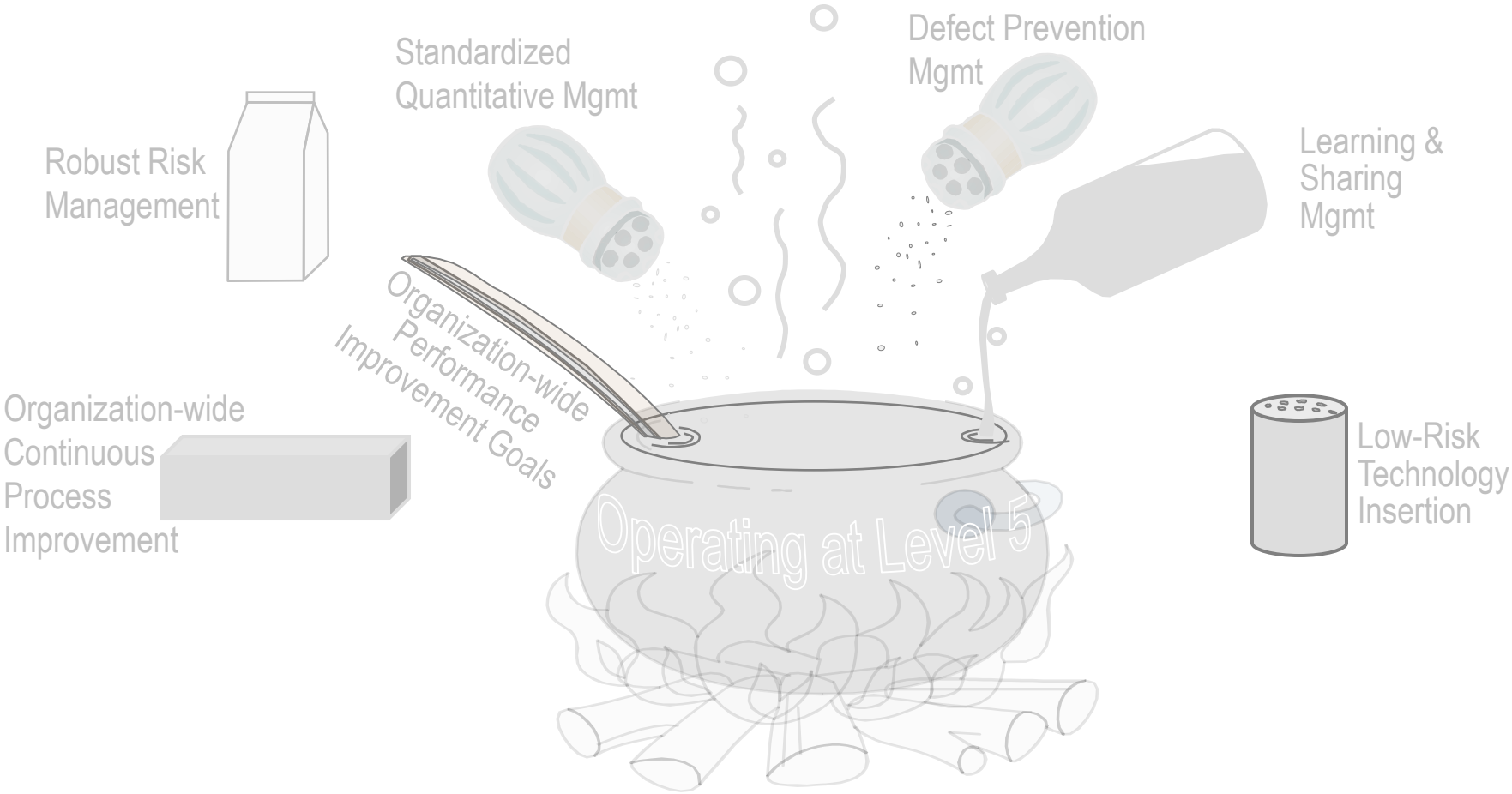
Learning & Sharing Management

- **Robust Training Program**
  - Meets needs of Organization, project, and employee
  - Training is considered a high priority
- **Lessons Learned meetings (Learning from Experience) and databases**
  - Fagan Inspections are a learning experience and reduce defect insertion
  - Defect Prevention Causal Analysis Results
  - Technology Insertion Board recommendations
  - Lessons Learned sessions at the end of each project phase
    - Contribute to the database
    - Retrieve from the database
  - Robust Lessons Learned Database
    - Search by Project, Project Phase, keyword
  - Best Practices Artifacts
  - Continually updated OSSP residing on website
- **Level 5 infrastructure greatly enhances assimilation of new personnel**
  - 30% growth in the last 1.5 years while continuing to sustain performance improvement



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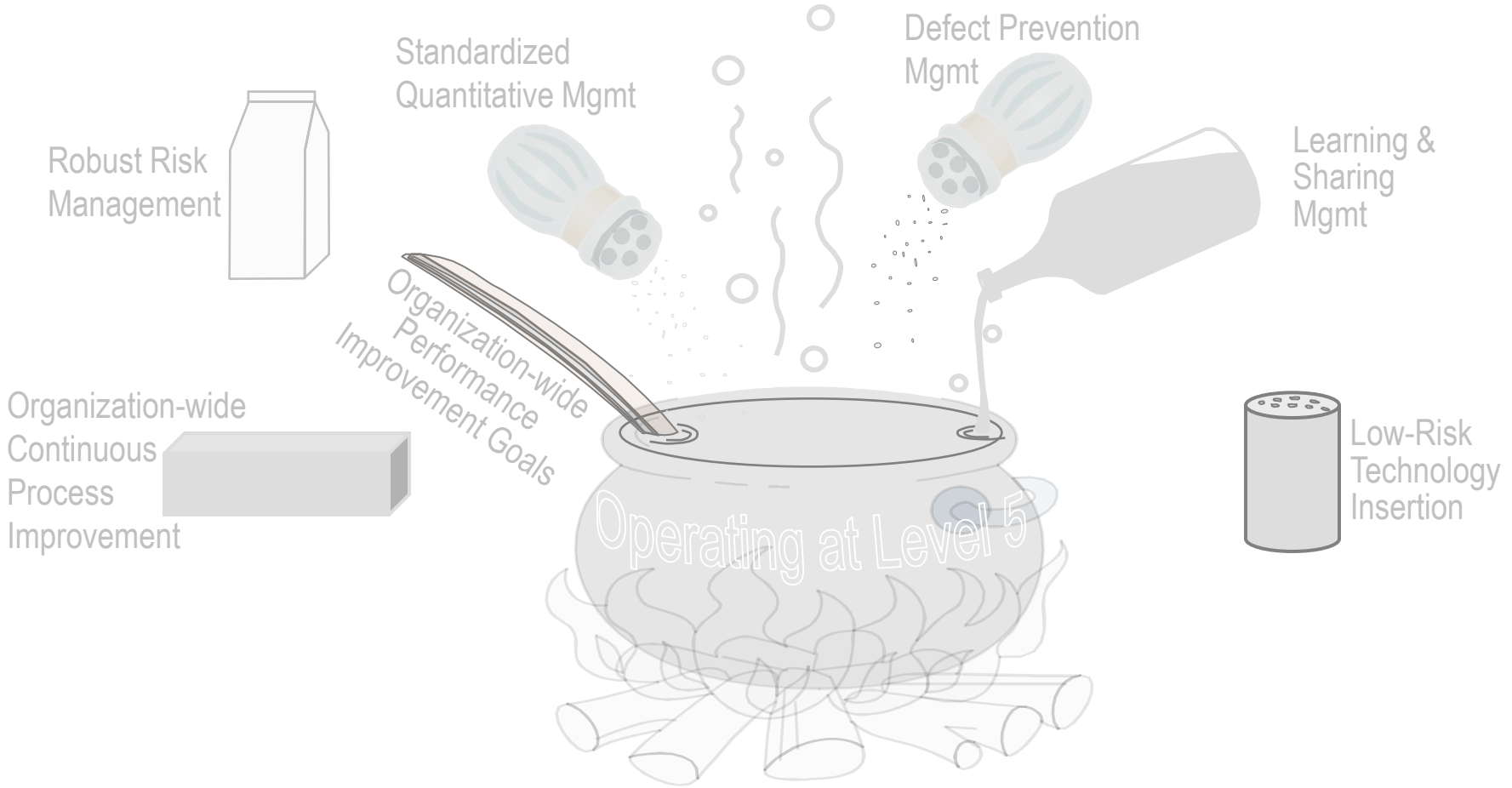
Improved Customer Satisfaction & Recognition

- **Enhanced Customer Satisfaction**
  - Level 5 companies are preferred suppliers – Level 3 (minimum) required for major DOD programs
  - Improved accuracy and estimates resulting in on-cost, schedule, quality, and functional deliveries
- **External Customer Satisfaction improved 9% in the past year resulting in major new contract awards**
- **Improved Customer Recognition**
  - Level 5 is in the top 2% of 645 US assessed companies; 5.3% Level 4 and 22% Level 3
  - Level 5 is in the top 3.9% of 280 DoD / Federal contractors; 8.9% Level 4 and 37.1% Level 3
  - Customers recognize Level 5 as world-class benchmark performance
- **Internal Customer Satisfaction improved 5% in the past year which exceeded the 3% improvement goal**



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Improved Employee Satisfaction

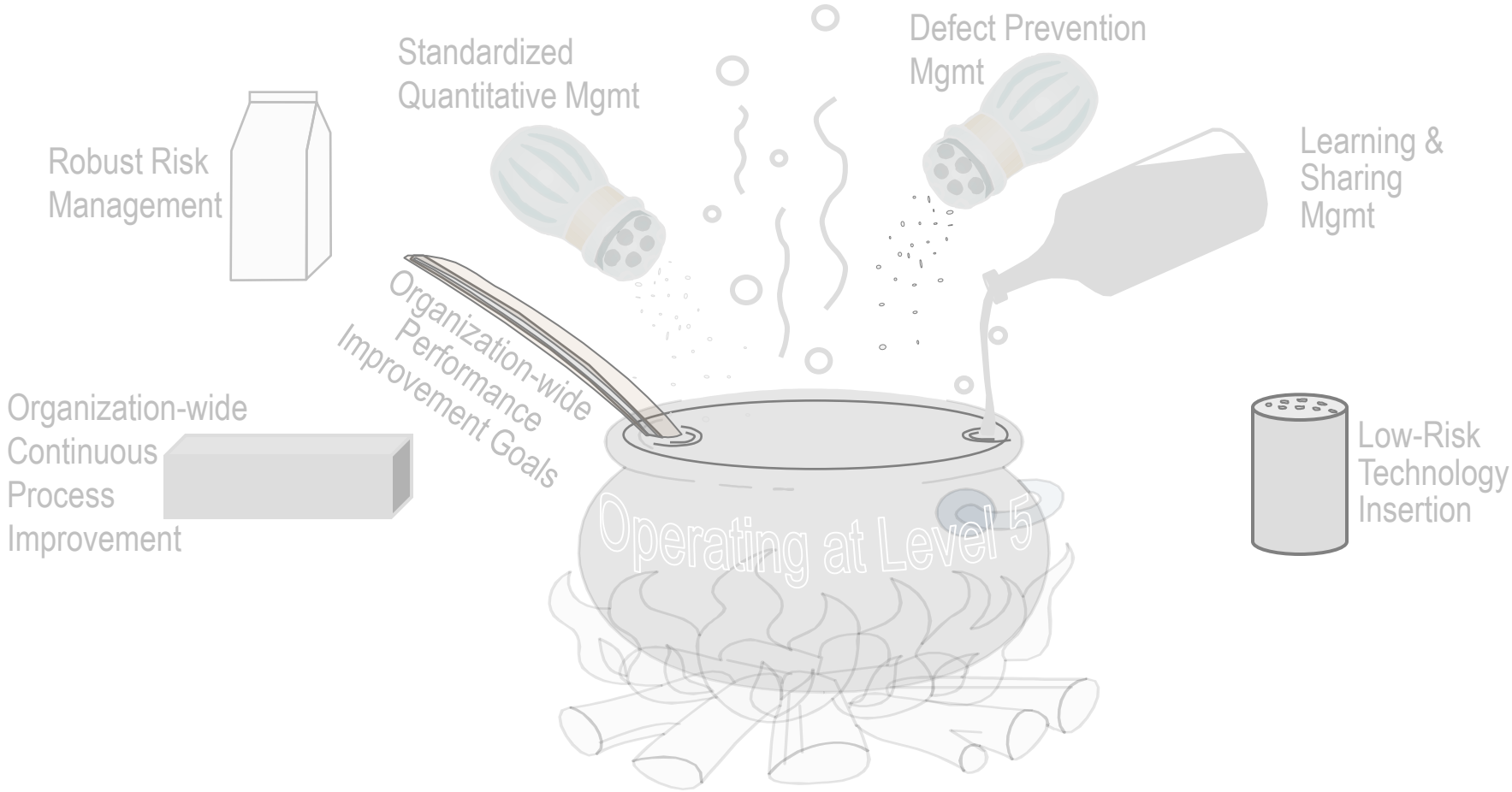
“People like being in a company that is striving to be World Class”

“I enjoy being with my family on the weekend prior to a formal customer qualification test”

“The Fagan process is really saving us integration time”

“Management is modeling the behavior for the company”

“I am proud to meet our customer milestones consistently”



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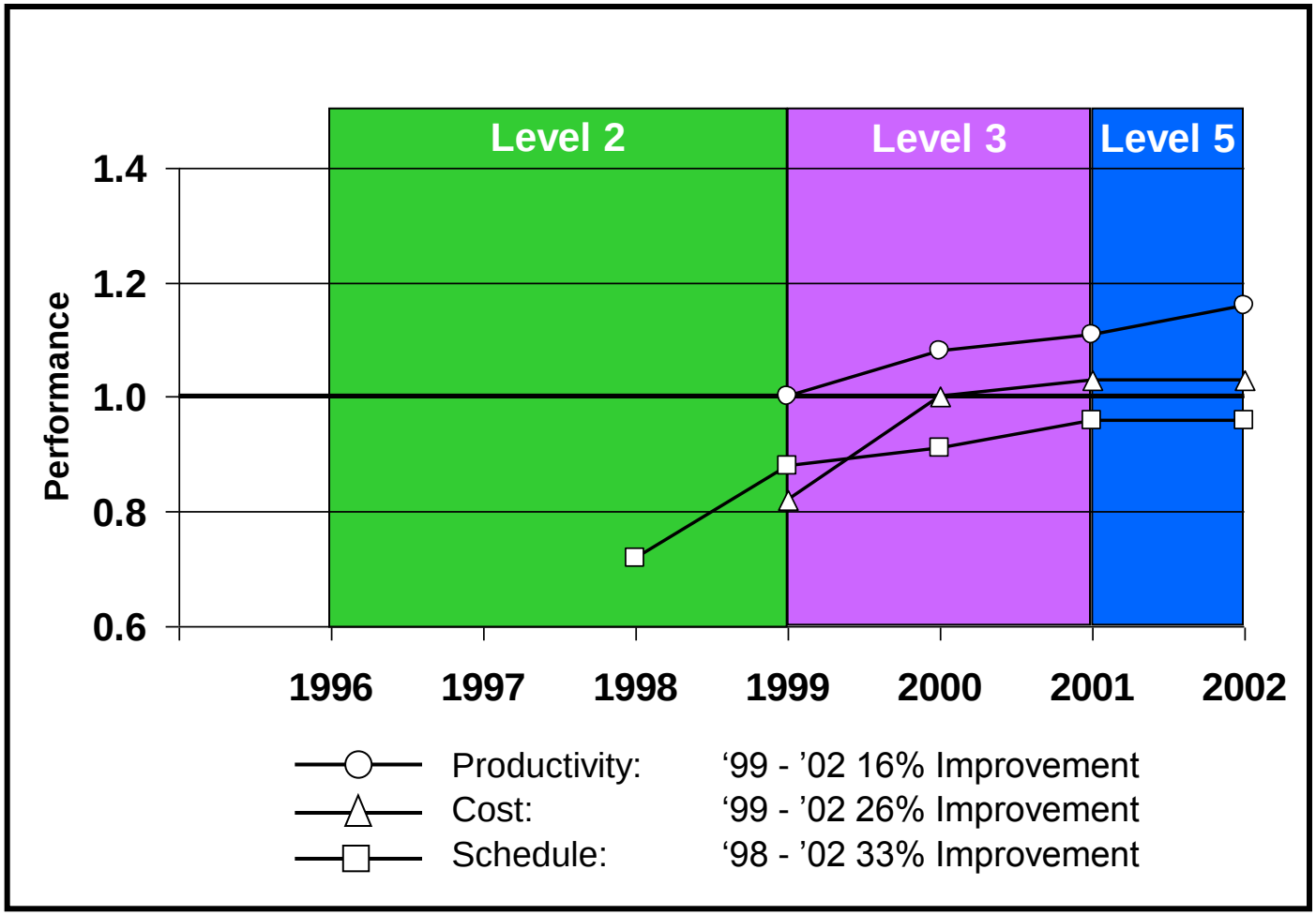
Performance Improvement



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