



**THE PROCESS OF ACHIEVING
COLLABORATIVE KNOWLEDGE
IN
ASYNCHRONOUS COLLABORATION (CASC)**

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Report Documentation Page

*Form Approved
OMB No. 0704-0188*

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1. REPORT DATE JAN 2004	2. REPORT TYPE	3. DATES COVERED 00-00-2004 to 00-00-2004			
4. TITLE AND SUBTITLE The Process of Achieving Collaborative Knowledge in Asynchronous Collaboration (CASC)		5a. CONTRACT NUMBER			
		5b. GRANT NUMBER			
		5c. PROGRAM ELEMENT NUMBER			
6. AUTHOR(S)		5d. PROJECT NUMBER			
		5e. TASK NUMBER			
		5f. WORK UNIT NUMBER			
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Naval Air Systems Command, Human Systems Integration Department (Code 4.6), Patuxent River, MD, 20670		8. PERFORMING ORGANIZATION REPORT NUMBER			
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)			
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)			
12. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited					
13. SUPPLEMENTARY NOTES Collaboration and Knowledge Management (CKM) Workshop, 13-15 Jan 2004, San Diego, CA					
14. ABSTRACT					
15. SUBJECT TERMS					
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT Same as Report (SAR)	18. NUMBER OF PAGES 52	19a. NAME OF RESPONSIBLE PERSON
a. REPORT unclassified	b. ABSTRACT unclassified	c. THIS PAGE unclassified			



OUTLINE



- **Summary of Overall Objectives and FY03 / FY04 Objectives**
- **Expected Final Products**
- **CASC Application and Impact**
- **Research Questions and Contribution to Collaboration Technology**
- **Phase I, II and III Experiments and Current Empirical Findings**
- **Accomplishments**
- **Transition and Demonstration of Structural Model of Team Collaboration in
NAVAIR and Naval Postgraduate School CKM Testbeds via modified Ewall
software**
- **Recent / Planned Publications**
- **Lessons Learned**



PROJECT SUMMARY OVERVIEW



- **Overall Goal:** understand the unique cognitive mechanisms that should be employed to optimize collaborative decision-making activity in a geographically distributed and time-delayed situation

- **Objectives:**
 - (1) To understand the cognitive processes of building knowledge in an asynchronous, distributed collaboration environment
 - (2) To develop an empirically-based theory of collaboration, including knowledge building components, during asynchronous, distributed collaboration
 - (3) To understand how agents can support humans in achieving collaborative knowledge during asynchronous, distributed collaborative problem solving

- **FY03 / 04 Objectives:**
 - (1) Conduct experiments in collaborative problem solving in both face-to-face and asynchronous, distributed environments to understand the unique cognitive processes within asynchronous, distributed collaboration
 - (2) Update model of collaboration based on experimental results



EXPECTED FINAL PRODUCTS



1. Empirical Data / Journal Articles

- **Describing the cognitive processes of building knowledge with distributed team members engaged in asynchronous, quick response collaboration**

2. Empirically-based Theory for Asynchronous, Distributed Collaboration including Knowledge Building Components

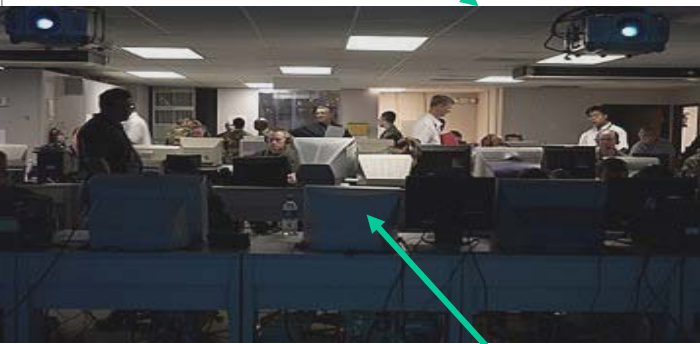
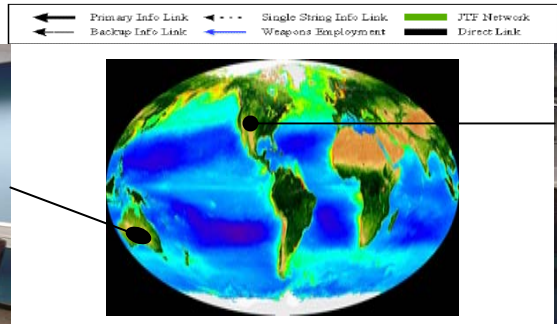
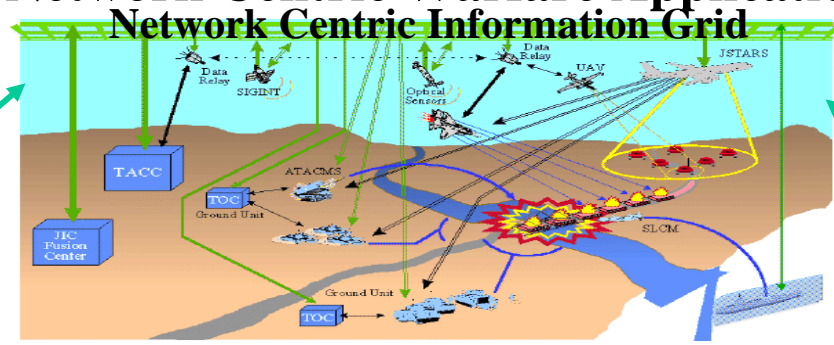
3. Empirical Data on Agent Support for Achieving Collaborative Knowledge in Asynchronous, Distributed Collaboration

4. Demonstration of the Knowledge Building Processes during Asynchronous, Distributed Collaborative Problem Solving using an Integrated EWall / NEO Scenario Testbed.

- **Testbed is laptop based, portable and can be used to demonstrate Ewall collaboration tool and knowledge building processes to other agencies (e.g. NPGS, universities) and Operational communities (e.g. PACOM, JIFCOM, SPAWAR FORCEnet)**



Network Centric Warfare Application



Asynchronous, Distributed Ewall Collaboration Tool With Agent Based Knowledge Building Model

CASC Client Application - Station 1 Connected: ->192.168.0.122

File Network Help	let me check on fuel thing brb	longest range helicopter goes 500 mi	what is the crew capacity, because we	do you see what I am saying?	hahah I dont have fuel info	longest range can hold 39 extra people,	a Navy sh-60, I believe can carry 12
(Station 3) Untitled	(Station 3) Untitled	(Station 1) Untitled	(Station 2) Untitled	(Station 3) Untitled	(Station 1) Untitled	(Station 3) Untitled	(Station 2) Untitled
am i ok? red crosses and still be ok?	a marine team has medics too right?	transferring, can refuel in flight for ride back	So we are kinda leaning on helo's?	ok that sounds good, now where and when?	amrine=marine, sorry	coral reefs could be a problem	I would think that it would take too long

Knowledge Building and Collaboration

Untitled

ZOOM

go over entry so how will

Untitled

ZOOM

longest range can hold 39 extra people,

Untitled

ZOOM

amrine=marine, sorry

Untitled

ZOOM

if we use amrine CH-30 it can refuel in

Transport

ZOOM

helicopter

Personnel

ZOOM

army

General Information Expertise

Holding Room Knowledge Building and Collaboration Consensus Room Final Planning

0:45:27



CASC POTENTIAL IMPACT



- **Improve total collaborative problem solving time** of an Asynchronous, Distributed team to that of a Face-To-Face team. Applicable across different domains (e.g. Network Centric Warfare)
 - * Asynchronous, Distributed teams are usually an order of magnitude slower than Face-To-Face teams (i.e. from literature and CASC data)
 - * Improvement achieved through:
 - (1) understanding the **collaboration stages and cognitive processes** used in Face-To-Face and Asynchronous, Distributed Collaborative teams
 - (2) understand the **collaboration dynamics** between team members (i.e. the transition states for both stages and cognitive processes)
 - (3) Using knowledge from (1) & (2) develop **an agent-based support system** for Asynchronous, Distributed collaborative teams
- **Military impact** --- optimize collaborative decision-making activity in asynchronous, distributed teams for mission planning and mission execution



- What is the knowledge building process humans use in asynchronous, distributed collaborative problem solving?
- What is the effect of the following variables on the knowledge building process during asynchronous, distributed collaboration?
 - * **Collaboration Modes** (face-to-face versus asynchronous, distributed)
 - * **Knowledge Distribution** (homogeneous versus heterogeneous)
 - * **Knowledge Dynamics** (static knowledge versus dynamic knowledge)
- What forms of agent support facilitate knowledge building in asynchronous, distributed collaborative problem solving?

- Understand the knowledge building process humans use in asynchronous, distributed collaborative problem solving and compare to existing Face-To-Face collaboration literature
- Extend existing collaboration theories to include knowledge building processes for asynchronous, distributed collaborative teams

Face-To-Face Collaboration

Asynchronous, Distributed Collaboration





OVERVIEW OF PHASE I, II, AND III EXPERIMENTS



- **Phase I Objective** = collect empirical data on the collaboration stages and cognitive processes during asynchronous, distributed team collaboration in a collaborative problem solving domain (murder mystery scenario). Emphasis is on the the cognitive processes of knowledge building.
 - Examine the effects of collaboration mode (face-to-face vs asynchronous, distributed), and knowledge distribution (homogeneous vs heterogeneous)
- **Phase II Objective** = building on phase I examine the effects of knowledge dynamics (static vs dynamic knowledge) on the cognitive knowledge building process using the NEO scenario within the Ewall collaboration environment
- **Phase III Objective** = within the context of the revised theory for knowledge building in asynchronous, distributed collaboration (based on Phase I and II results), define and empirically examine the beneficial forms of agent support?



CASC Phase I Scenario

Murder Mystery



See Appendix A for detail murder mystery information

- **The Case of the Fallen Businessman, (by Dr. Garold Stasser, Miami University, Oxford, Ohio)**

- **Major Characters**

Robert Gill: The victim

Mary Gill: The victim's wife

Lt. Mark Moody: Detective in charge of the investigation

Sgt. Cassini: Police officer assisting in the investigation

****Eddie Sullivan:** Handyman who worked for the Gills

****Billy Prentice:** Yardman who worked for the Gills

****Mickey Malone:** Owner of MM Auto Parts; business associate of the victim

Sam Nietzel: Parts manager for Gill Lincoln/Mercury

Dave Daniels: Owner of Dave's Quick Stop in the Eastwood Shopping Center

**** The ONLY suspects under consideration are: Mickey Malone**

Billy Prentice

Eddie Sullivan

- **Summary:** Robert Gill, a prominent local businessman was found dead behind his Crestview home this morning. Detective Lt. Mark Moody of the Hilltown precinct reported that Mr. Gill had apparently been assaulted when leaving his home to play golf early this morning. He was struck on the head over the left eye and fell down a flight of stairs leading from a second story deck at the rear of the house. The preliminary coroner's report concluded that death was caused by injuries sustained from the fall and not from the blow to the head. The report estimated that Mr. Gill's death occurred between 6:30 and 7:00 AM. Lt. Moody would neither confirm nor deny rumors that Mr. Gill had been robbed. "We're following all leads. That's all I have to say for now," said Lt. Moody.
- **Team Objective:** Collaborate on the detailed murder information and develop a team consensus on who killed Mr. Gill



TECHNICAL PLAN

CASC Phase I Experiment



Independent Variables:

- Collaboration Mode (face-to-face vs asynchronous, distributed)

- * **Face-to-Face** = team interacts synchronously with each other through speech
- * **Asynchronous, Distributed** = team interacts with each other at different times and from different locations through a text based web forum

- Knowledge Distribution (homogeneous vs heterogeneous)

- * **Homogeneous** = the members of the team have all the murder mystery knowledge in common
- * **Heterogeneous** = the members of the team have some murder mystery knowledge in common and some uniquely held murder mystery knowledge



CASC Phase I Experimental Design

(2x2 randomized factorial)



Knowledge Distribution

Homogeneous	Heterogeneous
Gp 1 * * Gp 7	Gp 15 * * Gp 21
Gp 8 * * Gp 14	Gp 22 * * Gp 28

Phase I

- 28 groups total
- 3 subjects / group
- 84 subjects total

Collaboration Mode

Face-to-Face (speech)

Asynchronous, Distributed (text)

Dependent Variables:

- Forum text and face-to-face audio / video recordings including time stamp per response (i.e. text and speech)
- Thinking Aloud Protocol (concurrent verbalizations) for asynchronous, distributed teams
- Total time to successfully complete the problem-solving task (time from the beginning of the task until task completion)
- Collaboration Maps (post session – subjects construct a map of their view of the stages & cognitive process states of team collaboration)
- Subjective Questionnaire – measuring expertise, trust between team members, and general collaboration opinions among members



CASC Phase I Hypotheses



Ho: no significant difference between face-to-face and asynchronous, distributed collaboration modes on the collaboration stages and cognitive knowledge building processes in a collaborative problem solving domain

Ho: no significant difference between homogeneous and heterogeneous knowledge distribution on the collaboration stages and cognitive knowledge building processes in a collaborative problem solving domain

Ho: no significant interaction between collaboration modes and knowledge distribution on the collaboration stages and cognitive knowledge building process

Ho: no significant difference in time or frequency within each cognitive process state across collaboration mode and knowledge distribution conditions

Ho: no convergence of individual mental models with regard to collaboration stages and knowledge building processes



Types of Data Analysis

Phase I, II and III Experiments



- **Verbal Protocol Communication Analyses** – identification of collaboration stages and cognitive process states compared across collaboration mode and knowledge distribution. Compare results to preliminary structural model of collaboration.
- **Transition State Diagrams** – representation of the *dynamic* team collaborative behavior between collaboration stages and between cognitive process states within each collaboration stage compared across collaboration mode and knowledge distribution. Compare results to preliminary structural model of collaboration.
- **Parametric statistics** – for analyzing time, and frequency within each collaboration stage and cognitive process state across collaboration mode and knowledge distribution conditions. Also used for analyzing total time to complete task and questionnaire data.
- **Collaboration Maps** – determine the degree of convergence between individual mental model ‘s regarding collaboration stages and cognitive processes. In addition, compare how an individual thinks a group makes a decision in a collaborative setting and how the group actually performs.



CASC Phase I Experiment

Face-to-Face, Homogeneous Team Collaboration Example
(shows card sorting approach to information management)





CASC Phase I Experiment

Face-to-Face, Homogeneous Team Collaboration Example
(shows using maps to transfer meaning to team members)





CASC PHASE I EXPERIMENT

Asynchronous, Distributed, Homogeneous Team Example

Using Forum Collaboration Environment



Crew Systems Collaboration Research

Welcome to the Crew Systems asynchronous collaboration research page. If you are not a moderator, administrator, or subject in these experiments, leave immediately. You're IP address has been logged, and you have illegally accessed a military computer.

- [FAQ](#)
- [Search](#)
- [Memberlist](#)
- [Usergroups](#)
- [Profile](#)
- [You have no new messages](#)
- [Logout \[adhs19 \]](#)

Crew Systems Collaboration Research Forum Index -> Group 20

Post a reply

Subject

Message body

Font colour: Font size: [Close Tags](#)

Tip: Styles can be applied quickly to selected text

who do you guys think mu

I

Options

HTML is OFF

BBCode is OFF

Smilies are OFF

Notify me when a reply is posted

Add an Attachment

If you do not want to add an attachment to your post leave the fields blank

Filename

File Comment

All times are EST (U.S./Canada)

Jump to:

Topic review



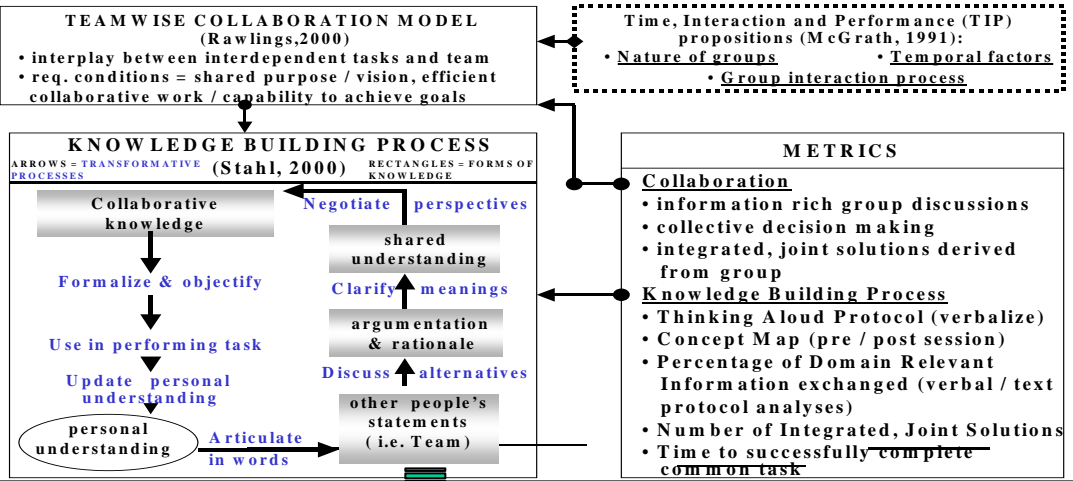
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MODEL EVOLUTION OF TEAM COLLABORATION

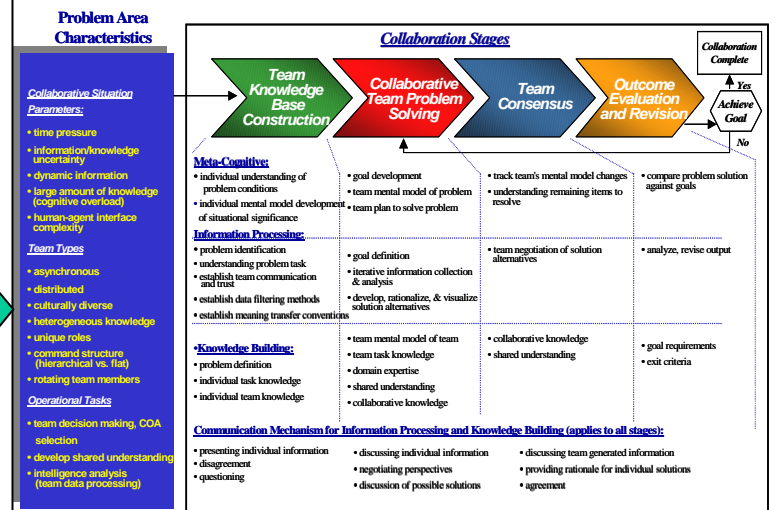
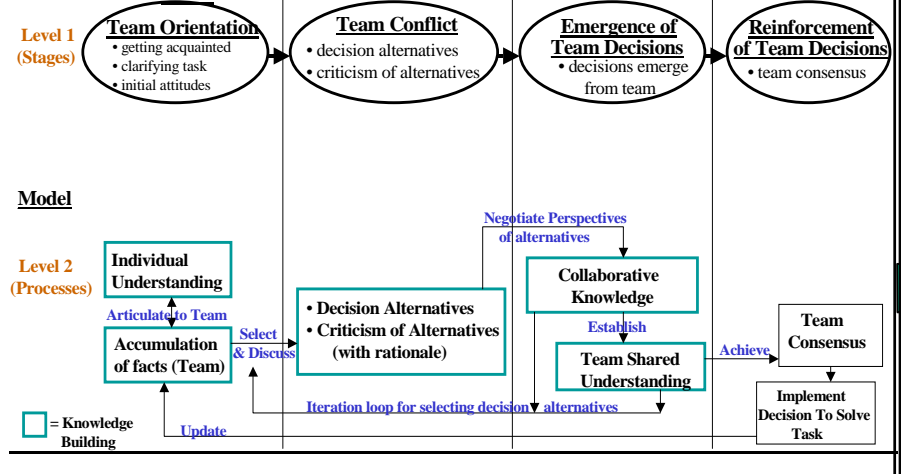


INITIAL THEORY FOR ACHIEVING COLLABORATIVE KNOWLEDGE IN ASYNCHRONOUS COLLABORATION



STRUCTURAL MODEL OF TEAM COLLABORATION

Preliminary Conceptual Model of Collaboration



STRUCTURAL MODEL OF TEAM COLLABORATION

Problem Area Characteristics

Collaborative Situation Parameters:

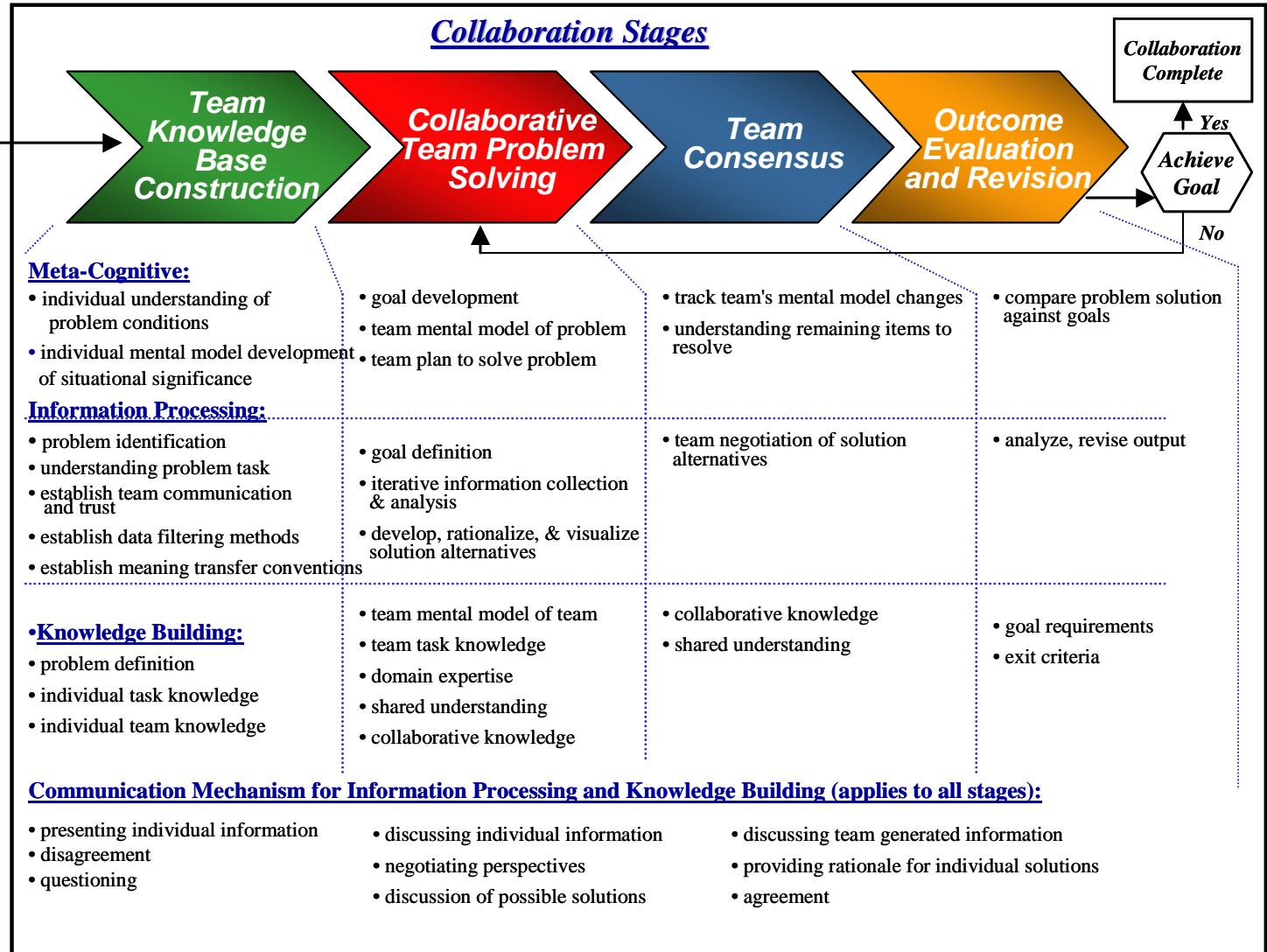
- time pressure
- information/knowledge uncertainty
- dynamic information
- large amount of knowledge (cognitive overload)
- human-agent interface complexity

Team Types

- asynchronous
- distributed
- culturally diverse
- heterogeneous knowledge
- unique roles
- command structure (hierarchical vs. flat)
- rotating team members

Operational Tasks

- team decision making, COA selection
- develop shared understanding
- intelligence analysis (team data processing)





CASC Phase I Collaboration Stages

Coding Definitions

(see Appendix B for complete list of examples)



- **Team Knowledge Base Construction (TK)**: “**Team members reading, clarifying information and understanding the problem.**”
 - * Defining the problem (realizing what they have to accomplish --- “We need to come up with a solution in 30 minutes.”)
 - * Clarifying the facts --- “What did they say about Joe’s hearing?”
- **Collaborative Team Problem Solving (TPS)**: “**Team members working together to develop solution options to the problem.**”
 - * Analyzing the facts to come up with a solution - - - “I think Joe did it because he tried to blame everything on Tim.”
- **Team Consensus (TC)**: “**Team negotiation of solution option and final agreement by all team members on a particular option.**”
 - * Agreeing on the final solution - - - “Do we all agree that Joe did it?”
- **Outcome Evaluation & Revision (OER)**: “**Team evaluation of selected solution option against problem solving goal. Team revises solution option if option does not meet goal.**”
 - * Choosing to accept the final decision or revise it - - - “I know we all agreed on Tim, but I think we better take a closer look at Joe.”
- **Additional Stages (MISC)**: “**Other unique team behavior not described in the above categories.**”
 - * Need to describe unique behavior and label stage.



CASC Phase I Cognitive Process States

Coding Definitions

(see Appendix B for complete list of examples)



Team Knowledge Base Construction: (TK) “Team members reading clarifying and understanding the problem to be solved.”

IPup: Information Processing (understanding problem) = stating the facts without applying that knowledge to any possible solution.

“Tim’s muffler was loud”

IPgd: Information Processing (goal definition) = defining the team goal.

“Our goal is to determine who killed Mr. Gill”

IPct: Information Processing (communication & trust) = establishing team trust.

“I understand why you thought it was Tim.”

IPdfm: Information Processing (data filtering methods) = team uses methods to sort data.

“using yellow note pads to sort data into categories”

IPtck: Information Processing (transfer conventions) = team uses methods to transfer meaning to other team members during knowledge construction.

“team uses map of Mr. Gill’s house to understand distances between objects.

KBpd: Knowledge Building (problem definition) = defining the problem (realizing what they have to accomplish)

“We need to come up with a solution in 30 minutes”

KBik: Knowledge Building (indiv. knowledge) = individual clarifying the facts; asking for clarification.

“What did they say about Joe’s hearing”

KBtk: Knowledge Building (team knowledge) = team clarifying facts

“Billy left the coffee shop at 7:00am”

“No that was Eddie that left the coffee shop at 7:00am

“Yes that was Eddie”



CASC Phase I Cognitive Process States

Coding Definitions

(see Appendix B for complete list of examples)



Collaborative Team Problem Solving: (TPS) “Team members working together to develop solution options to the problem.”

MCtp: Meta-cognitive (team plan) = establishing a plan of approach.

“ADHES 2, why don’t you say who you think it is, then I’ll say who I think it is.”

IPica: Information Processing (information collection & analysis) = collecting and analyzing the facts to come up with a solution but no specific solution mentioned.

“The killer seems to blame everything on Tim.”

IPtcp: Information Processing (transfer conventions) = team uses methods to transfer meaning to other team members during team problem solving.

“ Using maps or yellow stickers to transfer meaning to team members”

IPsa: Information Processing (solution alternatives) = developing, rationalizing and discussing solution alternatives.

“I think Eddie did it?”

KBde: Knowledge Building (domain expertise) = team members state their own domain knowledge and apply that knowledge to the problem.

“Yes I am a Maryland State Trooper and they is no concrete evidence for Billy killing Mr. Gill.”

KBsu: Knowledge Building (shared understanding) = using facts to justify a solution.

“I think Eddie did it because he was hard of hearing and had his fingerprints on the crowbar.”

KBck: Knowledge Building (collaborative knowledge) = Convincing others of a specific thought without absolute consensus of the final solution.

“You’re right. I didn’t think about that.”



CASC Phase I Cognitive Process States Coding Definitions



(see Appendix B for complete list of examples)

Team Consensus: (TC) “Team negotiation of solution option and final agreement by all team members on a particular option.”

MCitr: Meta-cognitive (items to resolve) = team stating remaining items to resolve.

“We need to compare Mickey’s and Eddie’s location times with Billy’s”

IPtn: Information Processing (team negotiation) = team negotiation of solution alternatives ending in a final solution.

“ I believe it is Eddie because he was hard of hearing”

“ I concur which also means Eddie was lying about where is was”

“I also think it was Eddie because of his fingerprints on the crowbar.

“We all in consensus, it was Eddie”

KBckc: Knowledge Building (collaborative knowledge) = convincing others of a specific thought without absolute consensus of the final solution.

“You’re right. I didn’t think about that.”

KBsuc: Knowledge Building (shared understanding) = using facts to justify a solution.

“It couldn’t have been Tim because his muffler was loud and the car at the coffee shop had a quiet muffler.”



CASC Phase I Cognitive Process States Coding Definitions



(see Appendix B for complete list of examples)

Outcome Evaluation & Revision: (OER) “Team evaluation of selected solution option against problem solving goal. Team revises solution option if option does not meet goal.”

MCps: Meta-cognitive (problem solution) = compare problem solution against goal(s).

“Are we done or do we want to talk about it some more?”

IPar: Information Processing (analyze, revise output) = analyze final solution option and revise if necessary.

“I know we all agreed on Tim, but I think we’d better take a closer look at Joe.”

KBgo: Knowledge Building (goal obtainment) = understand if solution option fits specific goal criteria.

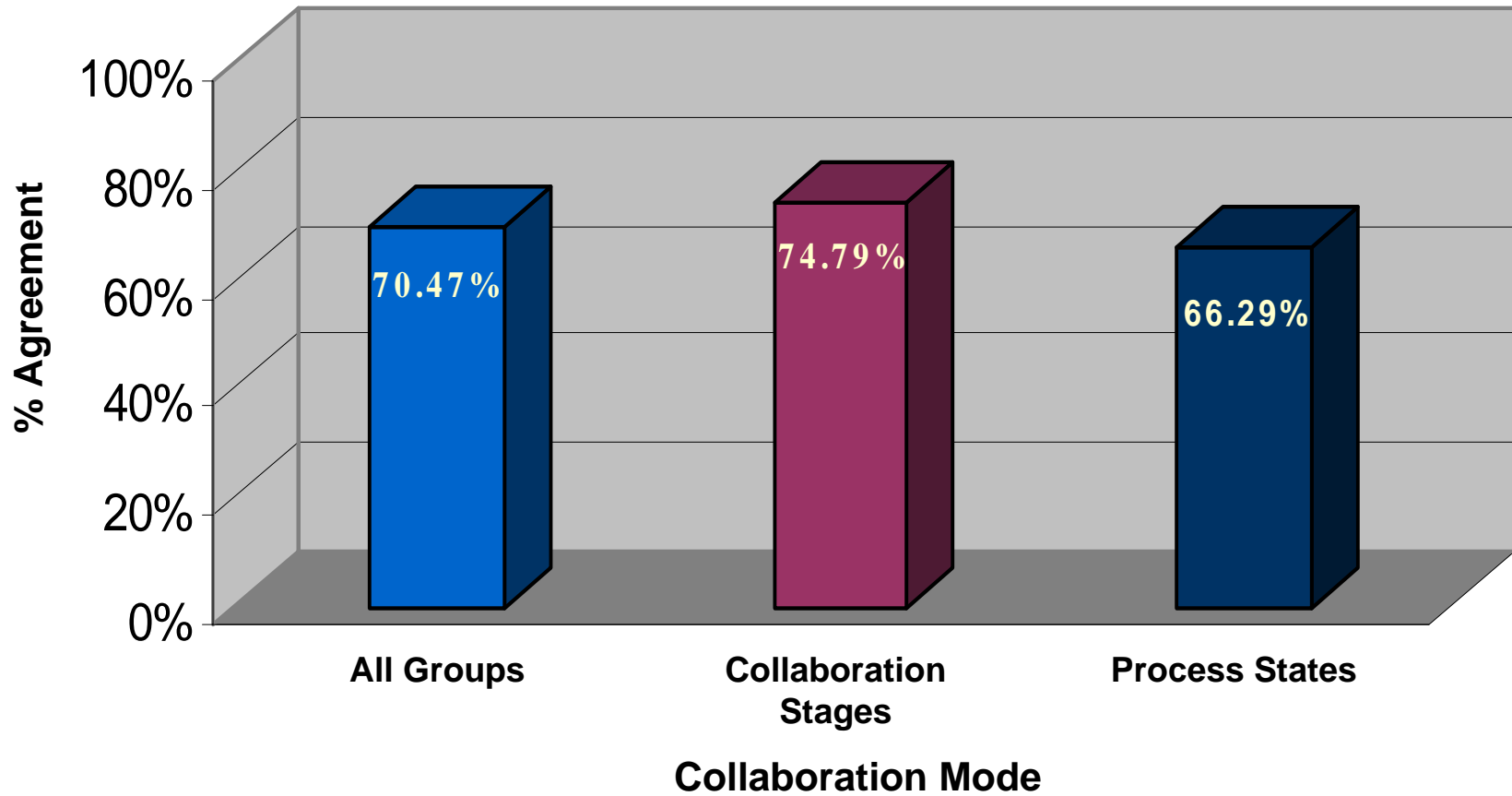
“ the murder had a truck with a loud muffler, was at Mr. Gills house around 10:30am, and pushed Mr. Gill down the porch steps”.



CASC Phase I Results



Interrater Reliability Percent Agreement





CASC Phase I Results

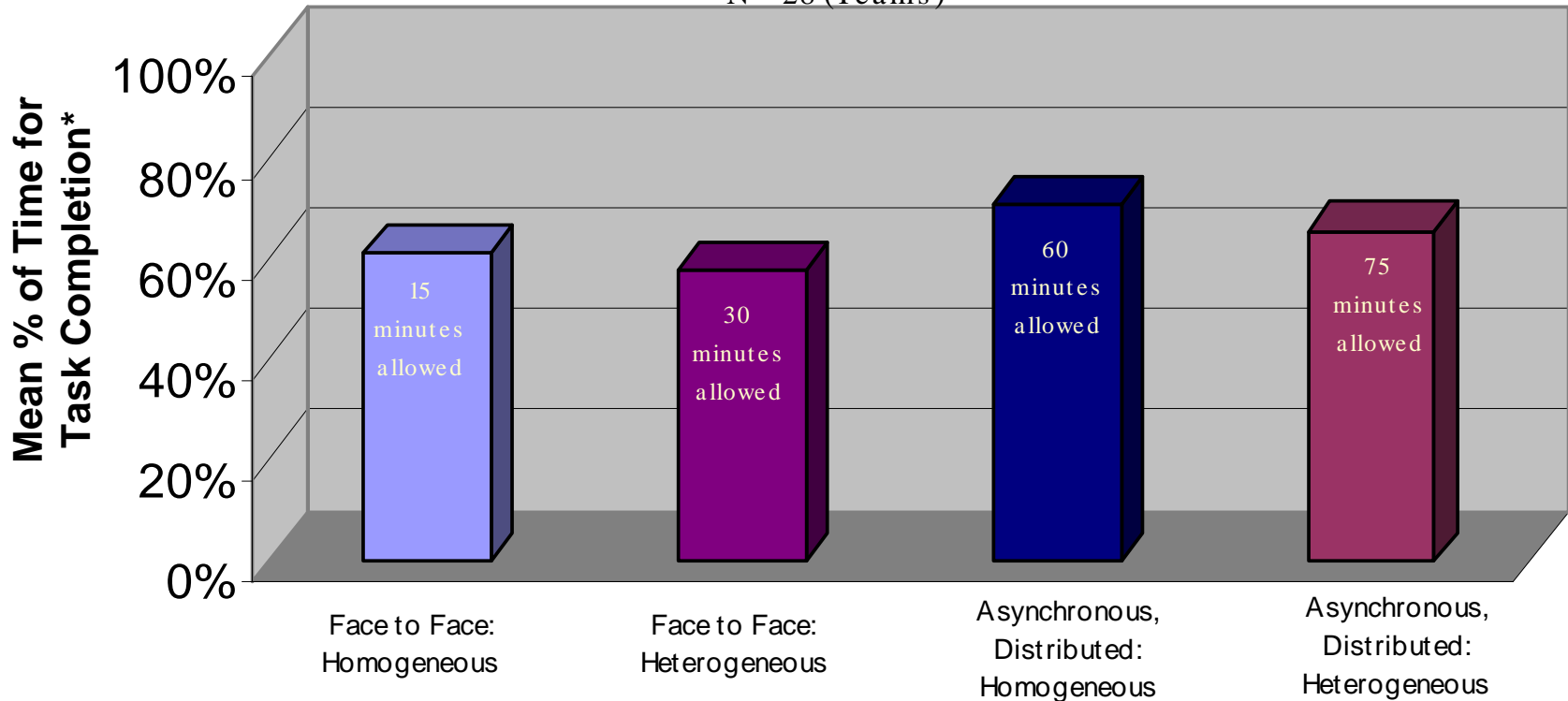


Mean % of Time for Task Completion by Collaboration Mode & Knowledge Distribution

CM: $F = 0.6406$, $p = 0.431353$ KD: $F = 0.1491$, $p = 0.702782$

CM*KD: $F = 0.0006$, $p = 0.933647$

N = 28 (Teams)



*Team time = utterance time for each team
Divided by time allowed for each team

Collaboration Mode vs. Knowledge Distribution



CASC Phase I Results



Mean % Time by Collaboration Stages Collaboration Mode (CM) vs. Knowledge Distribution (KD)

Team Knowledge Base Construction:

CM: $F = 5.51323$, $p = 0.027449$
 KD: $F = 1.70682$, $p = 0.203780$
 CM*KD: $F = 6.02627$, $p = 0.021724$
 N = 84

Collaborative Team Problem Solving:

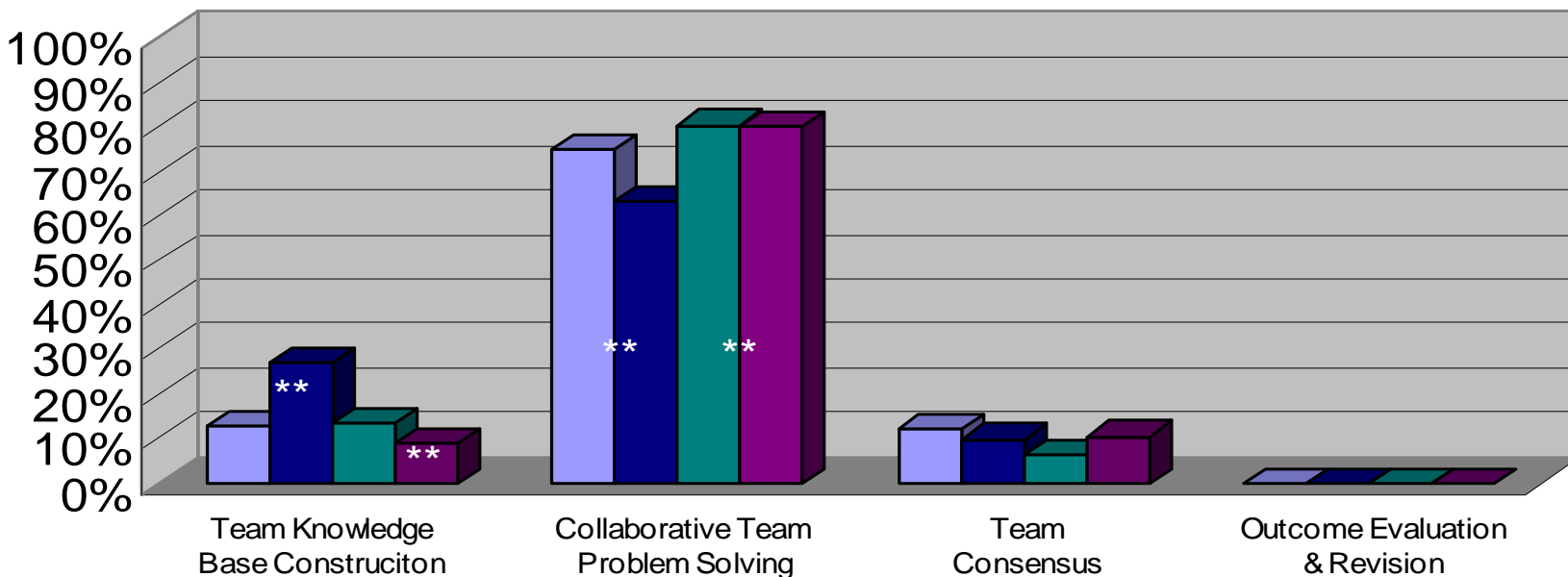
CM: $F = 6.944$, $p = 0.014504$
 KD: $F = 2.010$, $p = 0.169097$
 CM*KD: $F = 1.876$, $p = 0.183471$
 N = 84

Team Consensus:

CM: $F = 0.51854$, $p = 0.478422$
 KD: $F = 3.43855$, $p = 0.07602$
 CM*KD: $F = 0.82967$, $p = 0.371425$
 N = 84

Collaboration Mode/Knowledge Distribution:

- Face to Face Homogeneous
- Face to Face Heterogeneous
- Asynchronous, Distributed Homogeneous
- Asynchronous, Distributed Heterogeneous



Adjusted* Mean % Time Spent in Each Stage

** = significantly different

Collaboration Stages

*Adjusted: Each team's time per stage was calculated by dividing the utterance time for each stage by the total utterance time for the team.

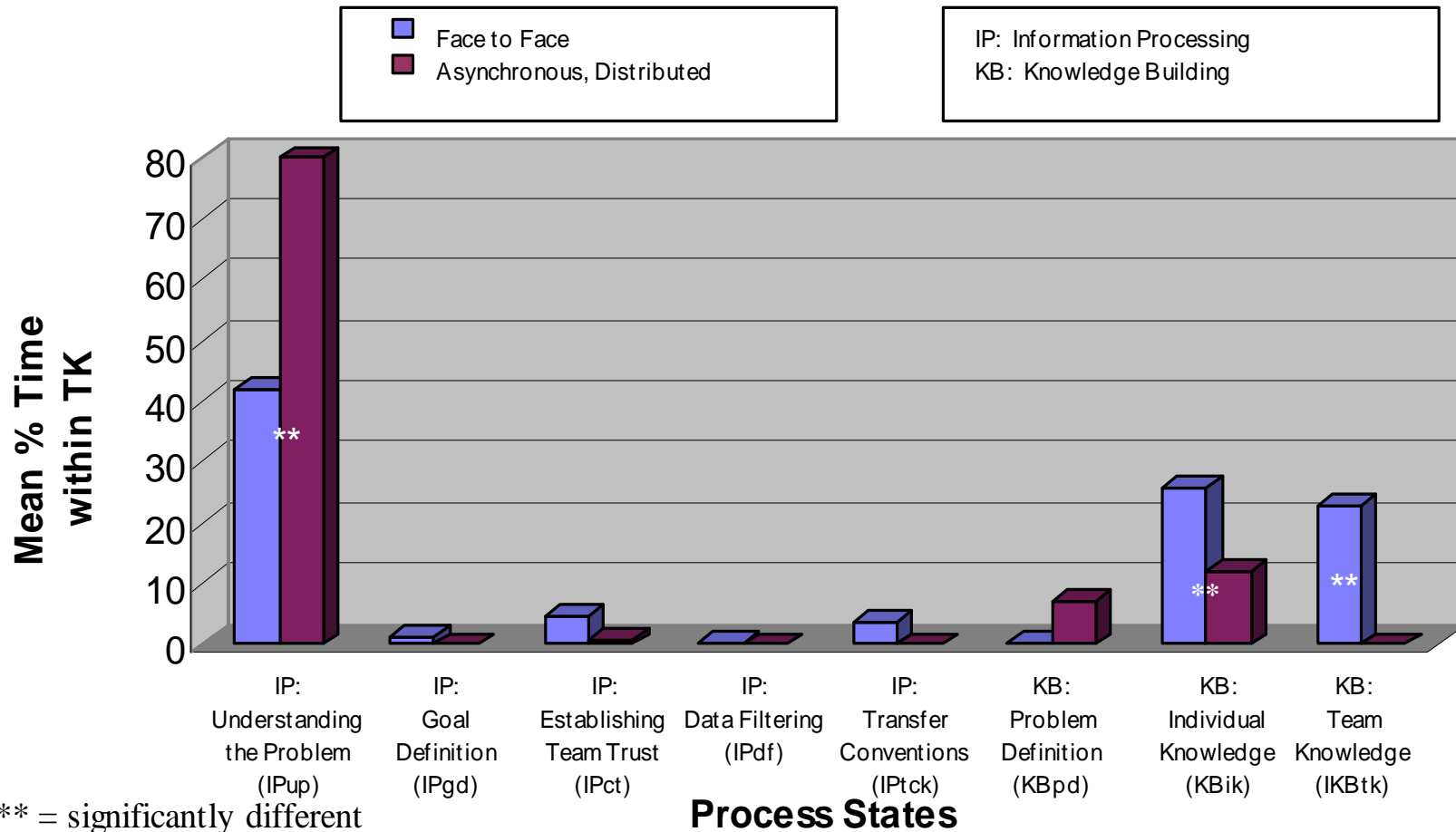


CASC Phase I Results



Mean % Time By Cognitive Process States: Team Knowledge Construction (TK)

Wilks lambda = 0.402182, F = 3.158681, p = 0.022010





CASC Phase I Results

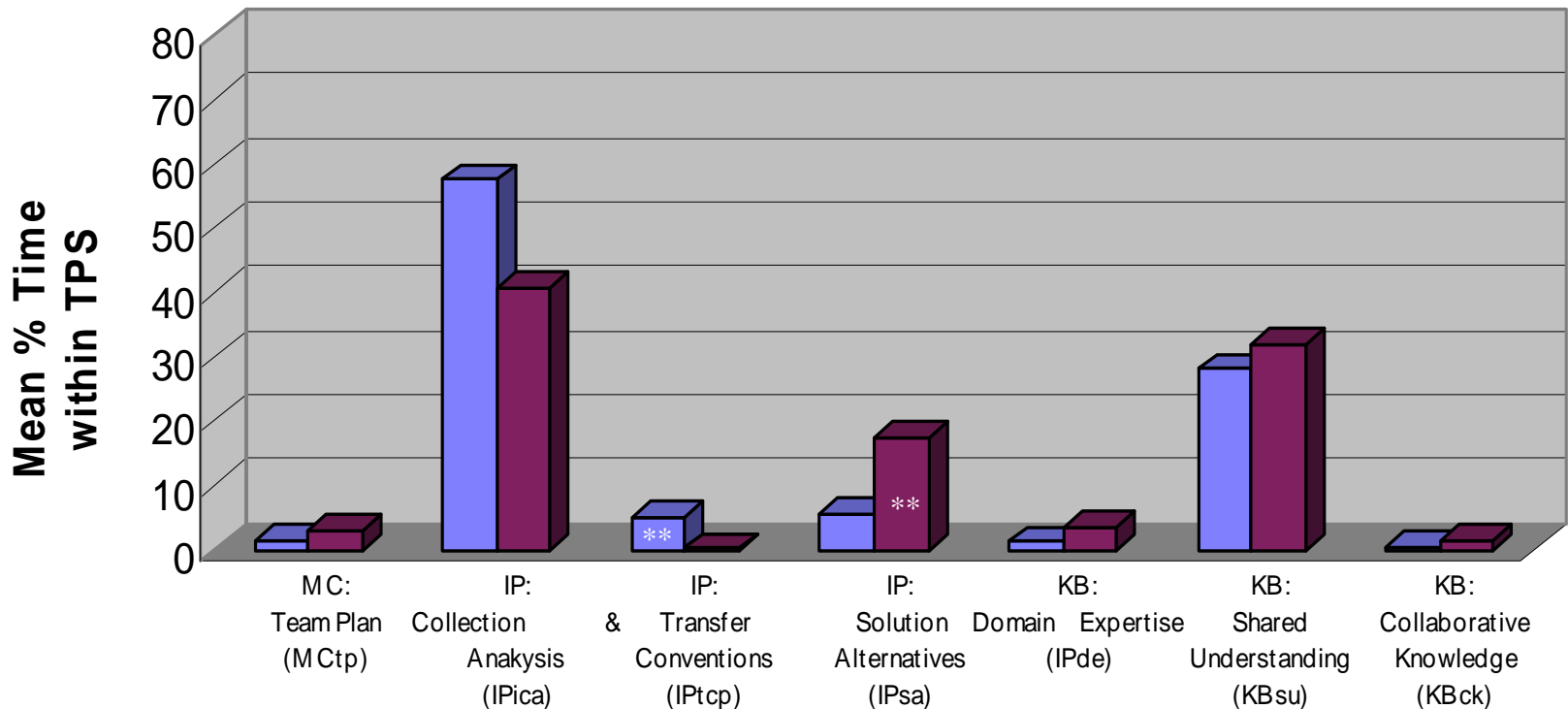


Mean % Time By Cognitive Process States: Collaborative Team Problem Solving (TPS)

Wilks lambda = 0.00033 F = 9605.498 p = 0.000000

- Face to Face
- Asynchronous, Distributed

MC: Meta-cognitive
 IP: Information Processing
 KB: Knowledge Building



** = significantly different

Process States





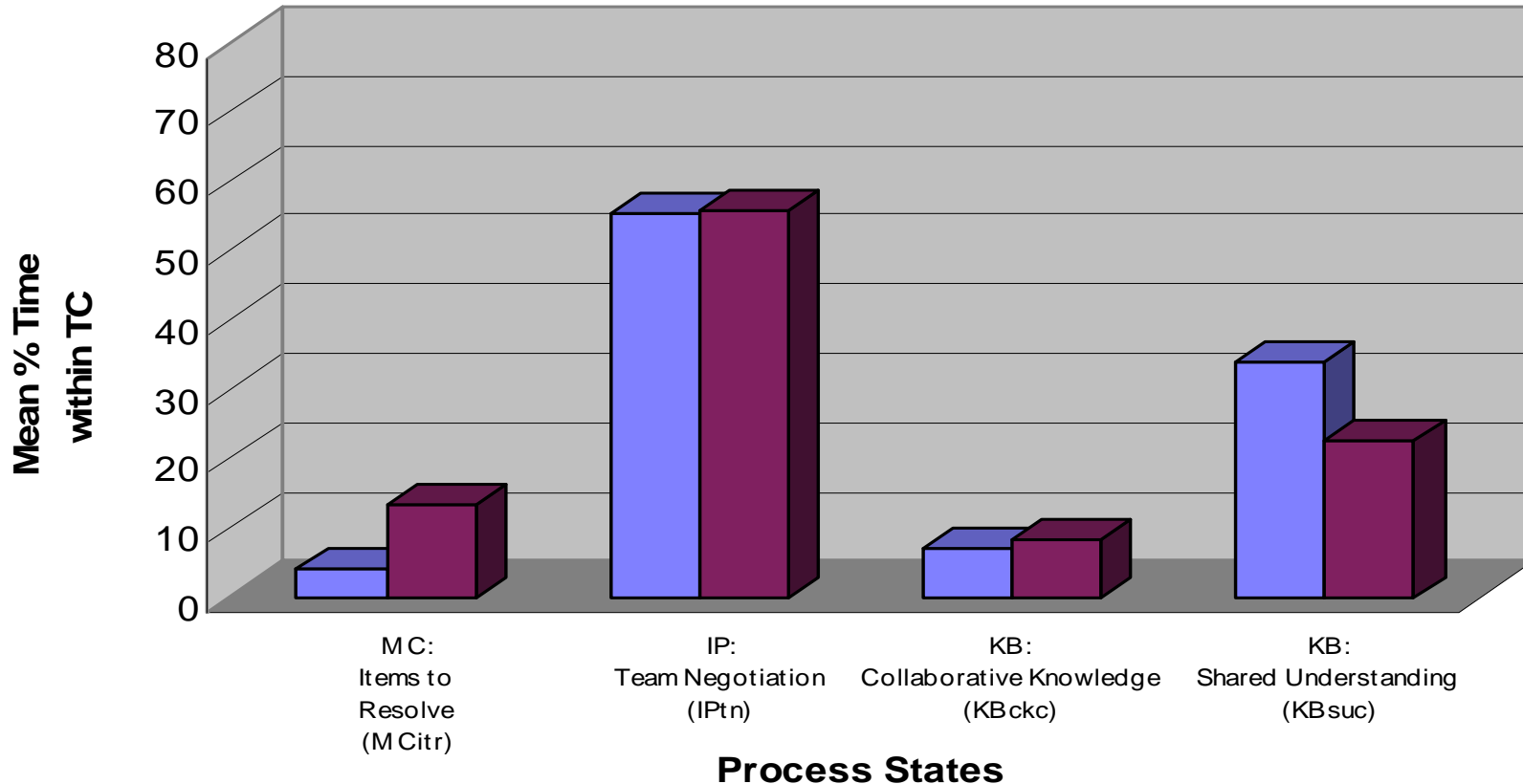
CASC Phase I Results



Mean % Time By Cognitive Process States: Team Consensus (TC)

Wilks lambda = 0.815855, F = 1.65519, p = 0.205648

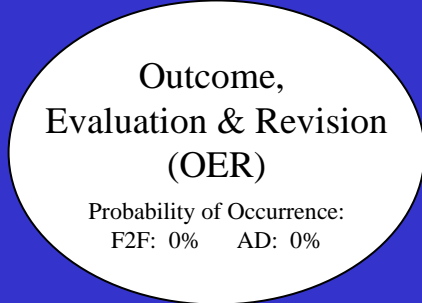
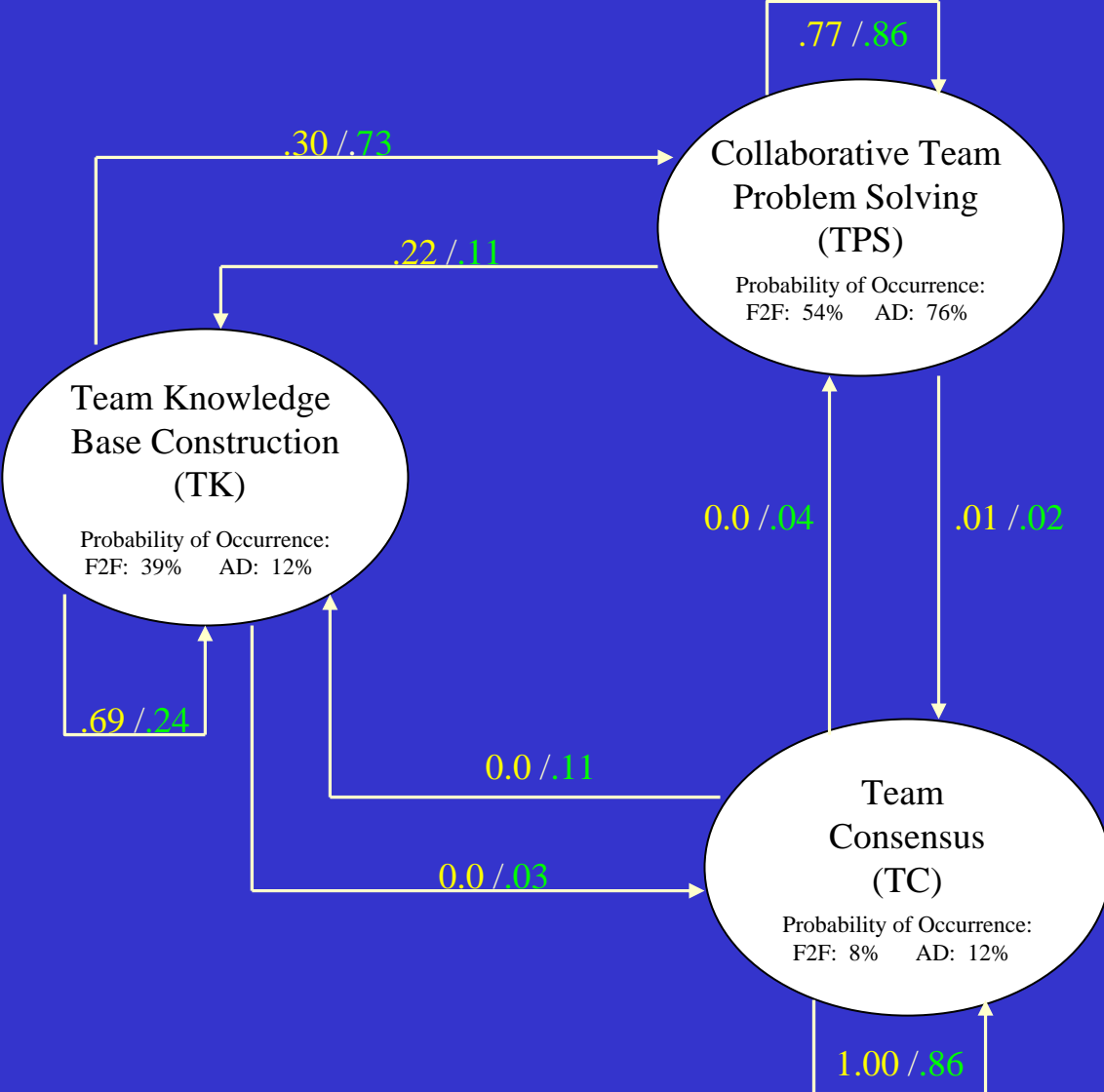
 Face to Face	MC: Meta-cognitive IP: Information Processing KB: Knowledge Building
 Asynchronous, Distributed	



** = significantly different



Transition Probabilities: Collaboration Stages



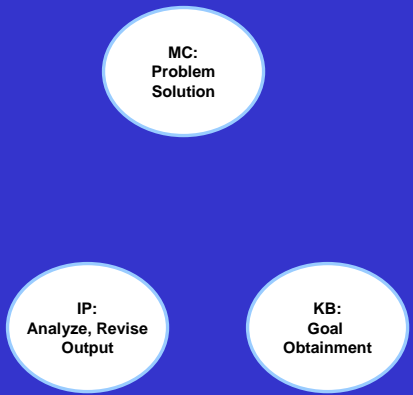
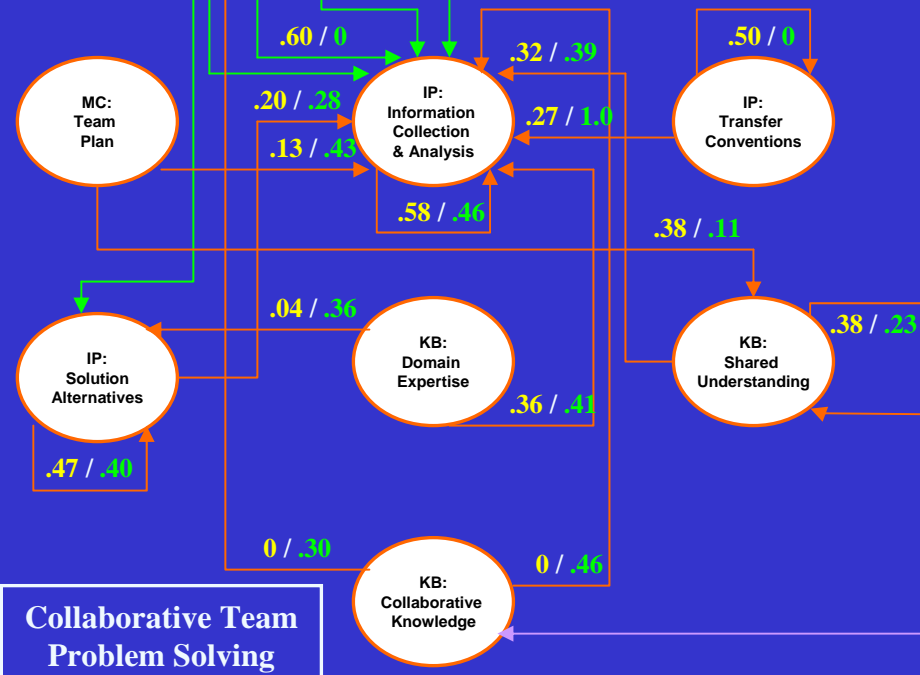
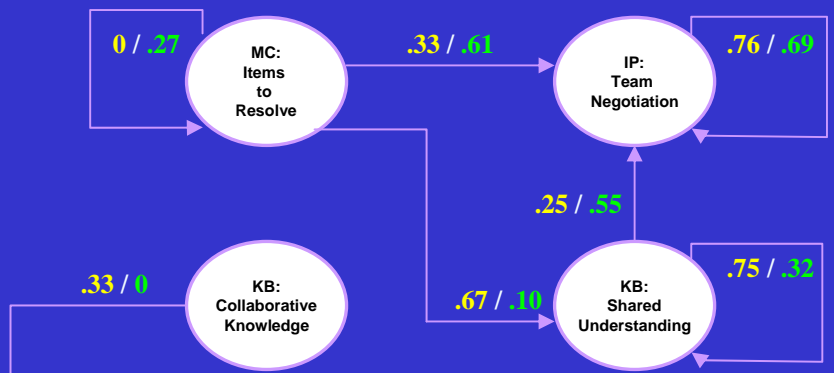
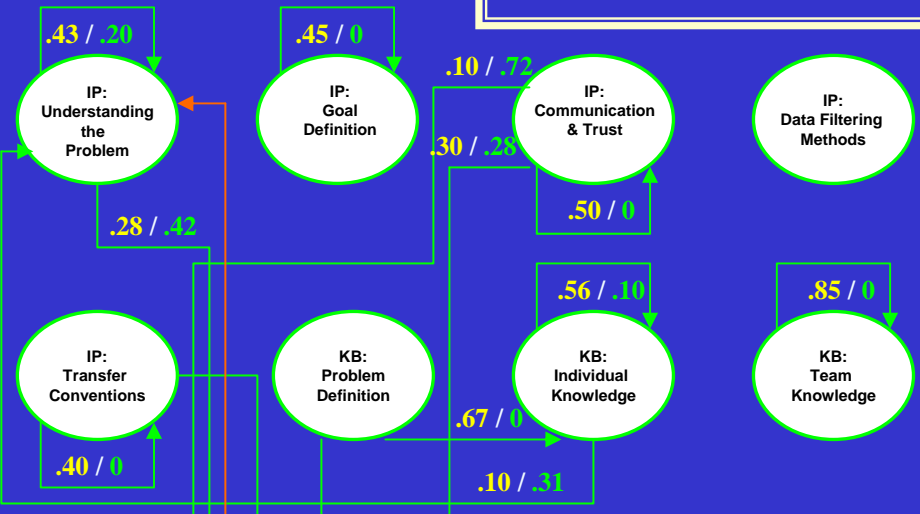
Legend:

- Yellow square: Face to Face (F2F)
- Green square: Asynchronous, Distributed (AD)

Transition Probabilities: Process States

Team Knowledge Construction

Team Consensus



IP: Information Processing
 KB: Knowledge Building
 MC: Meta-cognitive

Face to Face (F2F)
 Asynchronous, Distributed (AD)

NOTE: Transition probabilities are represented only if at least one value of the Face to Face/ Asynchronous pair is ≥ 0.25 .

Collaborative Team Problem Solving

Outcome Evaluation & Revision



CASC Phase I Conclusions



Collaboration Stages

- **Face-to-Face heterogeneous teams spend significantly *more time in team knowledge construction* than asynchronous, distributed heterogeneous teams. There was no difference between the homogeneous teams.**
- **Asynchronous, distributed teams spend *more time in the collaborative problem solving stage* than face-to-face teams. There was no difference between homogeneous and heterogeneous teams with regard to time spent in the collaborative problem solving stage.**
- **There was *no difference in the amount of time spent* in team consensus and outcome evaluation & revision stages between collaboration mode and knowledge distribution conditions**



CASC Phase I Conclusions

Cognitive Process States



- In **team knowledge base construction (TK)** the face-to-face teams spend significantly **more time developing individual knowledge and team knowledge** than the asynchronous, distributed teams. Asynchronous, distributed teams spend significantly **more time understanding the problem** compared to Face-to-Face teams.
- In **collaborative team problem solving (TPS)** the face-to-face teams spend significantly **more time in using conventions to transfer meaning** compared to asynchronous, distributed teams. Asynchronous, distributed teams spend significantly **more time developing solution alternatives** compared to Face-to-Face teams.
- In **team consensus (TC)** there were **no significant differences** between Face-to-Face and Asynchronous, Distributed teams in team consensus process states.



CASC Phase I Conclusions Transition Probabilities and Paths



- Both face-to-face and asynchronous, distributed teams **demonstrated dynamic transitions** between Team Knowledge Base Construction (TK), Collaborative Problem Solving,(TPS) and Team Consensus stages (TC). Outcome Evaluation & Revision stage was not used by either team type because there was no need to revise given our domain task.
 - * **Face-to-face teams** demonstrated mostly a **linear path** between TK, TPS and TC whereas **asynchronous, distributed teams** showed **non-linear path with feedback loops (area for agent support)**
- During **team knowledge base construction(TK)** face-to-face teams demonstrated **more transitions** between the TK cognitive process states than the asynchronous, distributed teams. **Transition probabilities** for the face-to-face teams **were higher** in most cases compared to the asynchronous, distributed teams
- During **collaborative team problem solving (TPS)** both team types focused on the **information collection and analysis** process state (IPica). Also, the IPica state was the **main transition state from the TK stage.**



CASC Phase I Conclusions

Transition Probabilities and Paths (continued)



- During **team consensus** both team types showed dynamic transitions between the process states of **team negotiation** and **shared understanding**. **Low probability of transition** back to cognitive process states within Team Problem Solving or Team Knowledge Construction stages
- **No dynamic transitions** into the cognitive process states of the Outcome Evaluation & Revision stage by either team type



Project Status

FY04 Plans



Phase II Experiment

- **Collaboration Task:**

- **Expanded NEO Mission Scenario (Warner, Wroblewski, Schuck, Cowen, Letsky, 2003)**
 - * see Appendix C for detail scenario
 - * developed with expertise from operational personnel (Navy Seal, Marine, Army aircrew)

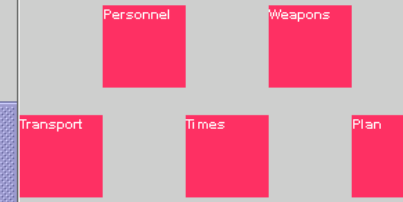
- **Mission Statement ---**

The time is 2:00am, January 15. Your mission is to rescue 3 stranded Red Cross workers from a church basement, on a remote island, caught in the middle of guerilla warfare, within 24 hours. The situation is described in the next few pages along with the assets of US forces which are available to rescue the workers. You need to work together and develop a course of action (using ANY assets available to you), which includes a plan for getting to the church, a plan for evacuating the workers, and a plan for the return to the Army base or aircraft carrier. The course of action solution can be an Army, Marine, Navy Seals solution, or a combination of the assets of the three. You want to choose the optimal and most efficient solution. You want to minimize damage to the village and villagers; you want to avoid contact with enemy if possible, and to rescue the workers safely. However, the rules of engagement are that any forces will defend themselves if needed. Good Luck!

- **Asynchronous, Distributed Collaboration Environment:**

- **Modified Ewall workstation and visualization area**
 - * see Appendix D for design specification for Ewall modifications
 - * see next four slides for modified Ewall workstation display

might be by helo risky, because of high visibility	let me check on fuel thing brb	longest range helicopter goes 500 mi	what is the crew capacity, because we	do you see what I am saying?	hahah I don't have fuel info	longest range can hold 38 extra people,	a Navy sh-60, I believe can carry 12
(Station 3) Untitled ZOOM and pick up 3 red crossers and still be ok?	(Station 3) Untitled ZOOM a marine team has medics too right?	(Station 1) Untitled ZOOM translator, it can refuel in fight for ride back	(Station 2) Untitled ZOOM So we are kinda leaning on helo's?	(Station 3) Untitled ZOOM ok that sounds good, now where and when?	(Station 1) Untitled ZOOM amrine=marine, sorry	(Station 3) Untitled ZOOM because the coral reefs could be a problem	(Station 2) Untitled ZOOM I would think that it would take too long



Knowledge Building and Collaboration

Untitled

ZOOM

go over
enemy so
how will

Untitled

ZOOM

amrine=marine,
sorry

Untitled

ZOOM

if we use
amrine CH-30
it can refuel in

Untitled

ZOOM

longest range
can hold 38
extra people,

Untitled

ZOOM

longest range
helicopter
goes 500 mi

Transport

ZOOM

helicopter

Personnel

ZOOM

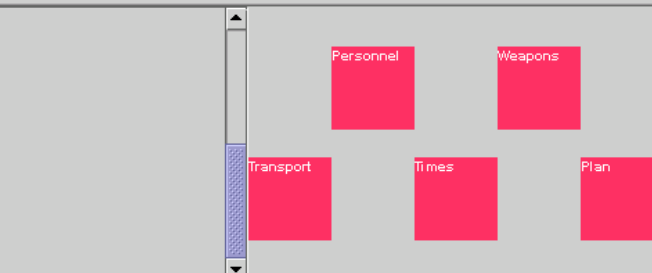
army

(Station 1) Untitled ZOOM The water temperature is 84o F.	(Station 1) Untitled ZOOM The waters around Drapo are a	(Station 1) Water Rescue ZOOM They shouldn't be too cold if they go by the water	(Station 1) Untitled ZOOM The water temperature is 84o F.	(Station 1) Untitled ZOOM The water temperature is 84o F.	(Station 1) Water Rescue ZOOM They shouldn't be too cold if they go by the water	(Station 1) Untitled ZOOM The waters around Drapo are a	(Station 1) Untitled ZOOM I still think we should fly over the mountains
(Station 1) Untitled ZOOM	(Station 1) Untitled ZOOM	(Station 1) Untitled ZOOM	(Station 1) Untitled ZOOM	(Station 1) Untitled ZOOM	(Station 1) Untitled ZOOM	(Station 1) Untitled ZOOM	(Station 1) Untitled ZOOM

Holding Room

(Station 1) Untitled ZOOM So, who do you think we should use?	(Station 1) Untitled ZOOM Personally, I'm leaning more	(Station 1) Untitled ZOOM I don't know. What do you think?	(Station 2) Untitled ZOOM I'm not sure.	(Station 2) Untitled ZOOM I'm thinking maybe the Navy	(Station 2) Untitled ZOOM The time is 2:00 am, January 15th.	(Station 2) Untitled ZOOM The island is 400 miles wide by 400	(Station 2) Untitled ZOOM Suppressive fire by aircraft can be used	(Station 1) Untitled ZOOM That's true... but are you sure you
(Station 1) Untitled ZOOM Choose the best and most efficient	(Station 1) Untitled ZOOM The water temperature is 84o F.	(Station 1) Water Rescue ZOOM They shouldn't be too cold if						

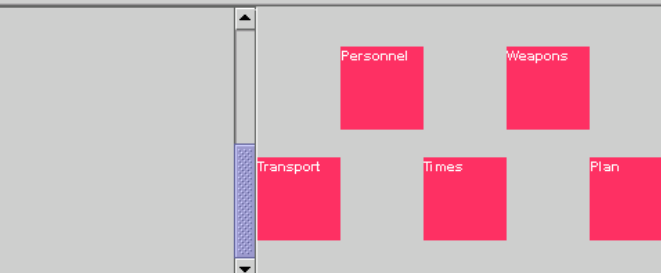
power, and with them a seal team on each bird	we take a translator in case or won't we need him?	Army base is too far, so how about 2 seahawks?	i suppose we sould send them out right	seahawks? what are they	when is the moon not its brightest?	black hawks with navy seals?	sorry, I meant SH 60
(Station 1) Untitled	(Station 3) Untitled	(Station 1) Untitled	(Station 3) Untitled	(Station 1) Untitled	(Station 3) Untitled	(Station 3) Untitled	(Station 1) Untitled
ZOOM	ZOOM	ZOOM	ZOOM	ZOOM	ZOOM	ZOOM	ZOOM
we wont be flying over enimy, we will	SH 60 is the same helo as a blackhawk, just Navy	ok, does the same things then fine	we want blackhawks from Army base??nright	yeah, with navt seals on board i guess	ok	ok to the consensus room?	writing on mirror plan what we know?



Consensus Room

Station 1	Personnel ZOOM army	Transport ZOOM black hawk	Times ZOOM leave base at 3am twards church	Plan ZOOM refue in flight on way back
Station 3	Transport ZOOM 2 UH 60 blackhawks			
Station 2	Transport ZOOM sh-60, I agree	Times ZOOM 3am		

I think so	well i think 9pm would be better, helo goes 184m/hr	we have to do this before the sun comes up today	to prep...manpo wer wise you know?	Are we still refueling on way back?	ok, how many miles from base to church?	sunrise is at 6am..so 5 would be too late	yes on refule Q
(Station 3) Untitled	(Station 3) Untitled	(Station 1) Untitled	(Station 1) Untitled	(Station 3) Untitled	(Station 2) Untitled	(Station 3) Untitled	(Station 3) Untitled
ZOOM	ZOOM	ZOOM	ZOOM	ZOOM	ZOOM	ZOOM	ZOOM
yes refueling	y'all decide on time, I just don't hink day	well it's either 3am (night) or 9pm (night)	put for wepons, riflemen		lets stick with the arrive 3 am	sorry, how many seals g	sorry, how many seals go in the church



Final Planning Room

Personnel	Transportation	Weapons	Critical Times	Detailed Plan	Additional Comments
2 teams of SEALS	2 uh-60 Blackhawks		Onset: 2:15 am Contact: 3:00 am Evacuation: 3:30 am Return: 4:15 am	Fly to church pick up red cross workers and refueling on way back	

Final Submission

Untitled

ZOOM

times are wrong, we can't start at 2, it's



Phase II Experiment FY04 Plans



Independent Variables:

- **Collaboration Mode** (face-to-face vs asynchronous, distributed)
 - * **Face-to-Face** = team interacts synchronously with each other through speech
 - * **Asynchronous, Distributed** = team interacts with each other at different times and from different locations through the Ewall collaboration environment

- **Knowledge Dynamics** (static vs dynamic knowledge)
 - * **static knowledge** = all information (I.e. background information, rebels, Navy Seals, Marine and Army assets, Intell, weapons and environment expertise information) remains the same throughout the collaborative NEO scenario problem

 - * **dynamic knowledge** = Selected information (I.e. rebels, weather, time to rescue, condition of red cross workers) changes at a standard time in the collaborative NEO scenario problem



CASC PHASE II EXPERIMENTAL DESIGN



(2x2 randomized factorial)

Knowledge Dynamics

Static	Dynamic
Gp 1 * * Gp 8	Gp 17 * * Gp 24
Gp 9 * * Gp 16	Gp 25 * * Gp 32

Phase II

- 32 groups total
- 3 subjects / group
- 96 subjects total

Collaboration Mode Face-to-Face (speech)

Asynchronous, Distributed (Ewall –text, pictures)

Dependent Variables:

Ewall cards and face-to-face audio / video recordings including time stamp per response (i.e. cards and speech)

- **Total time to successfully complete the problem-solving task (time from the beginning of the task until task completion)**
- **Collaboration Maps (post session – subjects construct a map of their view of the stages & cognitive process states of team collaboration)**
- **Subjective Questionnaire – measuring expertise, trust between team members, and general collaboration opinions among members**



CASC PHASE II HYPOTHESES



- Ho: no significant difference between face-to-face and asynchronous, distributed collaboration modes on the collaboration stages and cognitive knowledge building processes in the NEO collaborative problem domain**
- Ho: no significant difference between static and dynamic knowledge on the collaboration stages and cognitive knowledge building processes in the NEO collaborative problem domain.**
- Ho: no significant interaction between collaboration modes and knowledge dynamics on the collaboration stages and cognitive knowledge building process**
- Ho: no significant difference in time or frequency within each cognitive process state across collaboration mode and knowledge dynamic conditions**
- Ho: no convergence of individual mental models with regard to collaboration stages and knowledge building processes**



Accomplishments



- **Development of a Structural Model Of Team Collaboration**

- Describes team collaboration emphasizing the cognitive aspects of the collaboration process.
- The model includes the domain characteristics, collaboration stages, meta-cognitive processes, information processing tasks, knowledge required for each information processing task and the communication mechanisms for knowledge building and information processing tasks.
- Starting point for understanding the cognitive mechanisms of team collaboration
- Offers a model-based approach to experimentation of team collaboration
- Identifies and prioritizes important areas of research in team collaboration
- Serves as a design guideline for an agent-based support tool for team collaboration.

- **CASC Phase I Collaboration Experiment**

- Examined the collaboration stages and cognitive processes used by face-to-face versus asynchronous, distributed teams in a collaborative problem solving task.

- **Transition of Structural Model of Team Collaboration to Naval Air Systems Command Network Centric Warfare Simulation Facility**

- Collaboration model is currently being transitioned into the newly developed Naval Air Systems Command Network Centric Warfare Simulation Facility to improve collaboration between Commanders both at the front end (e.g. mission planning), and during mission execution
- The Naval Air Systems Command Network Centric Simulation Facility represents connectivity between all the relevant assets in a Network Centric battlegroup including air (i.e. Man-Flight Simulation Facility), ships (i.e. Aegis Simulation Facility), Command and Control, Battlespace Visualization (i.e. Crew Station Technology Laboratory) and Collaboration Technology (i.e. Collaboration and Automation Research Laboratory)
- The collaboration model will provide a significant improvement in asynchronous, distributed collaborative decision making within the Network Centric Warfare environment.



**TRANSITION AND DEMONSTRATION
OF
STRUCTURAL MODEL OF TEAM COLLABORATION
IN
NAVAIR AND NAVAL POSTGRADUATE SCHOOL CKM TESTBEDS**

Illustration of Integrated Ewall Environment for Team Collaboration (example: Ewall, Knowledge building model, Information Objects)

(Station 3) Untitled
ZOOM
and pick up 3 red crossers and still be ok?

(Station 3) Untitled
ZOOM
a marine team has medics too right?

(Station 1) Untitled
ZOOM
translation, it can refuel in fight for ride back

(Station 2) Untitled
ZOOM
So we are kinda leaning on helo's?

(Station 3) Untitled
ZOOM
ok that sounds good, now where and when?

(Station 1) Untitled
ZOOM
amrine=marine, sorry

(Station 3) Untitled
ZOOM
because the coral rees could be a problem

(Station 2) Untitled
ZOOM
I would think that it would take too long

Transport

Times

Plan

Knowledge Building and Collaboration

SELECTED NEWS VIEW INFORMATION

Ar defense systems rebolt since 1991 but probably still limited. (MMA) missile systems such as SAMs. Believed still to have some modified. Scud missiles with chemical or biological warheads. Range up to 400 miles. CBU (inc).

Update on Iraqi Forces

Population: 23m
Capital: Baghdad
Language: Arabic, Kurdish
Religion: Islam
Government: Republic
Ministry: Iraq, Dinar
Currency: Dinar

TARGET INFORMATION

Day Locations in Baghdad

GOALS

Target TV Stations

Limit Broadcasting Capabilities

Minimize Radio Trans.

The Iraqi no-fly zones

MIT Mezzanine Area

Title: _____

Criterion: HIST ADMN GAIN PROB

V.Low/Poor Avg. V.High/Good

Credibility: ? ?

Timeliness: ? ?

Confidence: ? ?

V.Neg. Neutral V.Pos.

Effect: ? ?

Importance: ? ?

Discard (1)Avg. (2)High (3)V.High

[Close](#)

Nov-12-03 7:12PM EST
Test

Untitled

General Information

Expertise

Holding Room

Knowledge Building and Collaboration

Consensus Room

Final Planning

0:45:27

Illustration of Integrated Ewall Environment for Team Collaboration

(example: Ewall, Knowledge building model, Information Objects)

(Station 3) Untitled ZOOM and pick up 3 red crossers and still be ok?	(Station 3) Untitled ZOOM a marine team has medics too right?	(Station 1) Untitled ZOOM translator, it can refuel in fight for ride back	(Station 2) Untitled ZOOM So we are kinda leaning on helo's?	(Station 3) Untitled ZOOM ok that sounds good, now where and when?	(Station 1) Untitled ZOOM amrine=marine, sorry	(Station 3) Untitled ZOOM because the coral rees could be a problem	(Station 2) Untitled ZOOM I would think that it would take too long
---	--	--	---	---	--	---	--

Knowledge Building and Collaboration

Nov-12-03 7:12PM EST
Test
Untitled

MIT Mezzanine Area

Untitled
ZOOM
longest range
helicopter
goes 500 mi

Transport
ZOOM
helicopter

Personnel
ZOOM
army

Illustration of Integrated Ewall Environment for Team Collaboration (example: Ewall, Knowledge building model, Information Objects)

(Station 1) Untitled
ZOOM
we wont be flying over enemy, we will

(Station 3) Untitled
ZOOM
sh-60 is the same helo as a blackhawk, just Navy

(Station 1) Untitled
ZOOM
ok, does the same things then fine

(Station 3) Untitled
ZOOM
we want blackhawks from Army base??nright

(Station 1) Untitled
ZOOM
yeah, with navt seals on board i guess

(Station 3) Untitled
ZOOM
ok

(Station 3) Untitled
ZOOM
ok to the consensus room?

News View: Transport, Times, Plan
Test
Untitled

Changes time to perform rescue suggested by team member 3. He concurs with 3am.

New ratings based on updated information (I.e. from News View)

Consensus Room

Station 1	Personnel ZOOM army	Transport ZOOM black hawk	Times ZOOM leave base at 3am towards church	Plan ZOOM refue in flight on way back
Station 3		Transport ZOOM 2 UH 60 blackhawks		
Station 2		Transport ZOOM sh-60, I agree	Times ZOOM 3am	



Journal Articles

- Warner, N.W., Letsky, M., Cowen, M.(In Press). Structural Model of Team Collaboration. Paper being submitted to Journal of the Human Factors and Ergonomics Society. (*peer reviewed*)
- Warner, N.W., Wroblewski, E., Vanderwalker, S., and Verma, N. (In Press). The Effect of Collaboration Mode and Knowledge Distribution on the Knowledge Building Process in an Asynchronous, Distributed Collaborative Problem Solving Task. Paper being submitted to the Journal of Human Factors and Ergonomics Society (*peer reviewed*)
- Warner, N. W. and Wroblewski, E.(2003). The Cognitive Processes Used in Team Collaboration During Asynchronous, Distributed Decision Making. Paper submitted to the 2004 Command and Control Research and Technology Symposium, June 15 –17, 2004, San Diego, CA. (*peer reviewed*)

Technical Reports

- Warner, N.W., Vanderwalker, S. and Verma, N. (2003). Collaborative Knowledge in Asynchronous Collaboration (CASC). Collaboration and Knowledge Management Workshop Proceedings, January 14-16, 2003. Office of Naval Research, Code 342, Arlington, Va.
- Warner, N.W. Vanderwalker, S., Verma, N. and Narkevicius, J. (2002). State of the Art Review of Human-Human Collaboration Research: An Integrated, Multidisciplinary Perspective. Collaboration and Knowledge Management Workshop Proceedings, January 14-16, 2003. Office of Naval Research, Code 342, Arlington, Va.



Lessons Learned



- Both face-to-face and asynchronous, distributed teams demonstrated behavior that **supports the existence of Team Knowledge Construction, Collaborative Problem Solving and Team Consensus** stages during collaborative problem solving. Phase I data showed that the stages are **task dependent** as the Outcome Evaluation & Revision stage was not used
- The significant cognitive process states were **Understanding the Problem, Individual Knowledge and Team Knowledge** development, **Conventions for Transferring Meaning**, and developing **Solution Alternatives**
- Knowledge Distribution (homogeneous / heterogeneous information) **significantly influenced** how team knowledge was developed
- Asynchronous, Distributed teams spent **more time** in Collaborative Problem Solving stage than face-to-face teams. Appears to be more difficult to solve collaborative problems with these types of teams even though collaboration environment is inherently more structured. Need to determine **why these teams spend more time** so collaborative problem solving can be facilitated
- Face-to-face teams used **conventions to transfer meaning** (e.g. yellow stickers, maps) whereas asynchronous, distributed teams did not use conventions. Need ways to easily create conventions with asynchronous, distributed teams (another area for agent support)