CRGP Collaboratory for Research on Global Projects

Understanding, Modeling and Simulating Global Projects

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Collaboratory for Research on Global Projects

http://crgp.stanford.edu

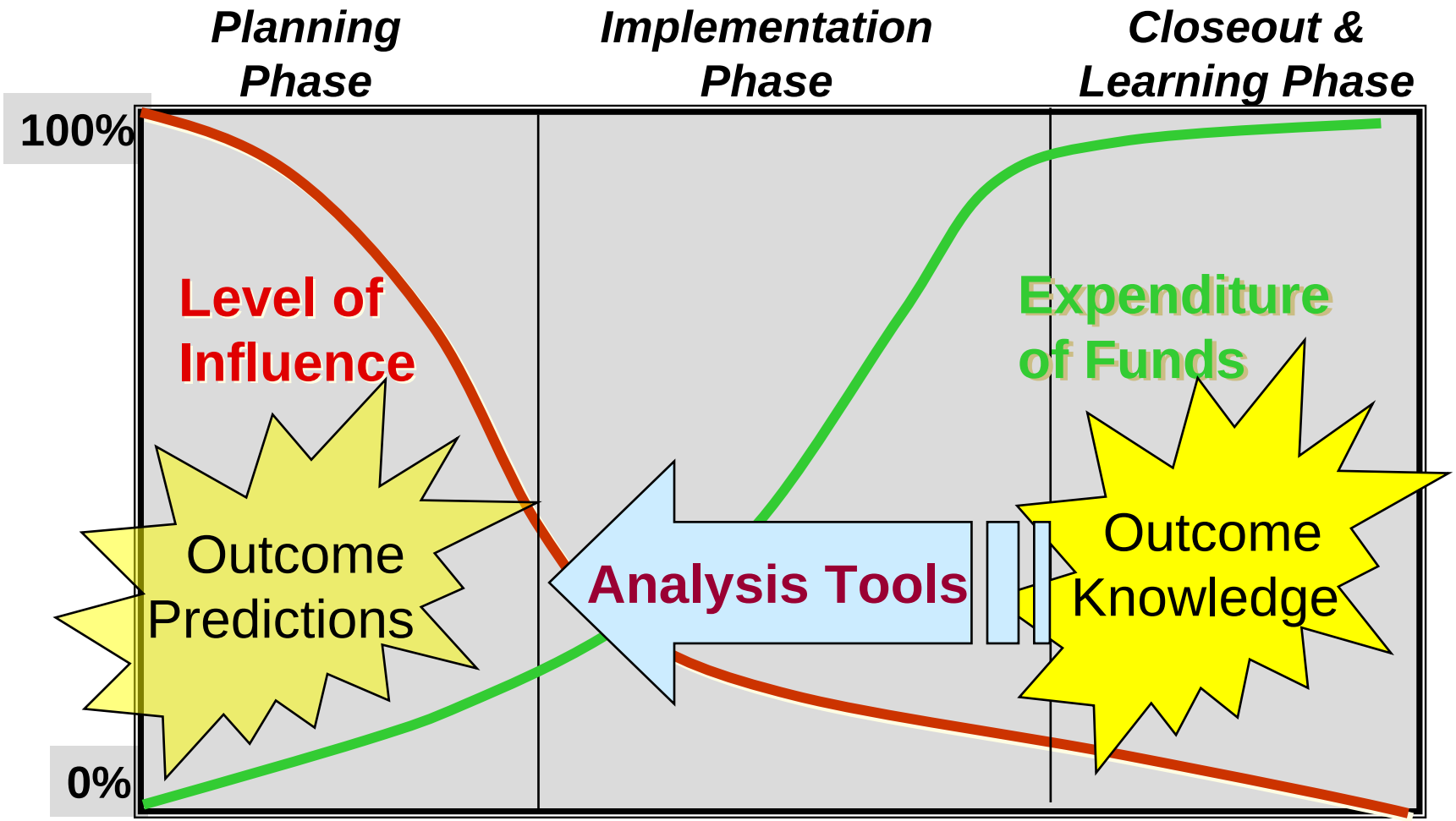
High-level Research Questions

- How can we measure, model and predict the effects of institutional differences on Global Projects?
- How can we design better organizations and institutions to enhance performance outcomes on a specific Global Project?

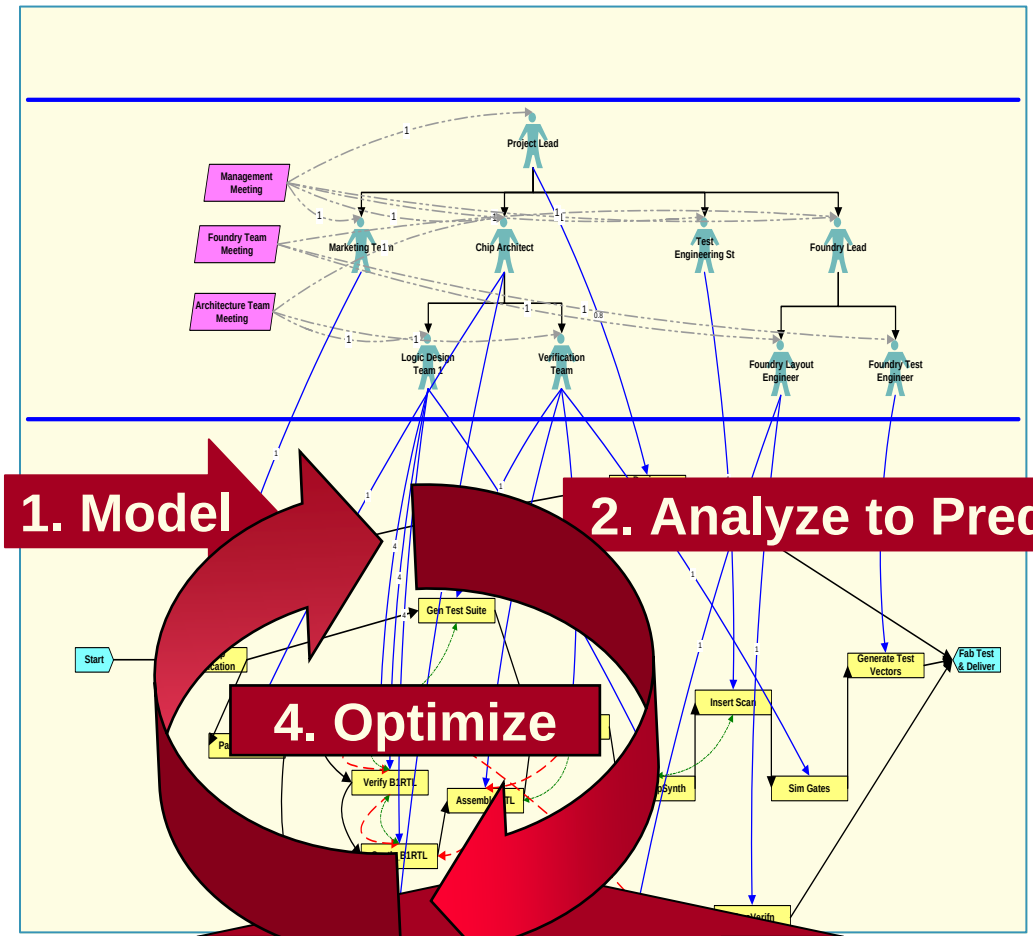
OUTLINE

- **Motivation for Computational Modeling of Organizations**
- VDT: An Information Processing Model of Fast-Track Project Organizations
- Impact of Culturally-Driven Normative Differences on Project Performance
- Diffusion of Systemic Innovations in Project-Based Industries — National Differences

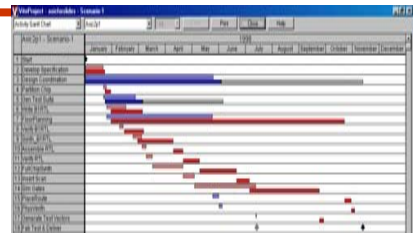
Computational Models Allow Managers to Predict & Mitigate Risks on Global Projects



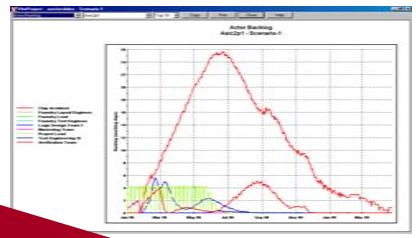
Steps in Organizational Engineering



Schedule



Backlog



Quality

Cost

A Natural Science Analogy

- VDT
  - **Information flow physics of project work processes and organizations**

- VDT-CC/POWER:
  - **Inter-personal and inter-organizational chemistry**

- Innovation Dynamics
  - **Evolutionary Biology**

Points of Departure

- Theoretical Base
  - Project/Matrix Organization Theory
  - Cross-Cultural Differences in Values, Beliefs
  - Institutional Theory
  - Mgt. of Technology and Innovation Theory
- Methods:
  - Ethnographies
  - Case Studies
  - Hypothesis testing
  - Computational modeling and simulation

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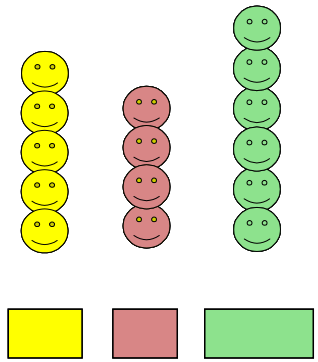
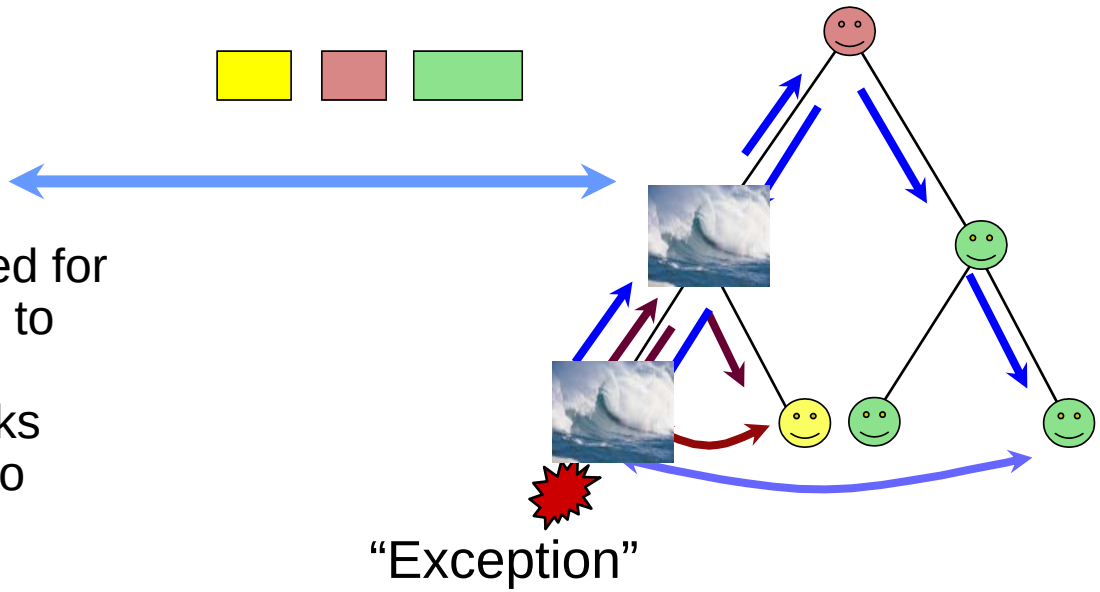
Risk of Information Processing Failures in Organizations

- Direct Work
  - Contributes directly to completion of each worker's or team's assigned tasks
- + "Hidden Work"
  - Arises from the need for workers and teams to **coordinate** their interdependent tasks and for managers to **supervise**,





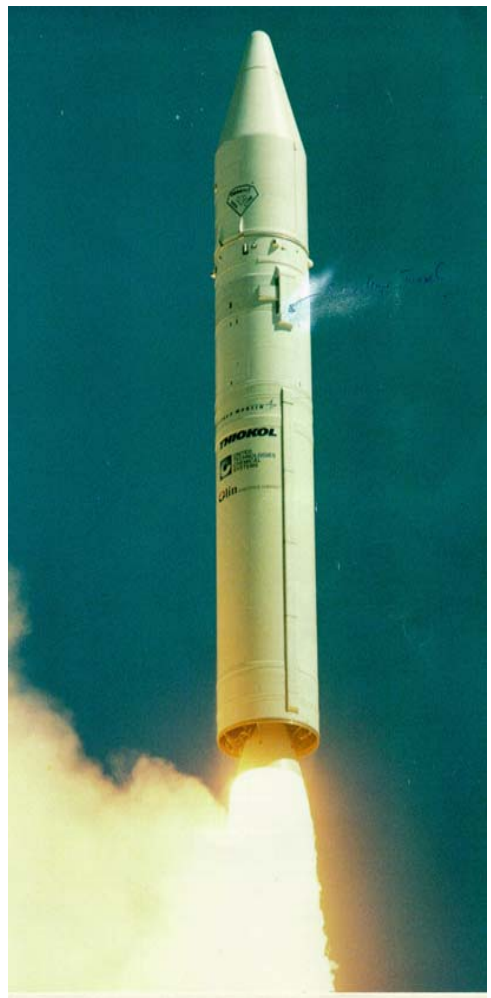
Source: Galbraith, Jay. *Designing Complex Organizations*. Reading, MA: Addison-Wesley, 1973.

Fast-Track Project Ethnography: ***Lockheed Martin Launch Vehicle***

- **Goal:** *Shrink time-to-market for LMLV by* 80% vs. Trident missile!
- **Highly concurrent**: many interdependent activities must be scheduled concurrently
- **Key components** will be outsourced to minimize cost

Case Study Results:
Lockheed Martin Launch Vehicle

- LMLV1 launched in mid-April 1996—almost **4 months later than planned**
- Launch vehicle "departed controlled flight" and **had to be detonated** by AF safety officer
- Analysis of telemetry data indicated most likely cause of failure to be a **misrouted cable** that shorted out!

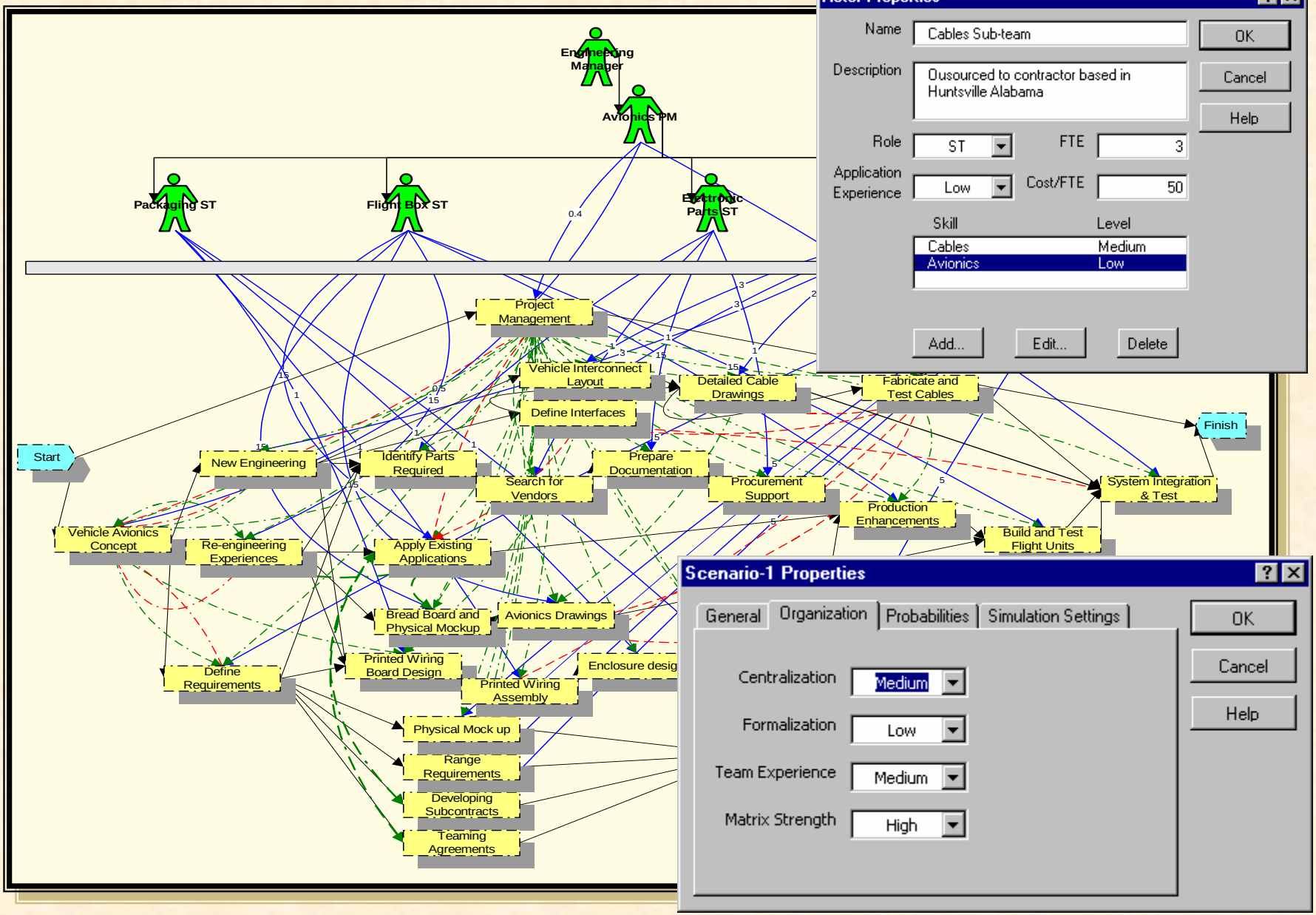


Evolution of Computational Model

Geoff Cohen, Tore Christiansen, Jan Thomsen

- **Model** planned fast-track work process and proposed organization realistically
- ***Simulate*** *organization executing work process to predict schedule/ quality risks*
- **Evaluate** predicted performance *vs.* plan, and intervene to mitigate risks
- **Iterate** to find optimal project design

LMLV Project Avionics Team: *VDT/SimVision* Model



Actor Properties

Name: Cables Sub-team

Description: Ousourced to contractor based in Huntsville Alabama

Role: ST

FTE: 3

Application Experience: Low

Cost/FTE: 50

Skill	Level
Cables	Medium
Avionics	Low

OK | Cancel | Help | Add... | Edit... | Delete

Scenario-1 Properties

General | Organization | Probabilities | Simulation Settings

Centralization: Medium

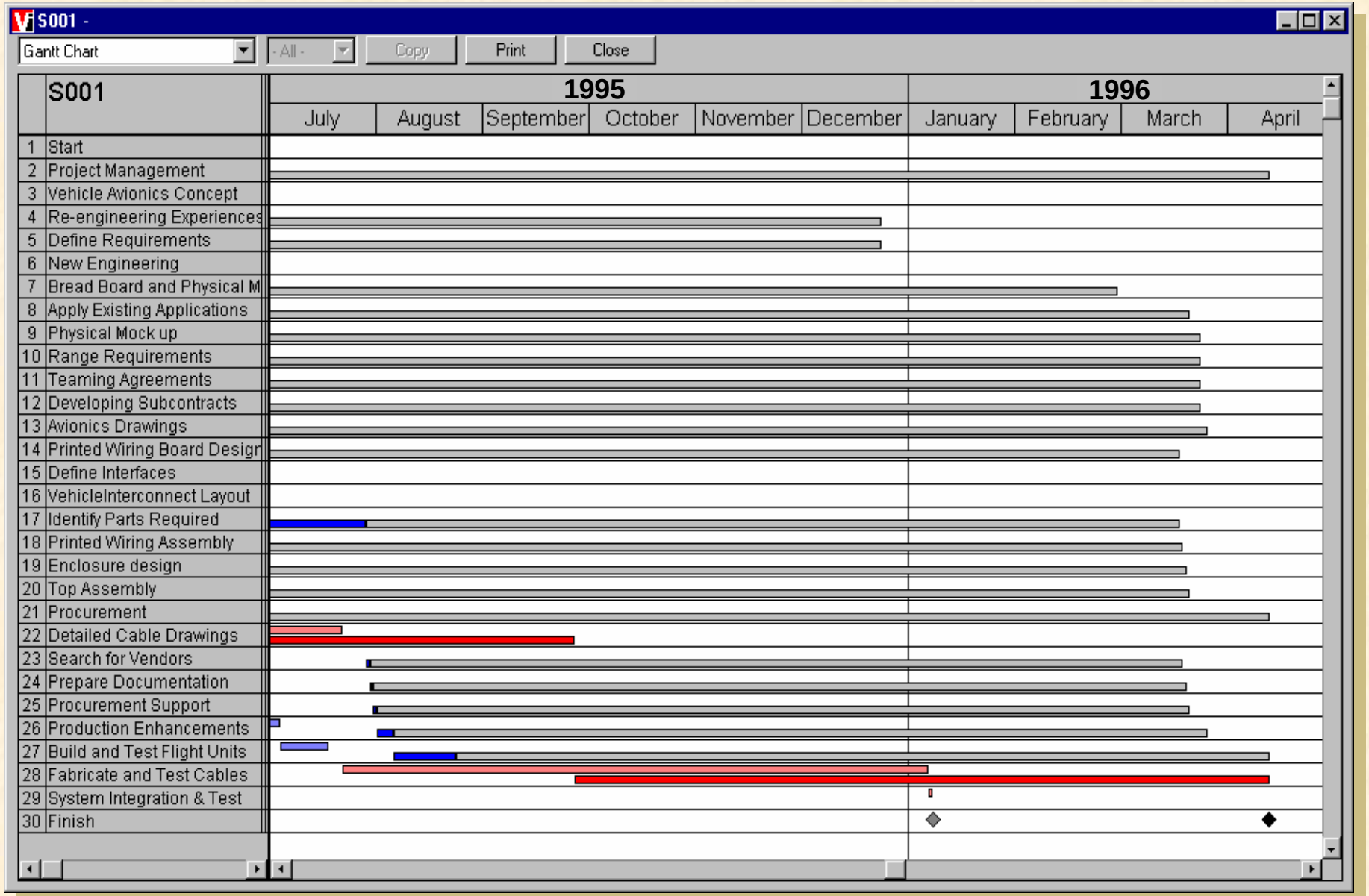
Formalization: Low

Team Experience: Medium

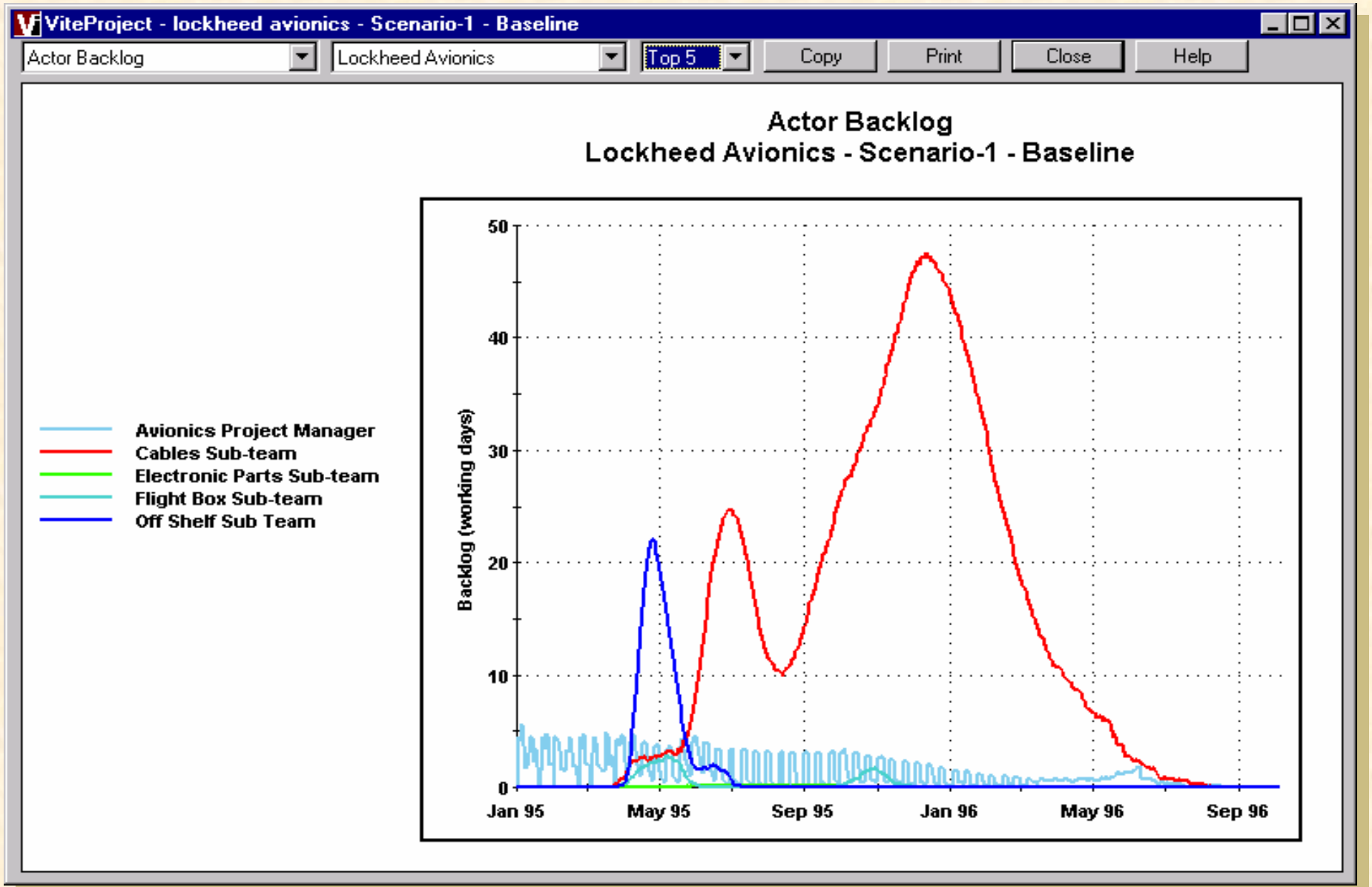
Matrix Strength: High

OK | Cancel | Help

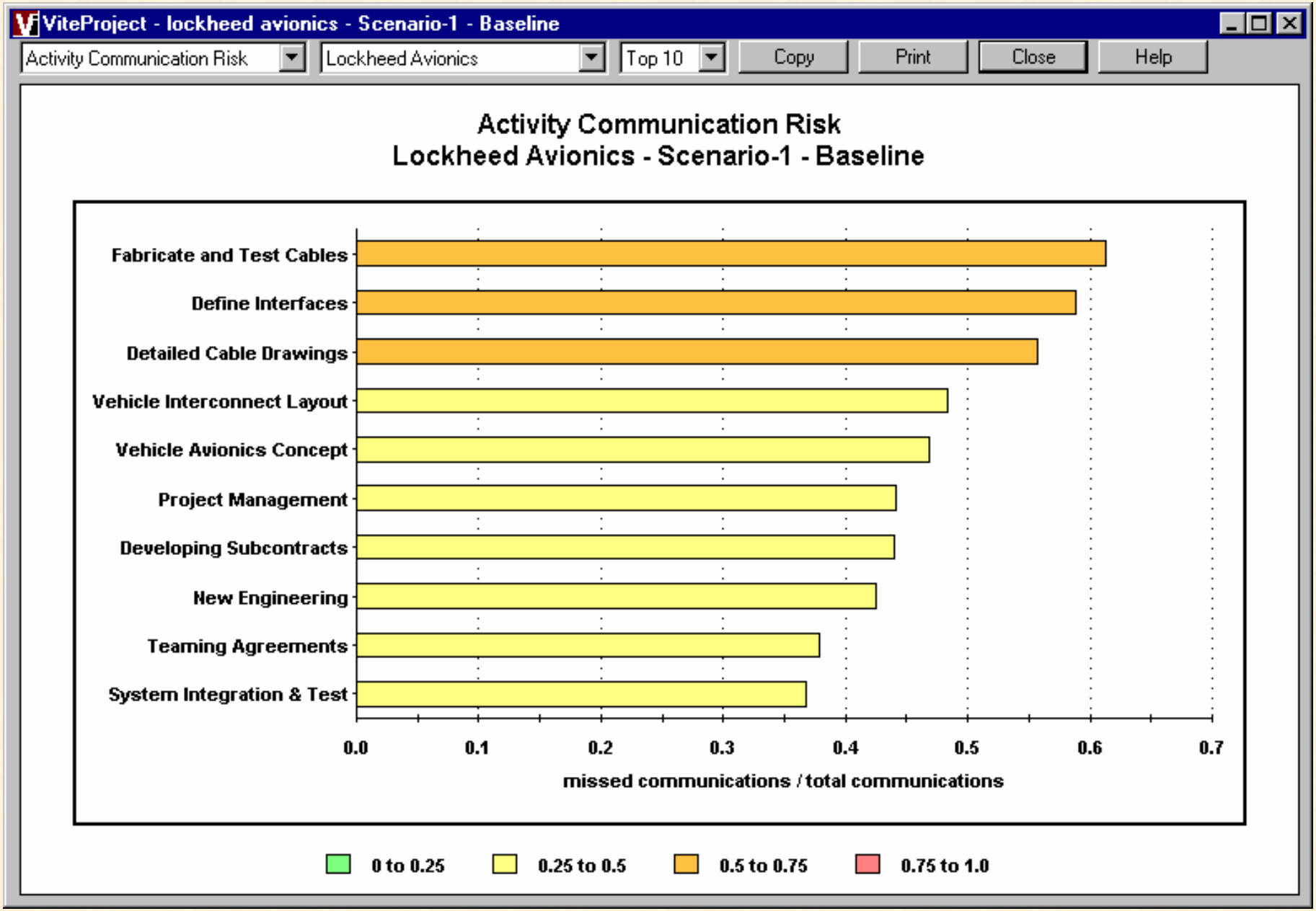
LMLV Project Avionics Team: *Gantt Chart*



LMLV Project: *Key Manager Backlogs*

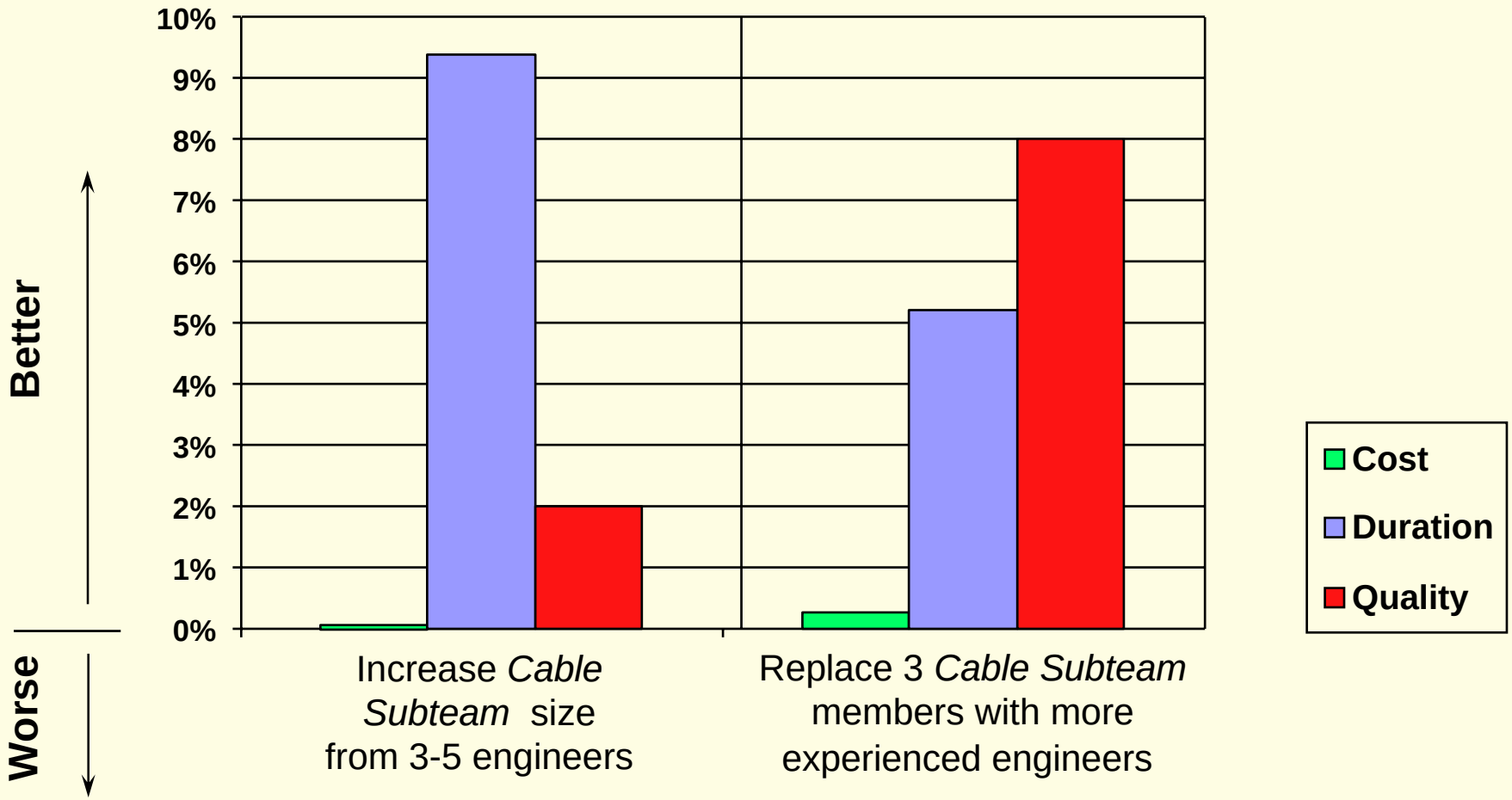


LMLV Project: *Predicted Process Quality Risks*



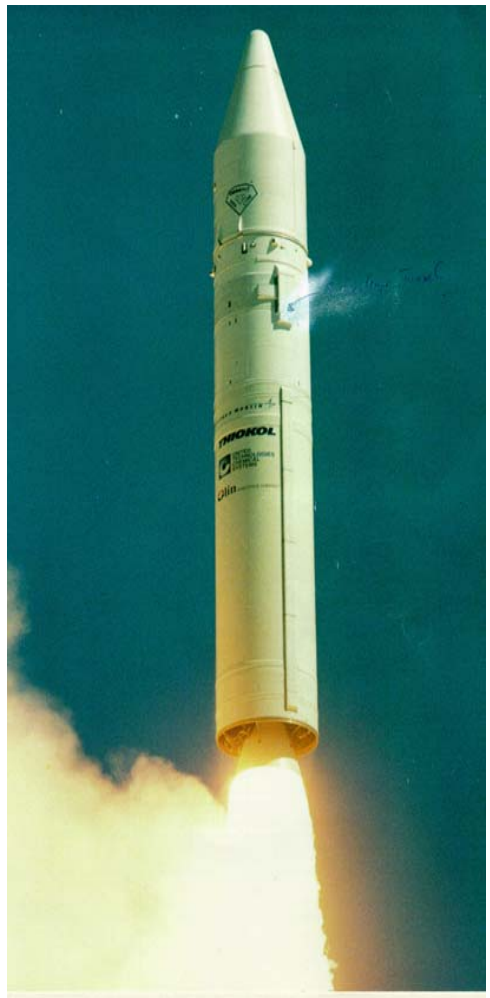
Flight Simulating Managerial Interventions

"What-if Analysis" of LMLV Avionics Team

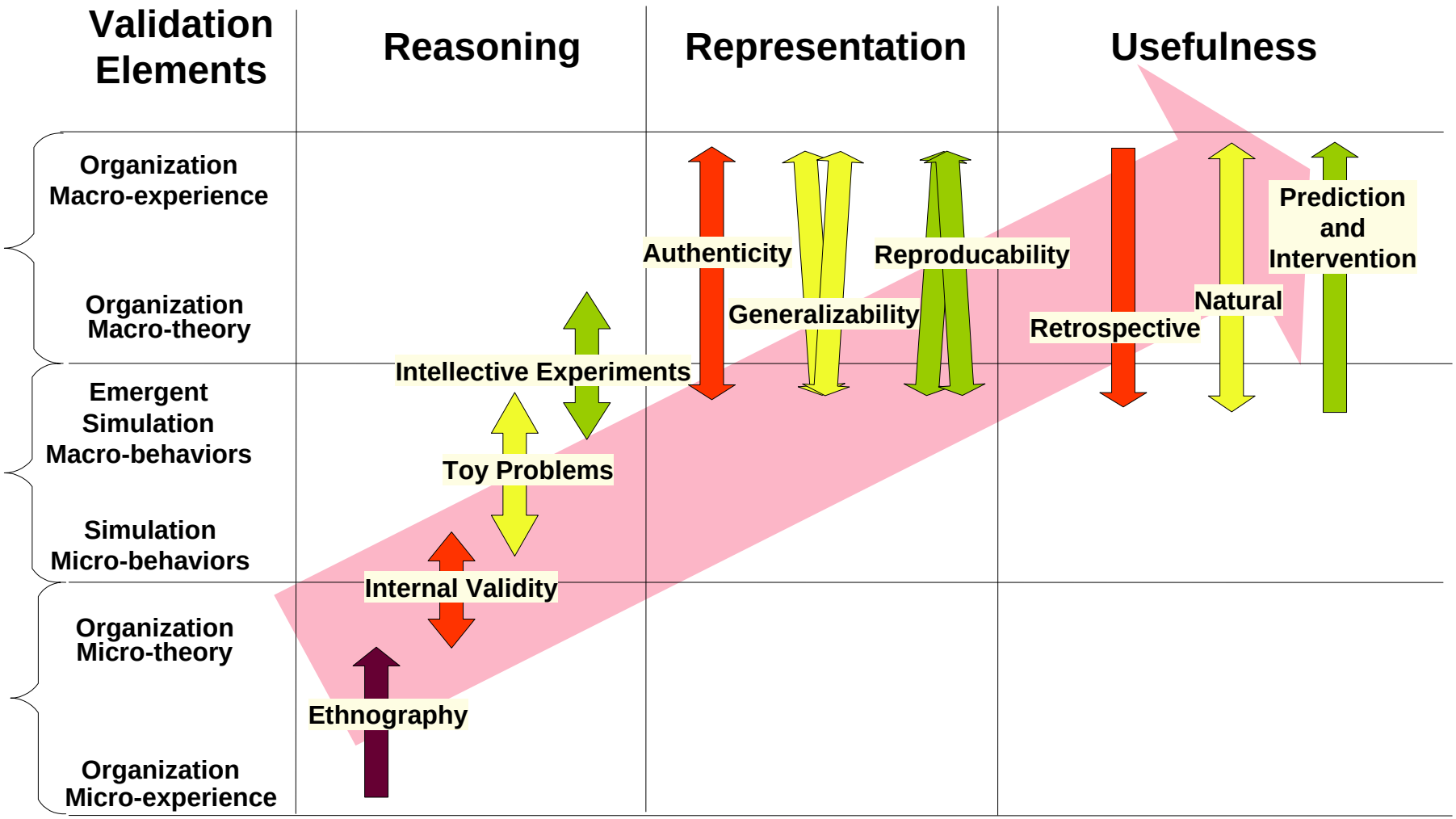


Lockheed Martin Launch Vehicle: *Model Validation Results*

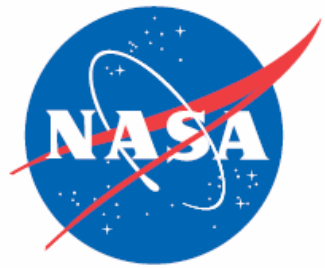
- Flight Simulated organization executing fast-track work process to predict schedule and quality risks
  - VDT/SimVision predicted launch date delay to within a few days, one year ahead!
  - VDT/SimVision predicted cable team quality risk that ultimately caused LMLV to fail!
- Predicted impact of two potential managerial interventions on outcomes



Validating an Organizational Analysis Tool



VDT/SimVision® is Supporting Real Organization Engineering



What Makes Global Projects Especially Challenging?

- Differences in Values & Beliefs?
  - Hofstede-House National Value-Belief Dimensions
    - Individualism-Collectivism
    - Power Distance
    - Uncertainty Avoidance
    - Masculinity-Femininity
    - Time Horizon for Decisions
  - Differences in values and beliefs do not reliably predict outcomes of global projects
- Need to Broaden Analysis Framework to consider "Institutional Differences"
  - Cognitive-Cultural
  - Normative
  - Legal/Regulative

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CRGP Collaboratory for Research on Global Projects

Understanding, Modeling and Simulating the Organizational Performance of IJVs

(NAACSOS Conference 2004 Best Paper Award)

Principal Advisor
Dr. RAYMOND E. LEVITT
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Dr. RICHARD BURTON
Dr. YAN JIN
Dr. MARTIN FISCHER

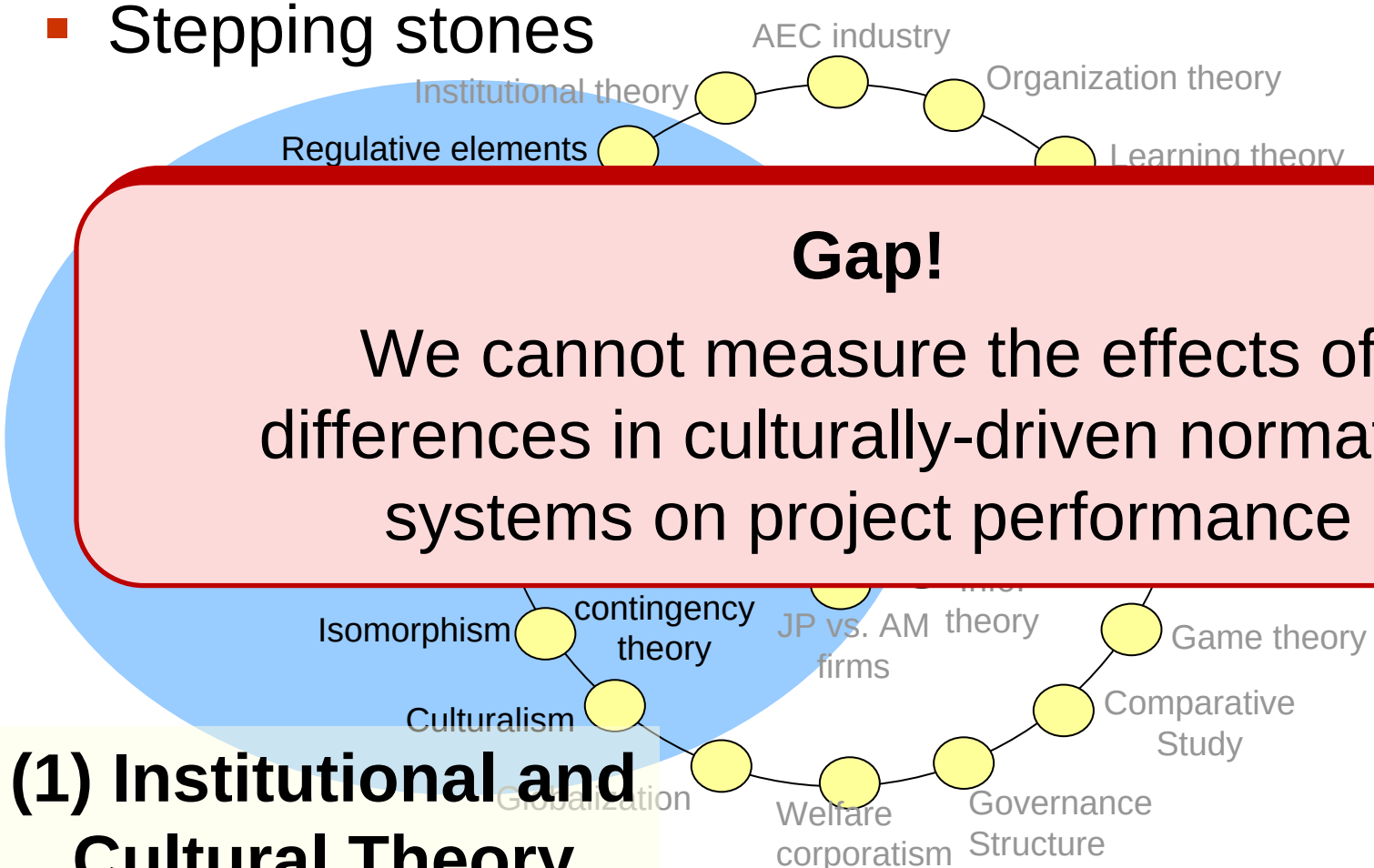
Presented by
TAMAKI HORII
Stanford University
CIFE iRoom, 550bldg,
June 8th, 2005

The Big Idea

A simulation model can help to understand the effects of cultural differences on organization performance of global projects

Points Of Departure

- Stepping stones



Gap!

We cannot measure the effects of differences in culturally-driven normative systems on project performance

(1) Institutional and Cultural Theory

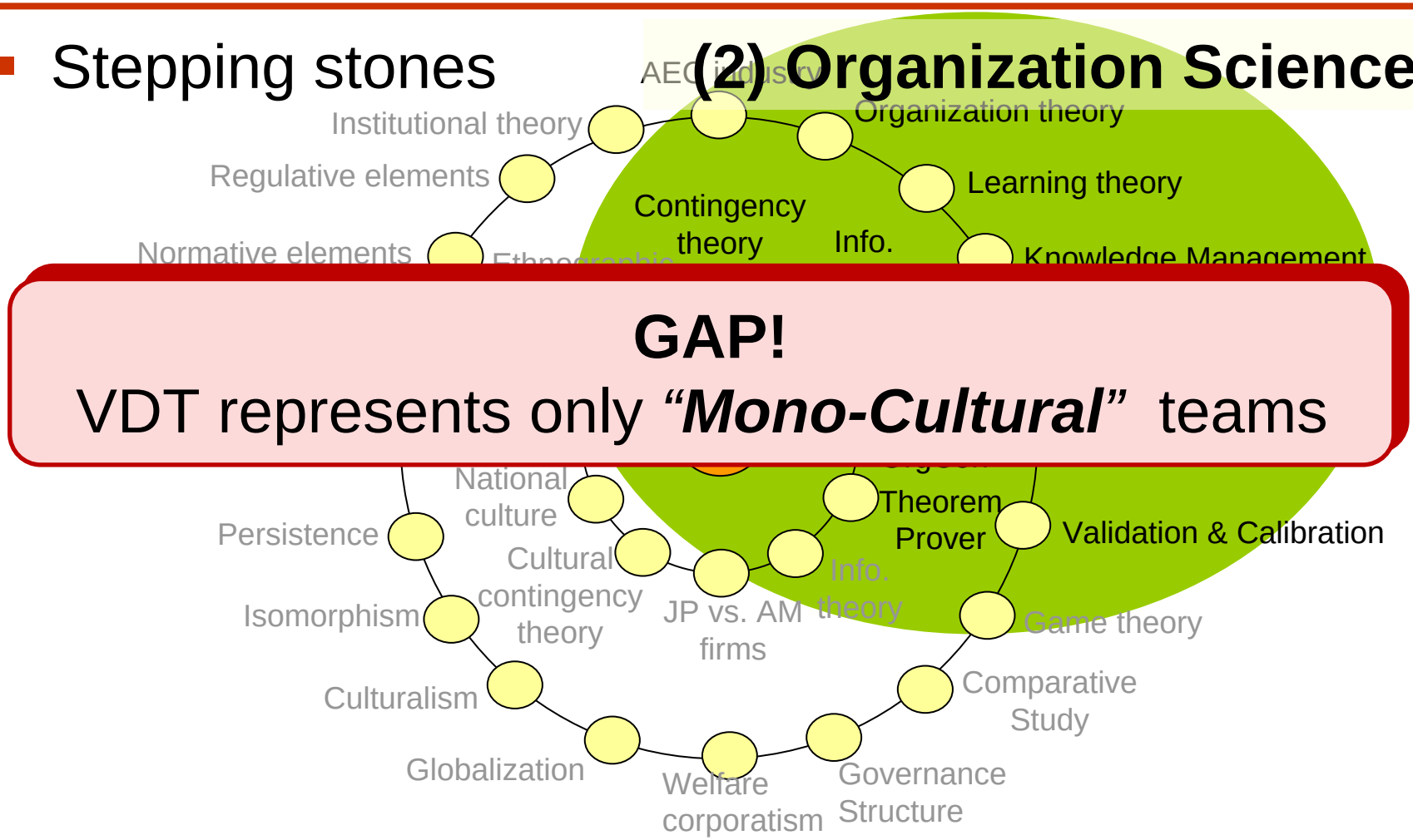
Cultural Values

- Hofstede's work provides a useful measurement of value gaps between J and A cultures

	USA	Japan	Gap
Power Distance	40	54	14
Masculinity vs. Feminity	62	95	33
Individualism vs. Collectivism	91	46	45
Uncertainty Avoidance	46	92	46
Long- vs. Short- Term Orientation	29	80	51

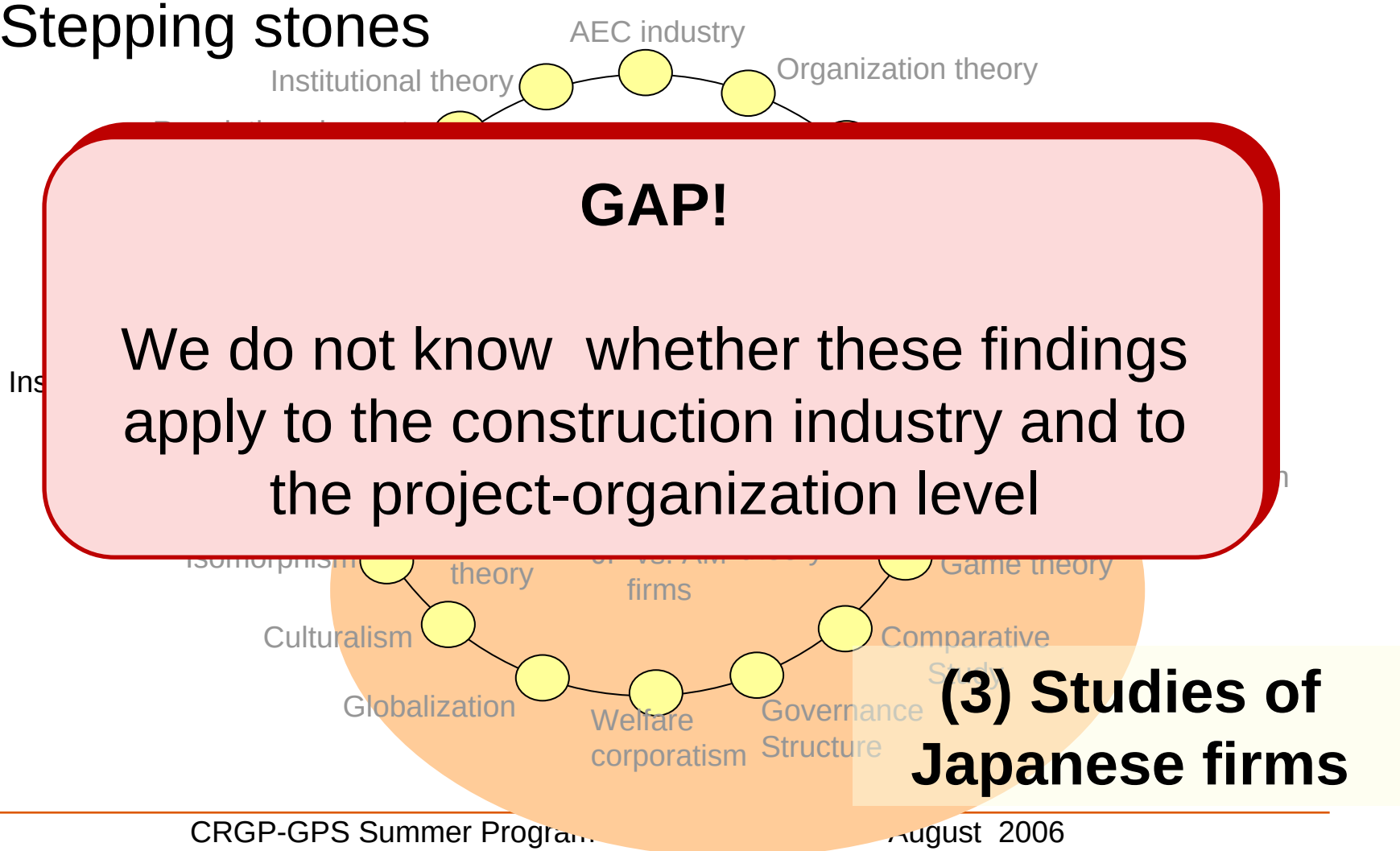
Points Of Departure 2

- Stepping stones



Points Of Departure 3

- Stepping stones



Research Method and Steps

- **Method**
  - Direct observations & Computational Model (Kahr and Simon, 2004)

- **Steps**
  - **Phase 1:** Case studies
  - **Phase 2:** Intellective experiment for **single** cultural teams
  - **Phase 3:** Extension of VDT
  - **Phase 4:** Intellective experiment for **mixed**-cultural teams

Four Case Studies

- Four case studies

Project	Contract Type	AM firms	JP firms
Semiconductor facility	Design&Build	Partners	**Prime con.,** Design services
Catwalk bridge project	Design&Build	**Prime con**., Design services	Steel fabricator *(20% of total budget)*
Sunfish bridge project	Design&Build	**Prime con.(60%)** Design services	Partner (40%)
TBM tunnel project	Design Bid Build	Partners	**Prime contractor**

*Prime con.: prime contractor
*Partner: Partner firm of Joint ventures

- Four projects are located in SF Bay area
- JP prime contractors vs. AM prime contractors

CC-VDT

Extension of VDT

Objective:

Extend VDT so we can design better organizations for global projects

- VDT does not have multiple behaviors in a project
- VDT does not have task control styles such as results vs. processes

Value-Practice Dimensions

- ***Values*** refer to desirable criteria or standards to evaluate behaviors that people exhibit in making task-related and communication-related decisions

- ***Practices*** include cultural norms for adopting or using specific organization designs to manage organizations and tasks**.**
  - Level of centralization
  - Level of formalization
  - Depth of hierarchy (Configuration)
  - Task control styles: Results vs. Processes

Value-Practice Dimensions Reveal the Key Cultural Differences in IJV Projects

Values (Behaviors)

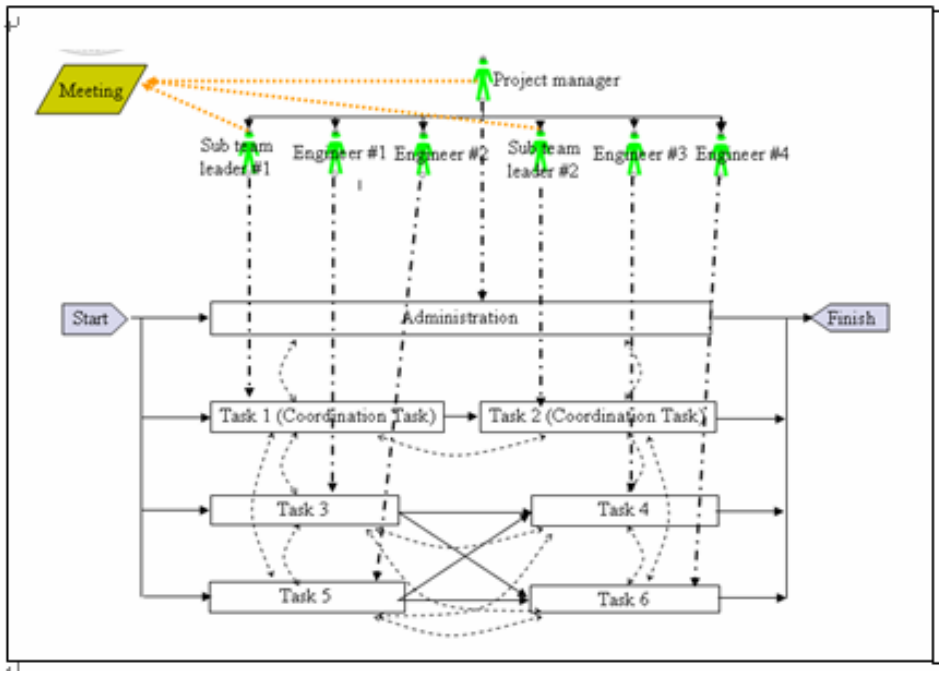
	American	Japanese
Decision making	Individually-based decision making	Group-based decision making
Communication	Individually-based communication	Group-based communication

Practices (norms)

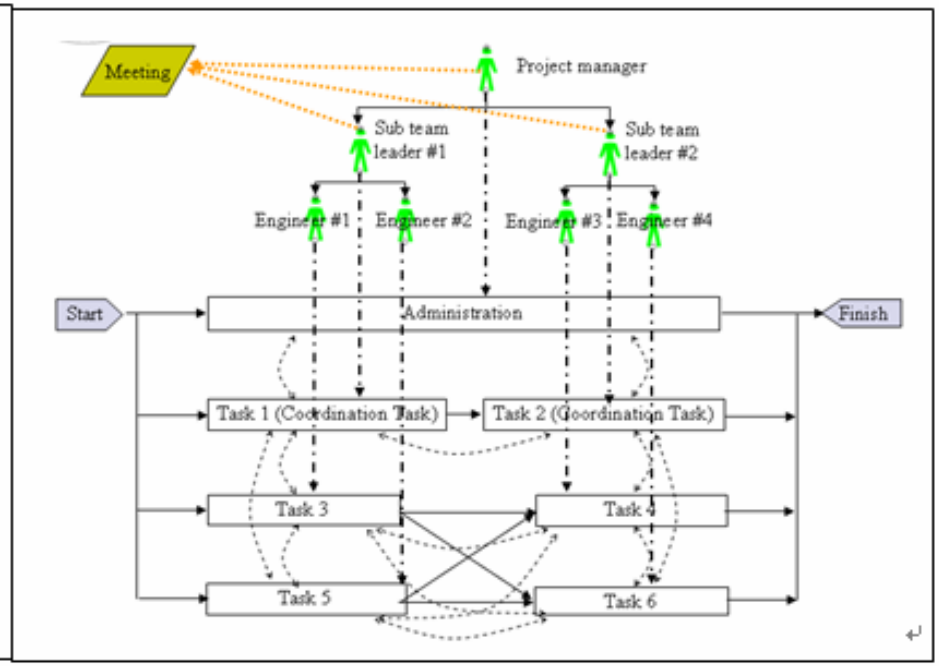
	American	Japanese
Centralization	Decentralized authority	Centralized authority
Formalization	Medium level of formalization	High level of formalization
Organizational hierarchy	Flat level of hierarchy	Multiple levels of hierarchy
Task control style	Results-based	Process-based

Overview of a Model

- Example of the “Intensive” case
  - → shows precedence links among tasks
  - ⇢ shows rework and communication links among tasks
  - ⇢ shows work assignment between team members and tasks



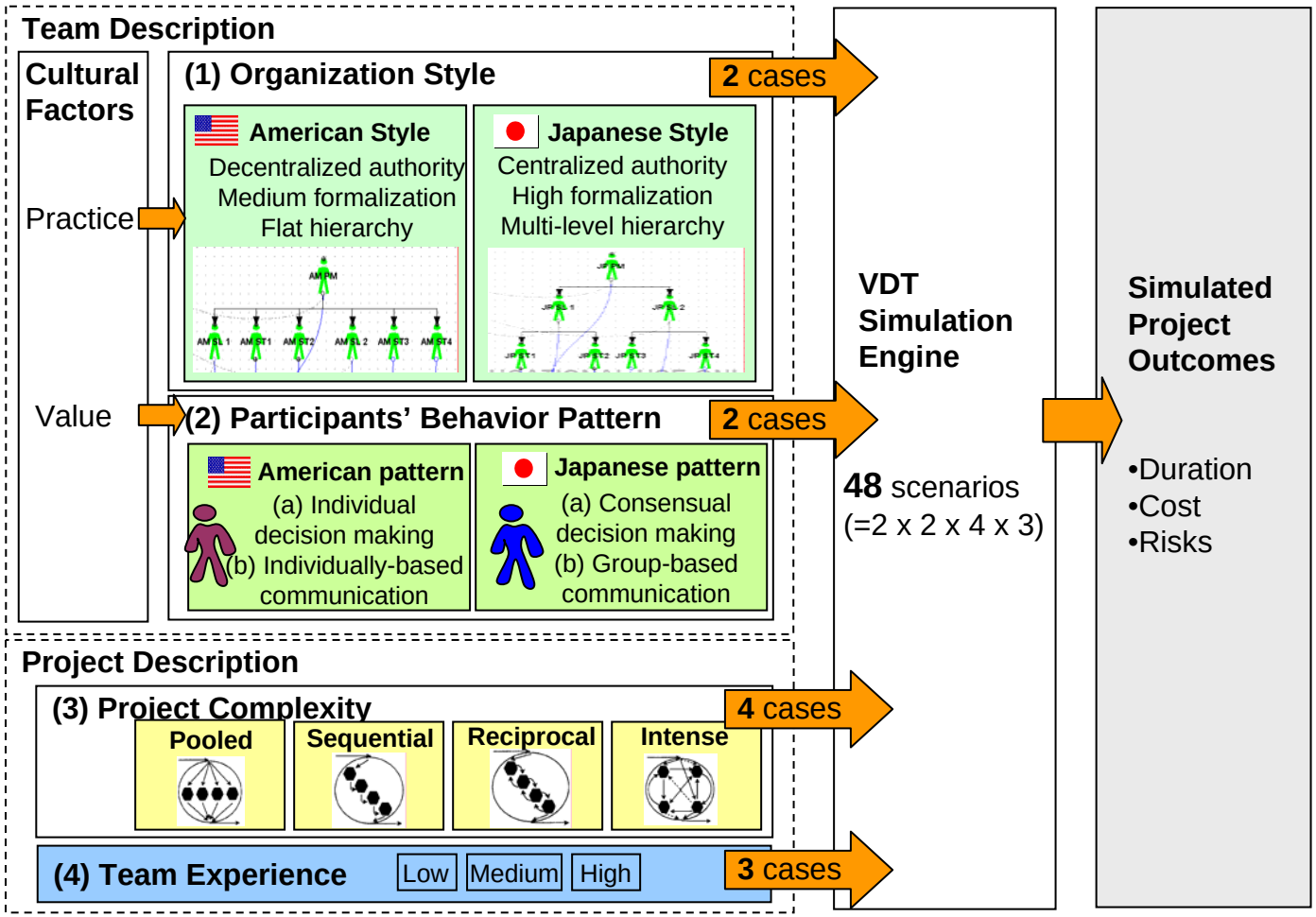
AM



JP

Framework of Intellective Experiment

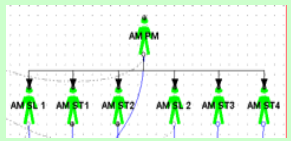
- Cultural factors link to org. styles and micro-level behaviors



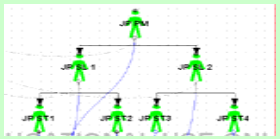
Effects of Changes in Org. Styles

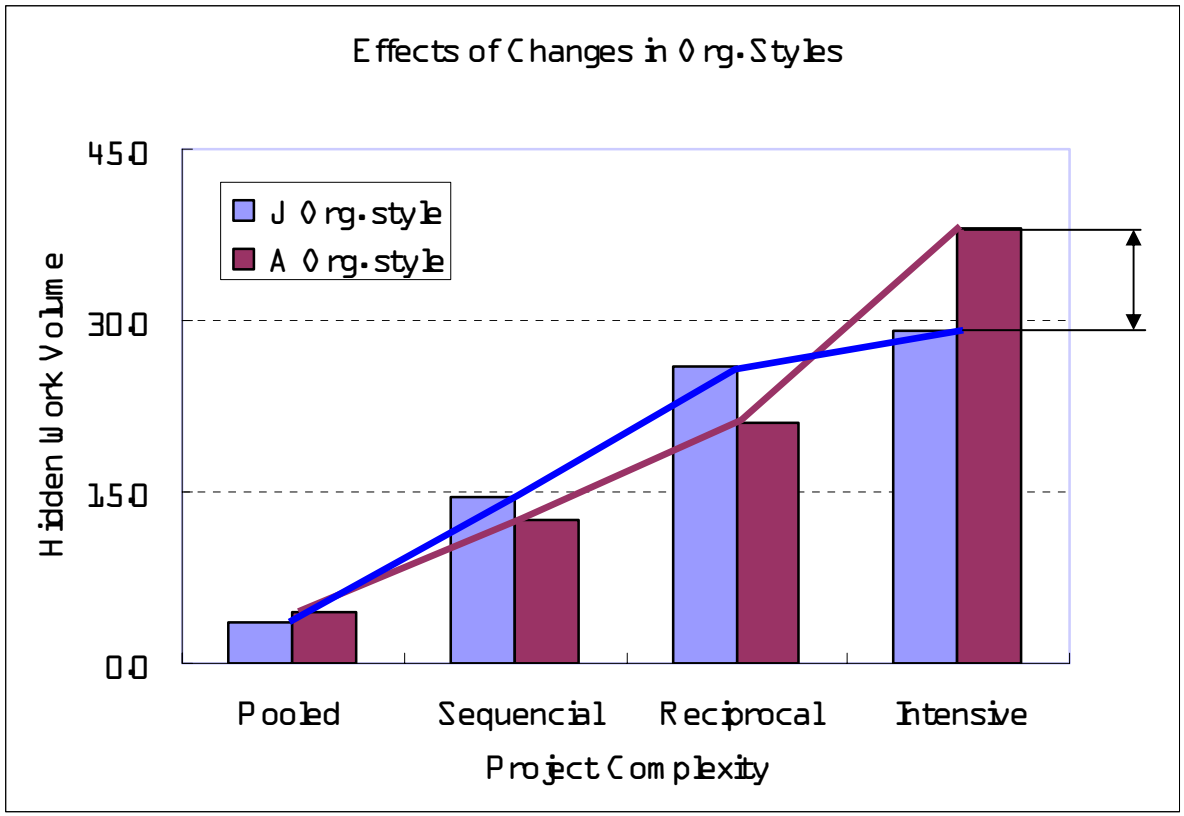
- Differences in hidden work volume: 16% -23%
  - Use the same micro-level behavior (the default version)

American Style
Decentralized authority
Medium formalization
Flat hierarchy



Japanese Style
Centralized authority
High formalization
Multi-level hierarchy





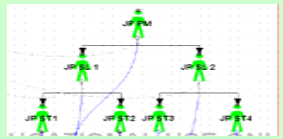
Effects of Changes in Participants' Behavior Patterns

American Style
Decentralized authority
Medium formalization
Flat hierarchy

American pattern
(a) Individual decision making
(b) Individually-based communication

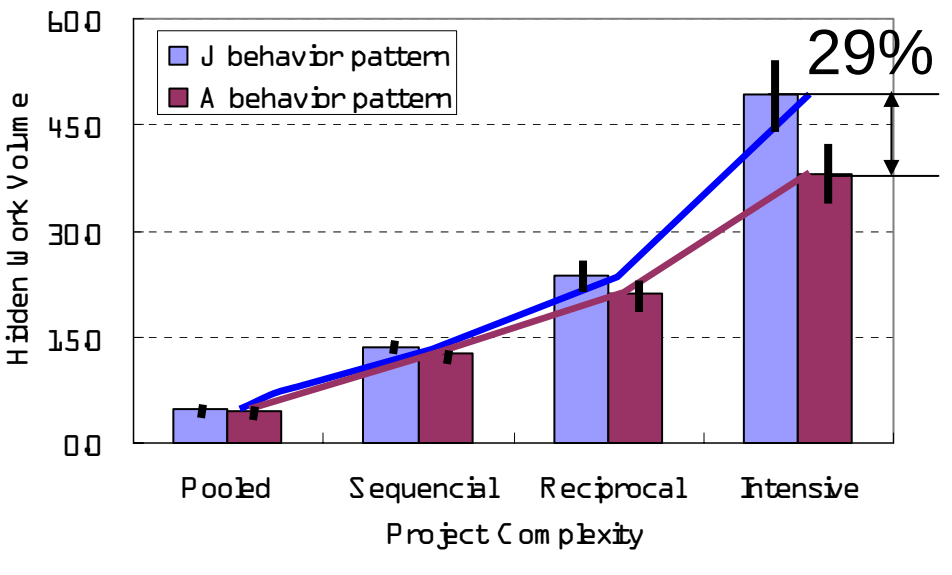
Japanese pattern
(a) Consensual decision making
(b) Group-based communication

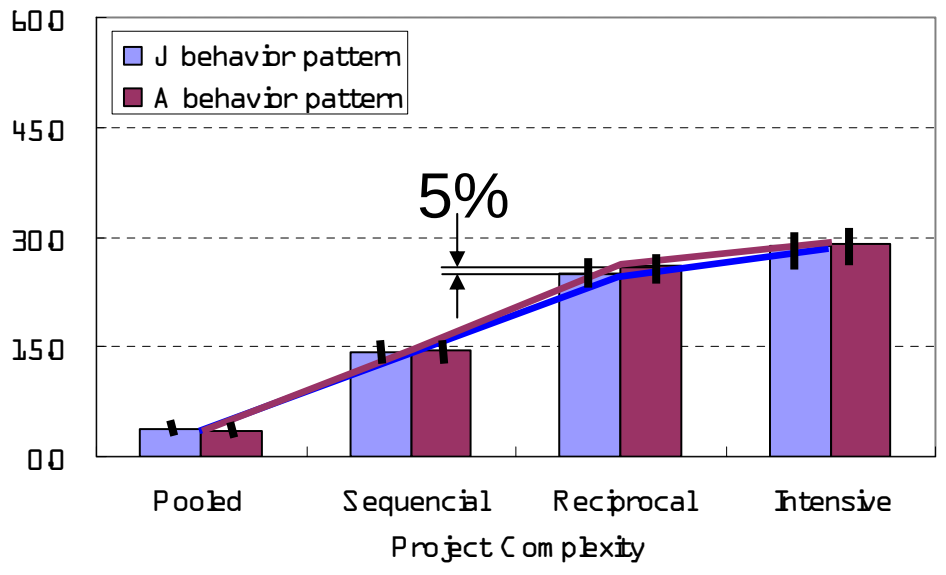
Japanese Style
Centralized authority
High formalization
Multi-level hierarchy



American pattern
(a) Individual decision making
(b) Individually-based communication

Japanese pattern
(a) Consensual decision making
(b) Group-based communication

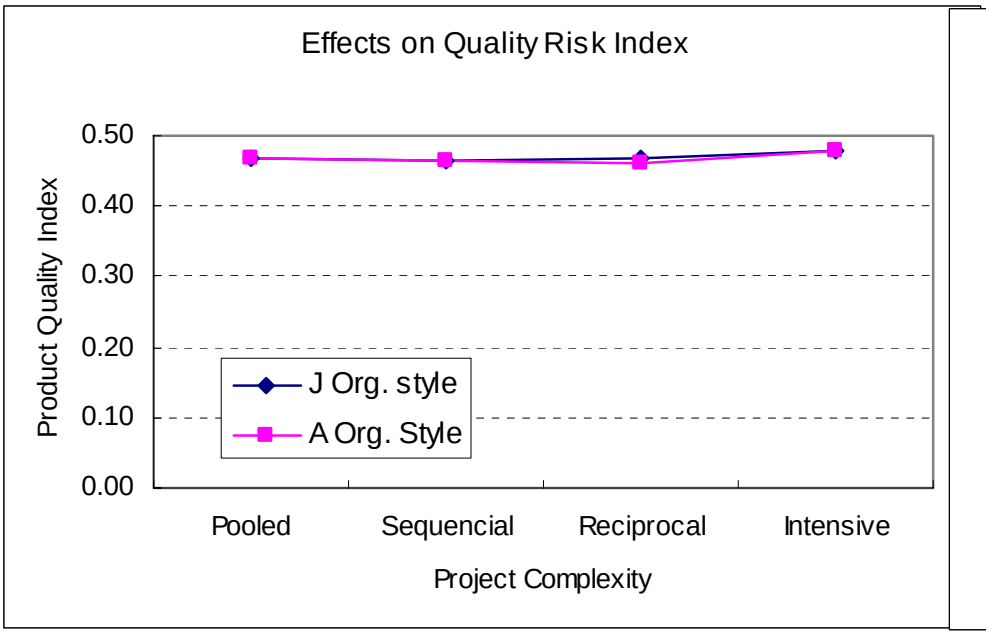




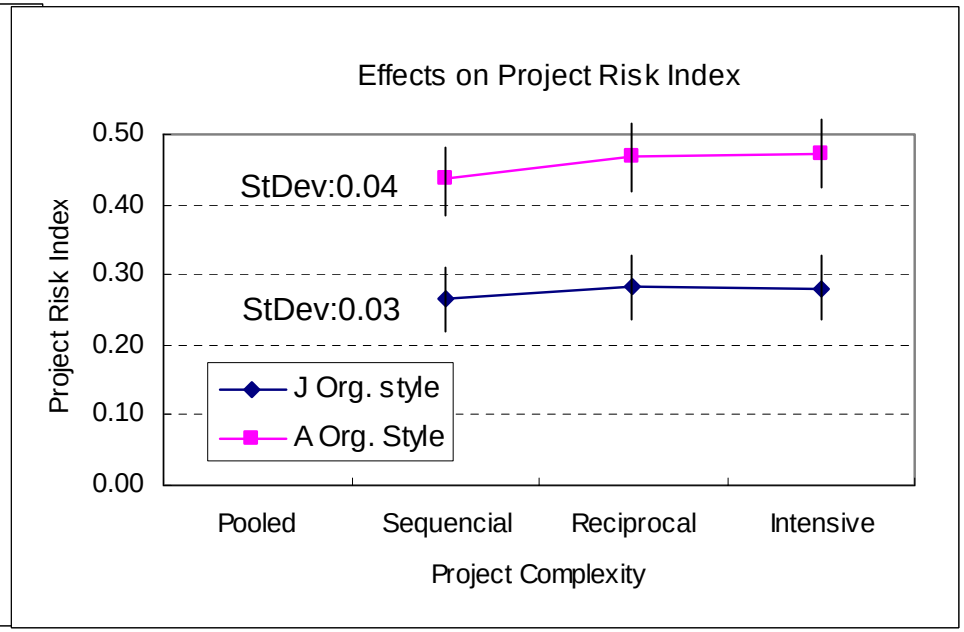
Effects on Quality Risks

- No effect on product quality risk
- Project risk: JP Org. Style show lower risk

Product Quality Risk



Project Quality Risk



Extending VDT to Model Cross-Cultural Teams: (Japan & USA)

- Project Scope *(Tamaki Horii's Ph.D. Research)*
  - Understanding and formalizing "Cultural Differences" on global projects
  - US-Japanese Joint Ventures with AM/JP PMs
  - Define the Context, Composition & Structure
  - Model Cross Cultural Behaviors
  - Analyze the impact on performance

Cultural Differences

- **Tendencies follow Hofstede's dimensions**
- **Different degree of importance for each dimension**

		JP	AM	Score Gap	Observation
Hofstede	PDI	54	40	**14**	**Medium**
	MAS	95	62	**33**	**Low**
	IDV	46	91	**45**	**High**
	UAI	92	46	**46**	**Medium**
Trompenaars	UNI	(0)	(2)	-	**Medium/ High**

Cultural Differences

- Team Experience (L, M, H)
  - L: Conflict most likely
  - H: Most cultural conflicts vanish
  - H: Cox proposed that “Cultural diversity brings Positive impacts”
- JP’s skill level (L, M, H)
  - L: Language barrier
  - L/M/H: Personal experience in the United States

Cultural Differences (continued)

- Characteristics of the dominant party
  - Decision making time (JP tends to be long)
  - Centralization (JP tends to be high – PDI/IDV)
- Meetings are formalized
  - Avoids misunderstanding
- Technological level
  - Incentive to work together / Need time to understand

Team Context

- Definition: Circumstances surrounding JV team

Components	Setting	Degree of impact	Descriptions
Team Experience	**L**	**H FPer/IEr**	Negative impacts on Fer/Per/IEr
	M	**M FPer/IEr**	Relatively negative impacts on Fer/Per/IEr
	H	**L FPer/IEr**	Positive impacts on Fer/Per/IEr
Technological level	**L Ex. Team**	**X 125%**	L team ex. cause H Fer
	M Ex. Team	**X 110%**	M team Ex. cause M Fer
	H Ex. Team	**X 90%**	H team ex. Improve Fer

Team Composition

- Definition: Characteristics of the JV team members

Characteristics Of Dominant party	**JP**	**H Centralization**	PDI/IDV
		M/H Formalization	Depends on the team experience
	AM	**M Centralization**	Average
		L/M Formalization	Depends on the team experience
Project Error (UNI/BUS/IDV)	**L Team Ex.**	**X 125%**	Cause relatively large Per.
	M Team Ex.	**X 110%**	Cause medium Per.
	H Team Ex.	**X 90%**	Minimize Per.
Formalization (UNI/BUS)	**L Team Ex.**	**H**	Most likely to have H -
	M Team Ex.	**M**	M formalization
	H Team Ex.	**L/M**	Depends on the dominant party. JP-M, A-L (High IDV country)

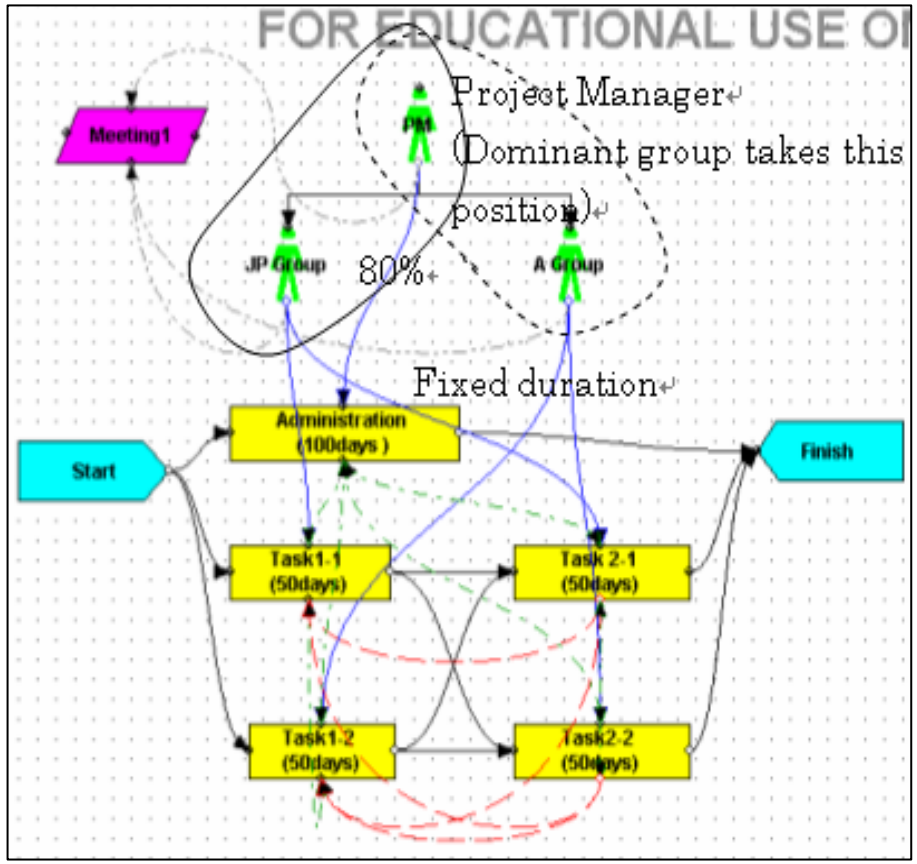
Team Structure

- Definition: Individual skill/Strength of relationships

Information Exchange (PDI/UAI/IDV)	**L Team Ex.**	**X 150%**	Increase IE by 50%
	M Team Ex.	**X 125%**	Increase IE by 25%
	H Team Ex.	**X 90%**	Decrease IE by 10%
Time-for -Decision (UAI/IDV)	**L Team Ex.**	**X 125%**	Increase by 25% (JP=Dominant)
	M Team Ex.	**X 110%**	Increase by 10% (JP=Dominant)
	H Team Ex.	**X 90%**	Decrease by 10%
Skill level of JP Actors (US Region)	**L**	**-JP actor only**	Low experience
	M	**-JP actor only**	Medium experience
	H	**-JP actor only**	High experience

Modeling

- **Actors: 1 PM, 2 Eng**
  - **PM position is filled by either JP or A**
- **4 + 1 Tasks:**
  - **4 tasks identical duration**
  - **6 Communication links**
  - **4 Rework Links**
- **Meeting: Once per week**
- **Finish-to-Start Precedence**



Modeling

L Team Ex. | **M Team Ex.** | **H Team Ex.**

JP (A) Team

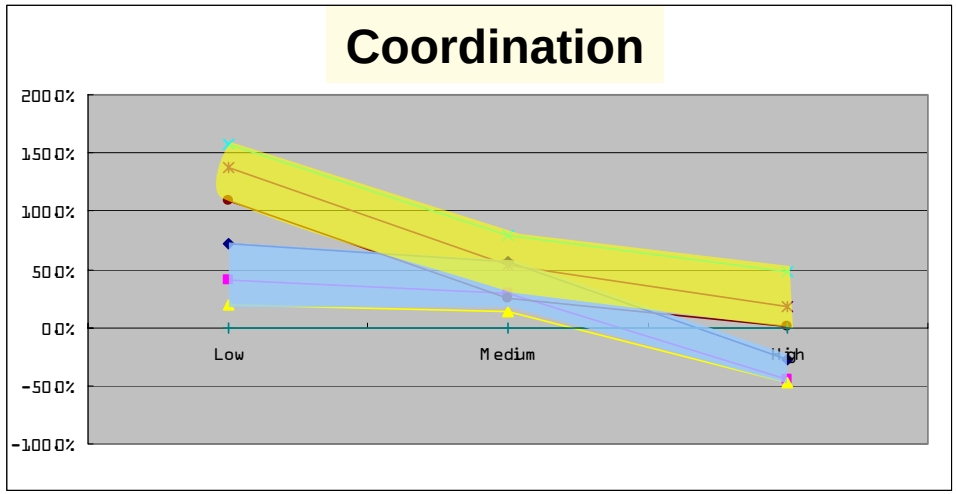
	Baseline	Case 1			Case 2			Case 3		
		1.1	1.2	1.3	2.1	2.2	2.3	3.1	3.2	3.3
Dominant party	–	JP takes PM position (Dominant)								
Team Experience	Medium	Low			Medium			High		
Functional Error	0.1	0.125			0.11			0.09		
Project Error	0.1	0.125			0.11			0.09		
Information Exchange	0.5	0.75			0.625			0.45		
Skill Level (JP)*	Medium	L	M	H	L	M	H	L	M	H
Time-For-Decision	100%	X125%			X110%			X90%		
Centralization	Medium	High								
Formalization	Medium	High			Medium			Medium		

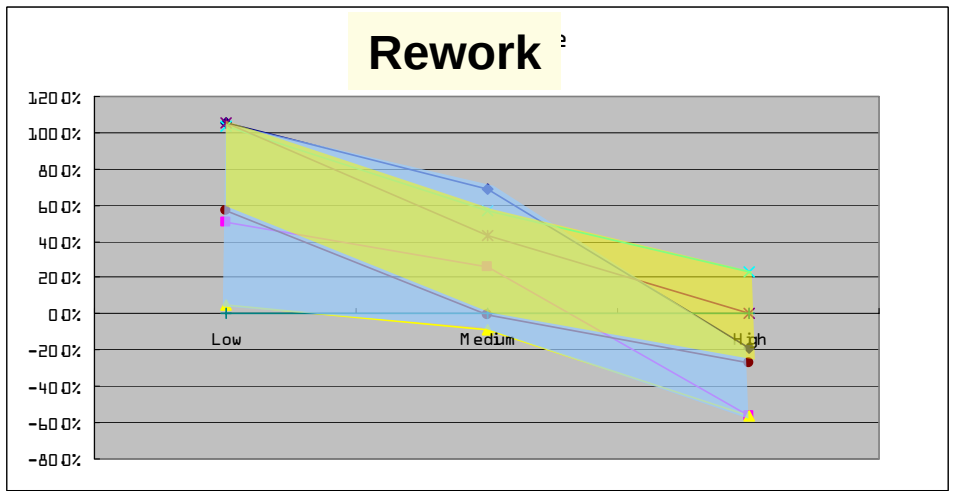
Dominant party	–	A takes PM position (Dominant)								
Team Experience	Medium	Low			Medium			High		
Functional Error	0.1	0.125			0.11			0.09		
Project Error	0.1	0.125			0.11			0.09		
Information Exchange	0.5	0.75			0.625			0.45		
Skill Level (JP)*	Medium	L	M	H	L	M	H	L	M	H
Time-For-Decision	100%	X100%			X100%			X90%		
Centralization	Medium	Medium								
Formalization	Medium	High			Medium			Low		

Results/Analysis: Effect of Skill Level and Team Experience

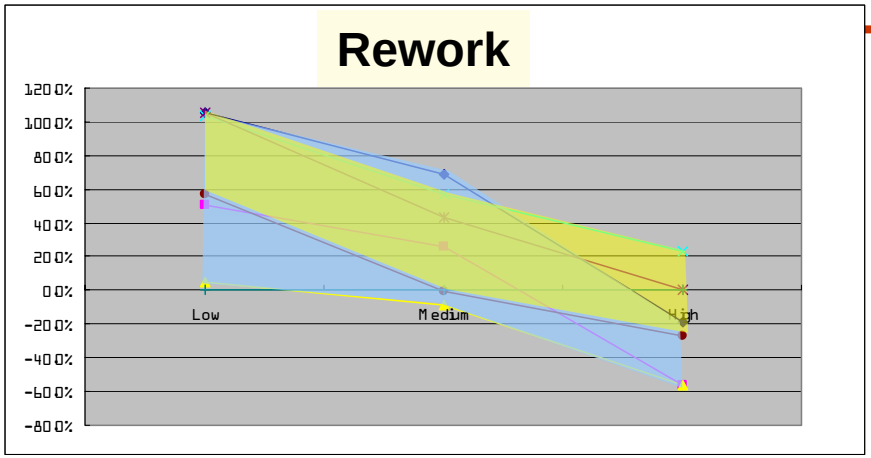
JP (A) Team

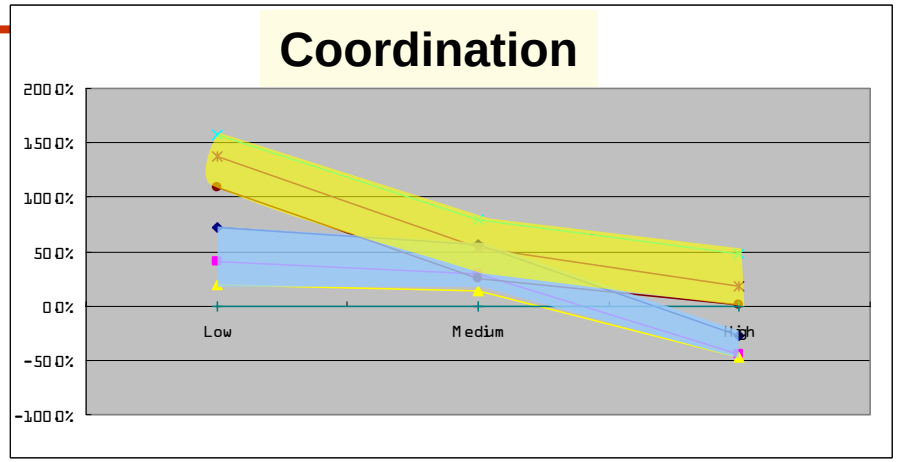
A (JP) Team





Results/Analysis





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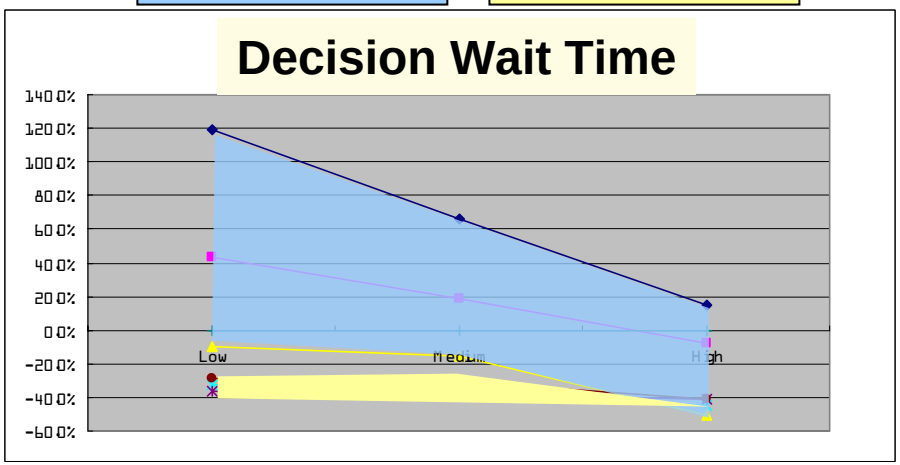


REWORK:

JP is sensitive to JP skill level

Similar tendency to Indirect Work

COORDINATION:

A is larger than JP

(High Formalization ?)

DECISION TIME:

JP is larger than A

Simulated Results Confirm Hypotheses

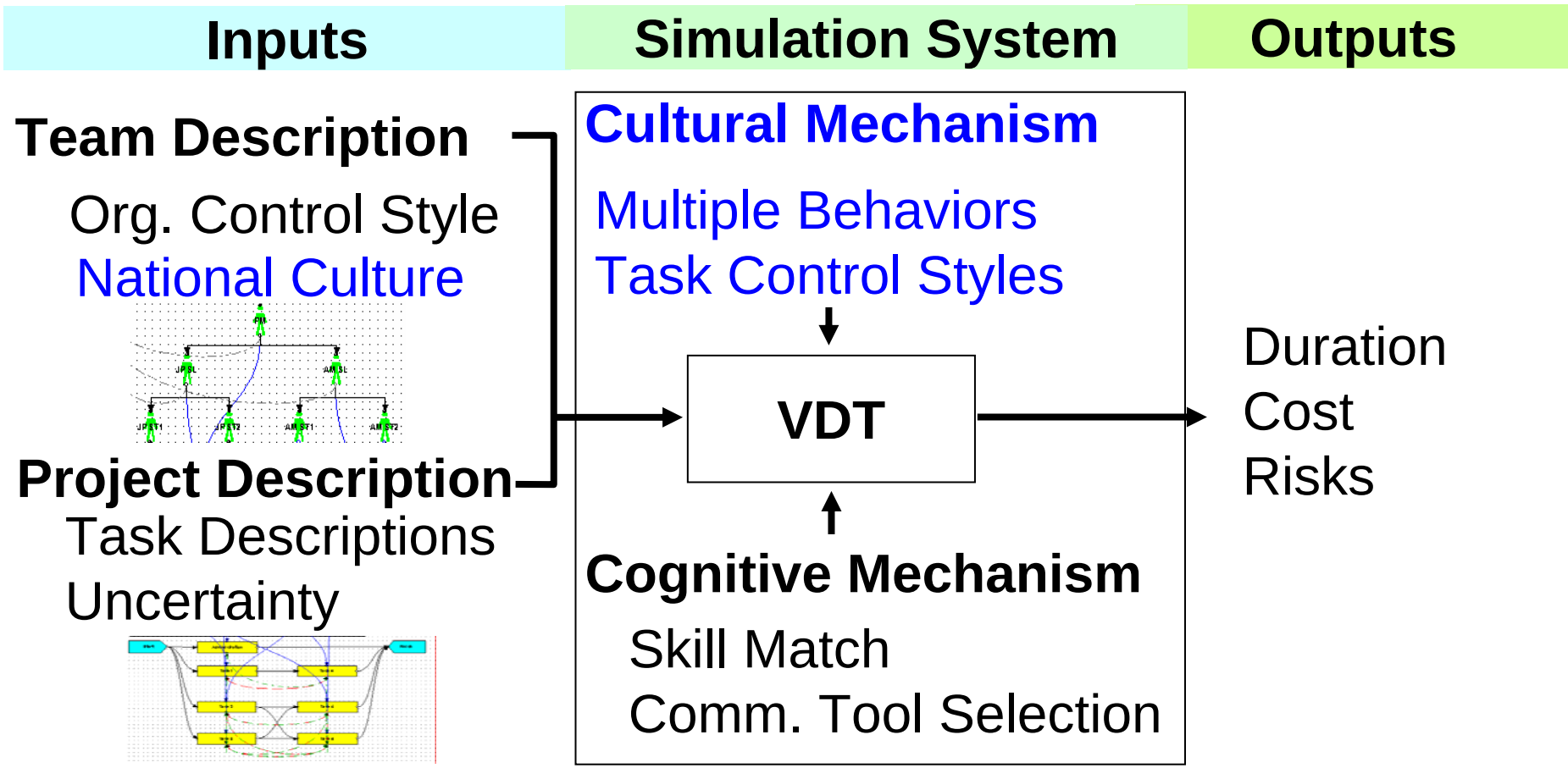
- Consistency with Contingency Theory
  - The more complicated projects become, the more exceptions project teams need to deal with
  - The idealized project contexts are appropriately captured in the model
- Consistency with cultural contingency theory:
  - AM teams show better performance when they use American organization styles.
  - JP teams show better performance when they use Japanese organization styles

Cultural Differences Influence on Team Performance

- AM org. style shows better performance for medium level of project complexity (16%)
- JP org. style shows better performance for high level of project complexity (23%)
- JP org. style shows better performance for project quality risk
- Switching from US to JP participants has a larger impact in an AM-style org. than in a JP-style org.

Framework of Extended VDT

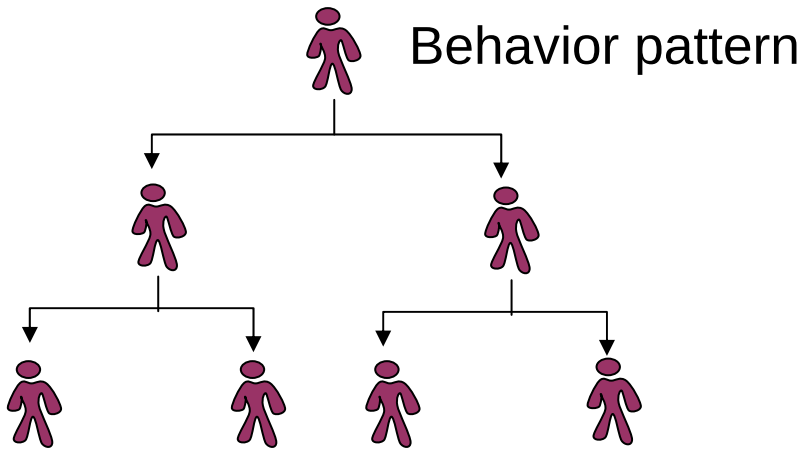
- Added Cultural Mechanisms



Multiple Behaviors In A Project

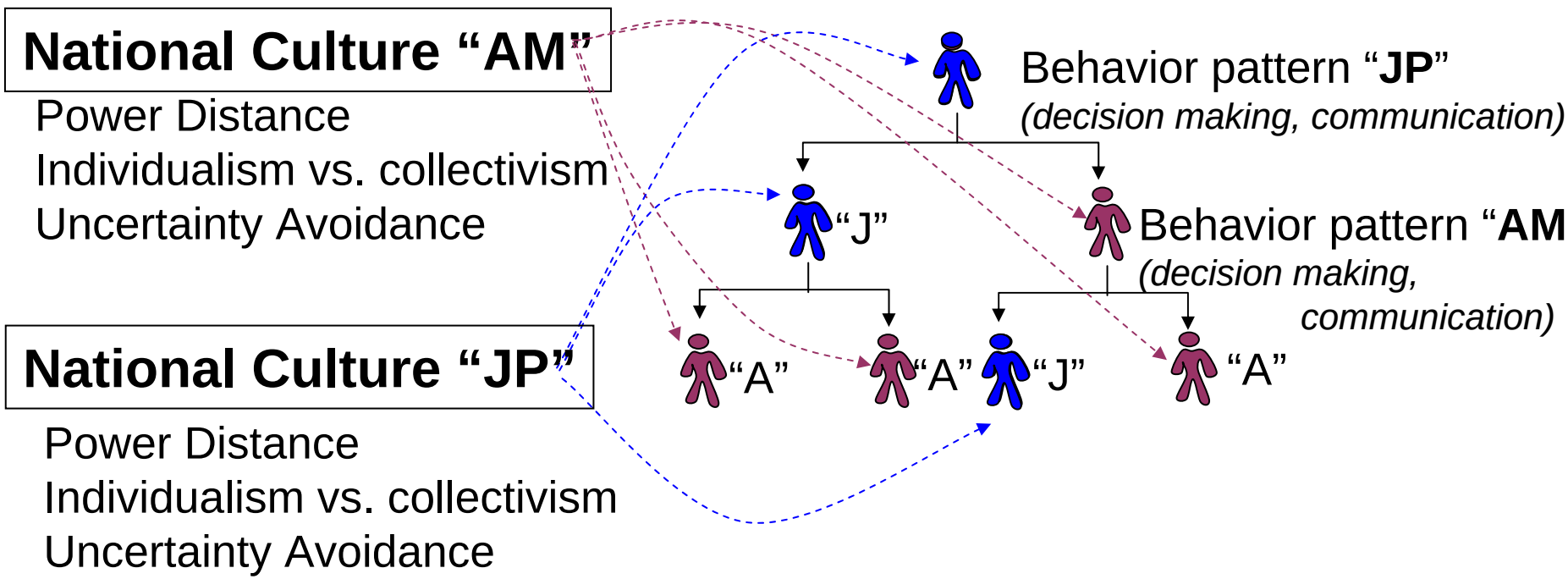
- The current VDT…

Organization Chart



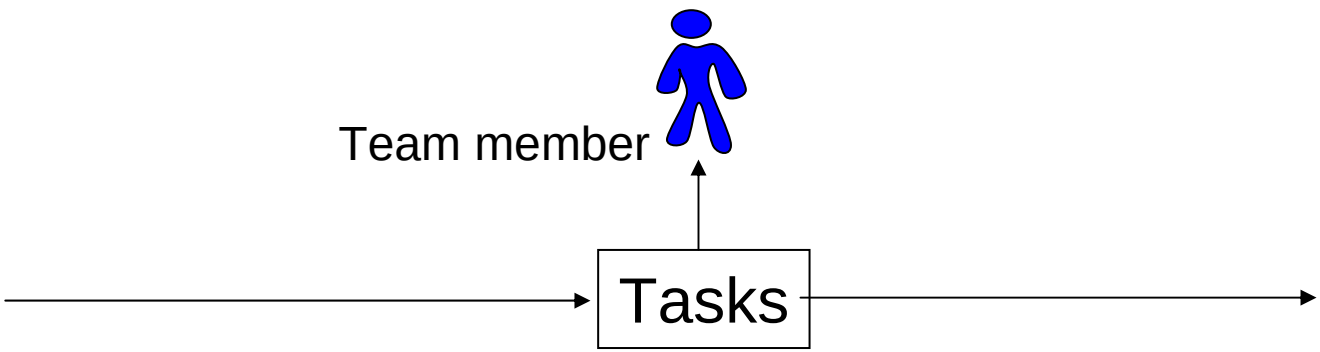
Multiple Behaviors In A Project

- The current VDT…
- Extended VDT



Differing Task Control Styles Cause Additional Exceptions

- Interface between actors is a key factor



Differing Task Control Styles Cause Additional Exceptions

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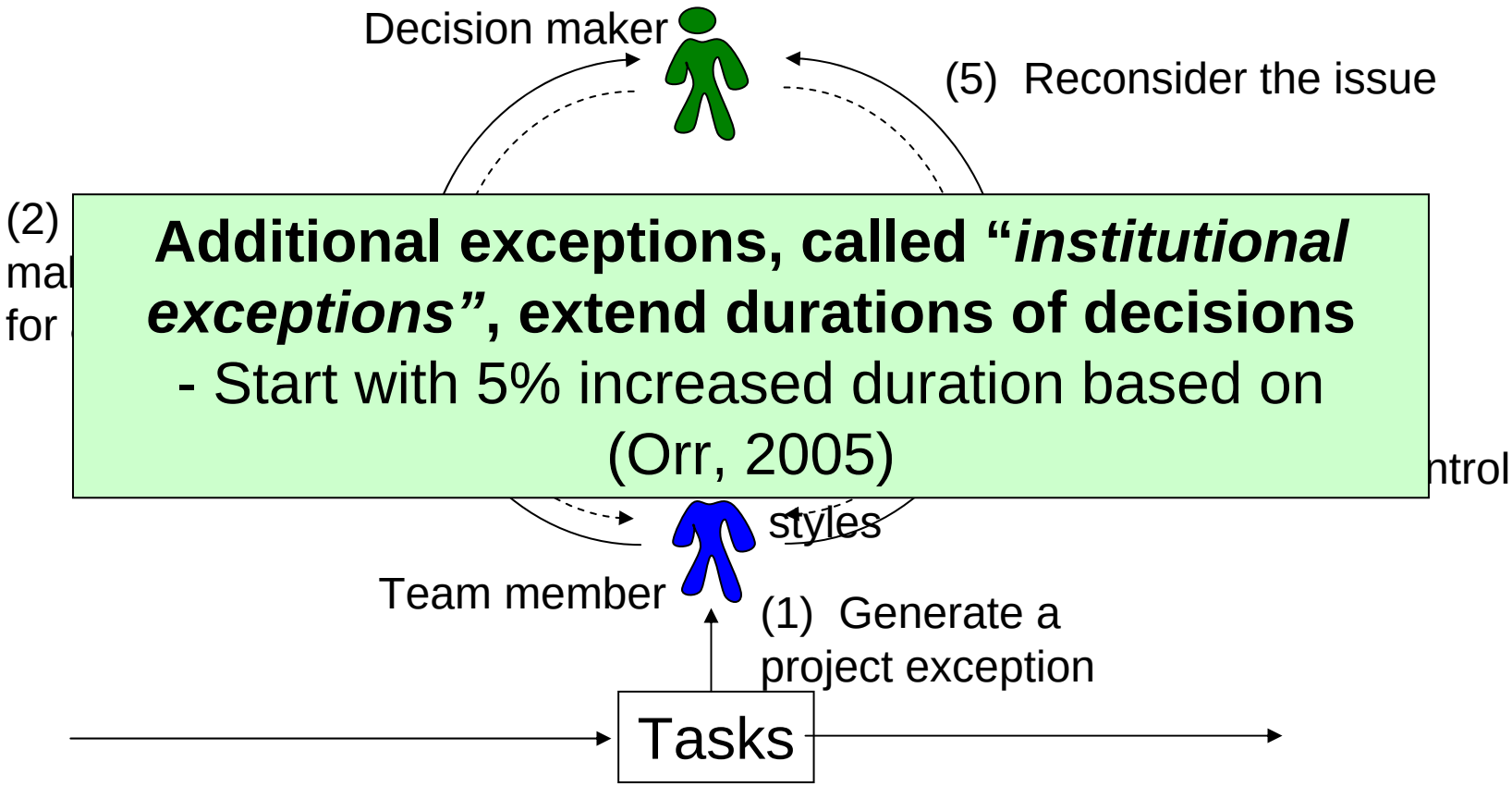


Phase 4

Intellective Experiment for Mixed Cultural Teams

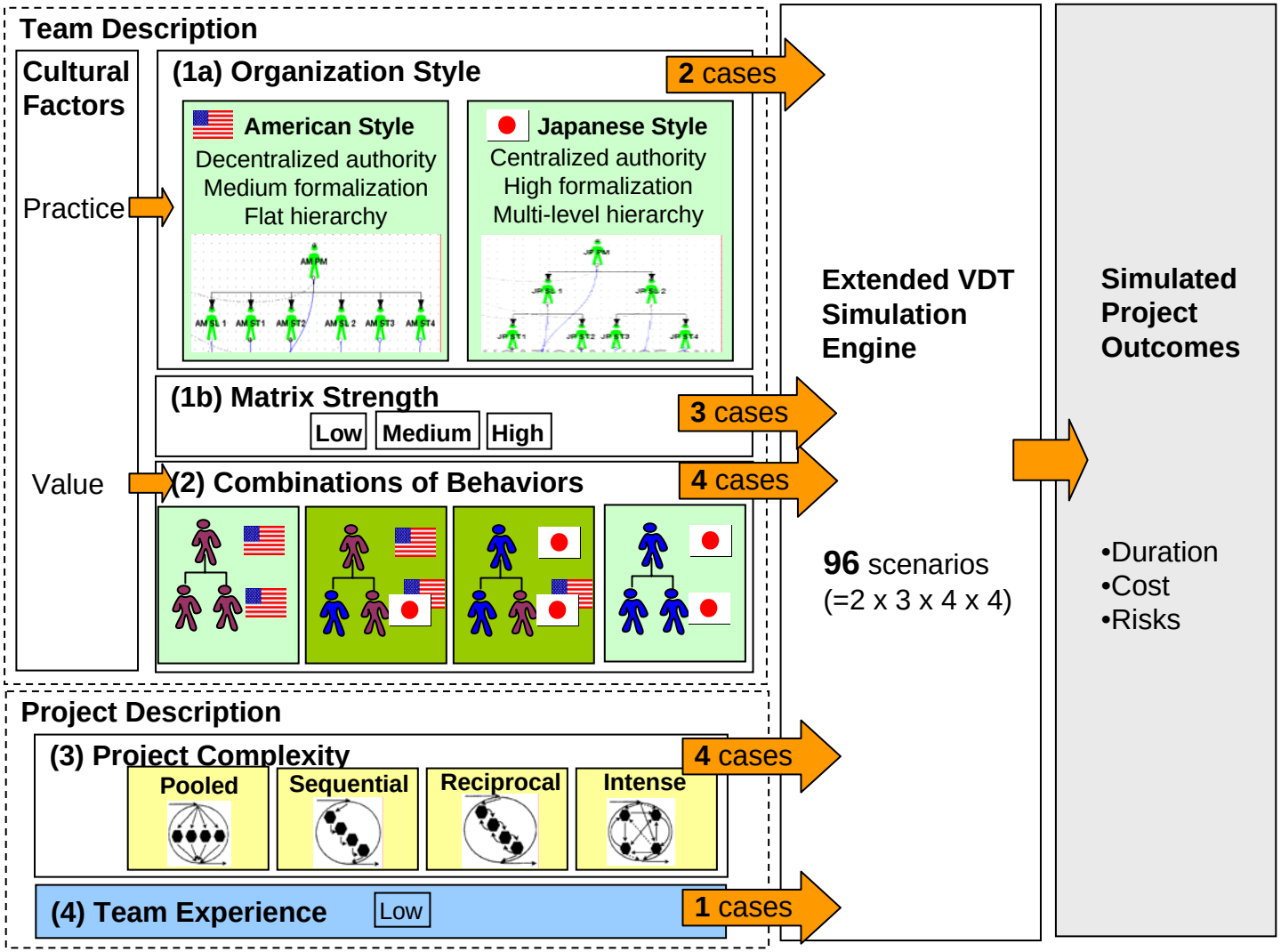
Sub research question 3:

How can we design better organizations for mixed-cultural teams?

Hypotheses Testing

- Hypothesis 1(Thompson, 1967):
  - Successful organization style is contingent upon **project complexity**
- Hypothesis 2: (Adler, 1997)
  - Decentralized structure is appropriate for mixed cultural teams
- Hypothesis 3: (Levitt, 2004; Adler, 1997)
  - **Mixed cultural teams** potentially show higher coordination costs than single cultural teams
- Hypothesis 4 (Hofstede, 1991, Davis and Lawrence, 1976):
  - **High matrix strength** is suitable for managing global teams

Framework for Intellective Experiment



Mixed- vs. Single-Cultural Teams

- Mixed-cultural teams show increased coordination costs *vs.* single-cultural teams

*Average of all cases

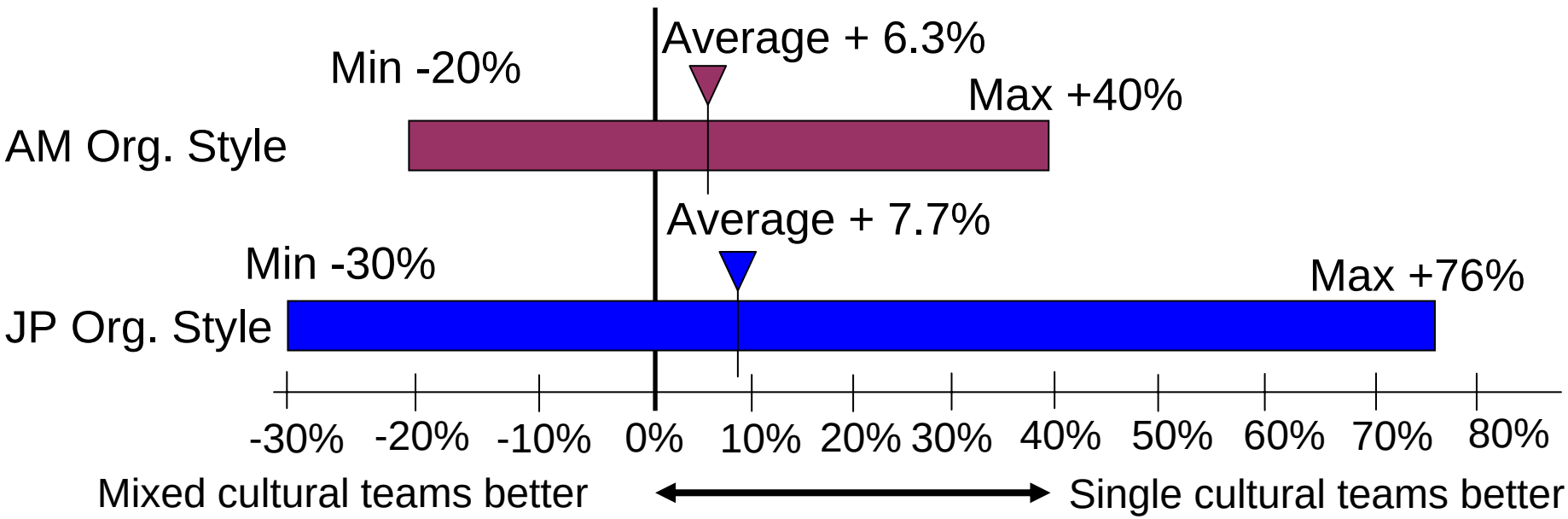
$$*\% = \frac{\text{Outcomes of } \textbf{mixed} \text{ cultural teams}}{\text{Outcomes of } \textbf{single} \text{ cultural teams}} \text{X } 100$$

	Average of increased duration or quality
Duration	**7.0%** increased
Hidden Work Volume	**2.0%** increased
Project Quality Risk	**28.3%** increased

Impact of AM vs. JP Organization Styles on Project Duration — All cases

- AM org. style is less impacted by mixed cultural teams than JP org. style
- JP style works better for complex projects, even with AM workers

$$*\% = \frac{\text{Outcomes of } \textbf{mixed} \text{ cultural teams}}{\text{Outcomes of } \textbf{single} \text{ cultural teams}} \times 100$$



High vs. Medium Matrix Strength

- High Matrix Strength Improves CPM Duration and Hidden Work Volume, but not Quality Risks

$$*\% = \frac{\text{Outcomes of } \textbf{high} \text{ matrix strength}}{\text{Outcomes of } \textbf{medium} \text{ matrix strength}} \text{ X } 100$$

	Average of increased duration or quality
Duration	**14.1%** improved
Hidden Work Volume	**16.6%** improved
Project Quality Risk	**No improvement**

Statistical Analysis

- Hypotheses testing

	CPM Duration	Hidden Work Volume	Project Quality Risk
H1: High vs. Low Project Complexity	0.48**	0.66**	0.75**
H2: A vs. J Org. Style	-0.19 †	-0.29*	0.16
H3: Mixed vs. Single Cultural Teams	0.04	0.03	0.18 †
H4: High vs. Medium Matrix Strength	-0.21*	-0.29*	-0.016

Correlation coefficient: r
Significance level of Correlation : **† p < 0.10** , *** p < 0.05** , **** p < 0.01**
Total sample size: n=**96**

Results for High (Reciprocal) Project Complexity?

- Hypothesis 2,3, and 4 become more significant

	CPM Duration	Hidden Work Volume	Project Quality Risk
H2: A vs. J Org. Style	-0.59**	0.76**	0.49**
H3: Mixed vs. Single Cultural Teams	-0.36 †	-0.10	0.70**
A org. styles (n=12)	0.40	0.12	0.58*
J org. styles (n=12)	0.53*	0.48 †	0.97**
H4: High vs. Medium Matrix Strength	-0.50*	-0.47*	-0.15

This is an example of the reciprocal complexity cases
Correlation coefficient: r
Significance level of Correlation: † **p < 0.10** , * **p < 0.05** , ** **p < 0.01**

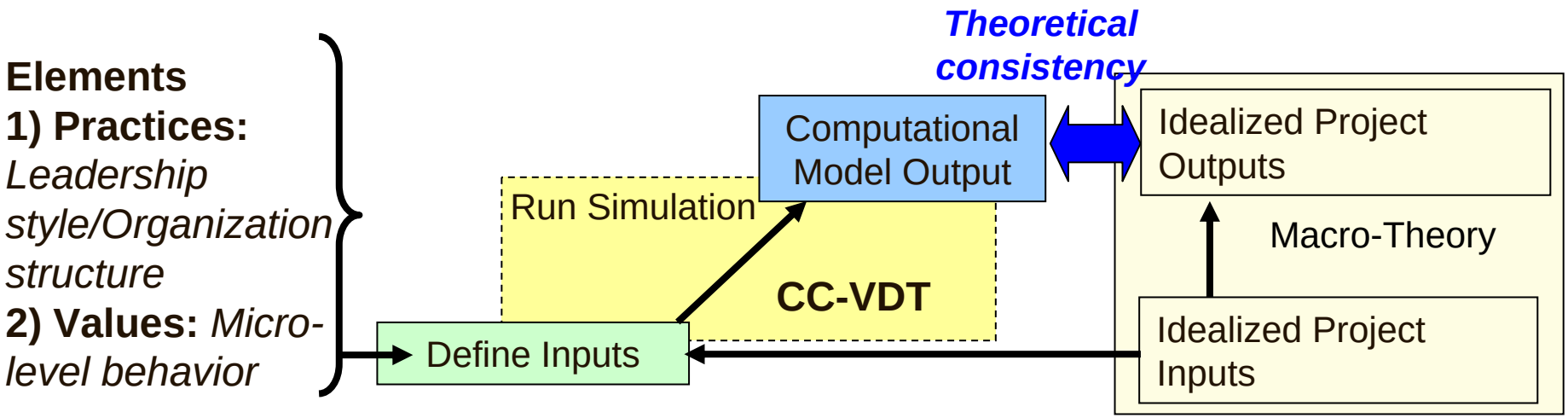
Intellective Experiments Confirm Hypotheses Under Specific Conditions

- **Contingency Theory:**
  - Project complexity has the greatest impact on project performance (CPM duration, hidden work volume, and Project quality risks)
- **Organization Style:**
  - Organization styles should be selected based on project complexity
  - Each organization style has pros and cons, for instance,
    - Centralized (JP) style has better performance in project quality risks
    - Decentralized (AM) style has better performance for mixed-cultural teams

Intellective Experiments Confirm Hypotheses Under Specific Conditions (Continued)

- **Mixed vs. Single cultural teams:**
  - In the most cases, mixed cultural teams show longer CPM duration, greater hidden work volume, and worse PQR than single cultural cases
  - However, some cases show that mixed cultural teams have better performance than single cultural teams,
- **High vs. Medium Matrix Strength:**
  - High matrix strength can improve CPM duration and hidden work volume, but not project quality risks
  - There is no significant difference from low to medium matrix strength

Validation



- Qualitatively validate the encoded parameters such as participants' behaviors (Intellective experiment for single cultural cases)
- Qualitatively validate reasoning (Thomsen, 1999) such as multiple participants' behaviors

Limitations

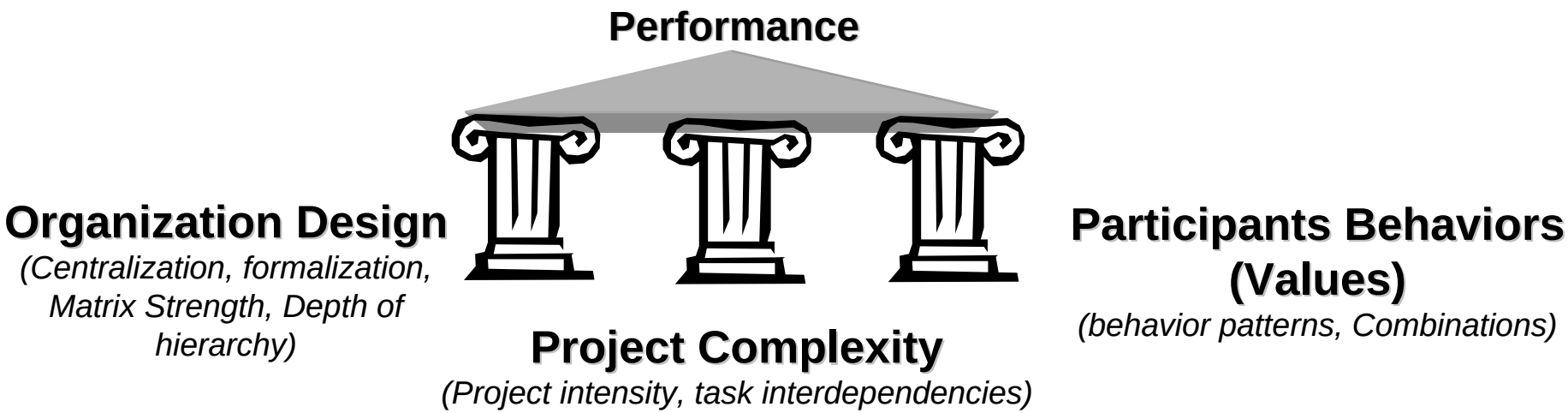
- Limited to only two cultural cases (JP and AM)
- Assumed that participants' motivation and productivity is consistent
  - Psychological factors such as motivation, emotion, and trust can influence on productivity
- Assumed that participant did not adopt partners' culture quickly
  - There is a possibility to have positive impacts such as learning and innovative ideas by cultural interactions
  - Innovative solutions can improve project quality risks

Conclusions

- Multiple culturally-driven normative systems coexist in an international joint venture
- Culturally-driven normative systems do influence team performance
  - Specifically, values and practices have different impacts on team performance
    - e.g., Values affect project quality risk
    - e.g., Practices affect duration and hidden work volume
  - Each practice style has pros and cons
    - e.g., JP practices are good for project quality
    - e.g., AM practices are good for mixed cultural teams

Conclusions (continued)

- Mixed cultural teams can be less efficient (e.g., >70% worse) or slightly more efficient (e.g., 20% improved) than single cultural cases, depending on a combination of three variables: project complexity, organization design, and participants' behaviors



Theoretical Contributions

- Presents a way to understand and measure the effects of cultural differences on organization performance
- Provides evidence of multiple culturally-driven normative systems in international joint ventures
- Links information processing view with contingency theory to incorporate cultural factors
- Illustrates a methodology that combines direct observations and computational modeling

Practical Contributions

- Provides a prototype managerial tool to assess organizational risks on different US-Japanese global projects
- Opens up the possibility to use the extended CC-VDT for other cultural cases (Finland, China, Canada, Italy, etc.)
- Provides a training tool for participants to build cohesive global team

Future Research

- Collect quantitative data to calibrate model parameters
- Model other culturally-driven normative systems, such as China, India, Canada etc
- Extend bicultural cases toward more culturally diverse teams
- Incorporate psychological factors such as “trust” (based on Zolin’s, Gavrieli’s work)
- Incorporate non-linear learning in global contexts (based on Orr’s research)
- Incorporate relationships between innovation types and cultures (based on Taylor’s work)

OUTLINE

- Motivation for Computational Modeling of Organizations
- VDT: An Information Processing Model of Fast-Track Project Organizations
- Impact of Culturally-Driven Normative Differences on Project Performance
- **Diffusion of Systemic Innovations in Project-Based Industries — National Differences**

CRGP Collaboratory for Research on Global Projects

Simulating Learning in Interorganizational Networks:

The Insidious Role of Task Interdependence and Relational Instability on System-level Learning

John Taylor

Raymond Levitt

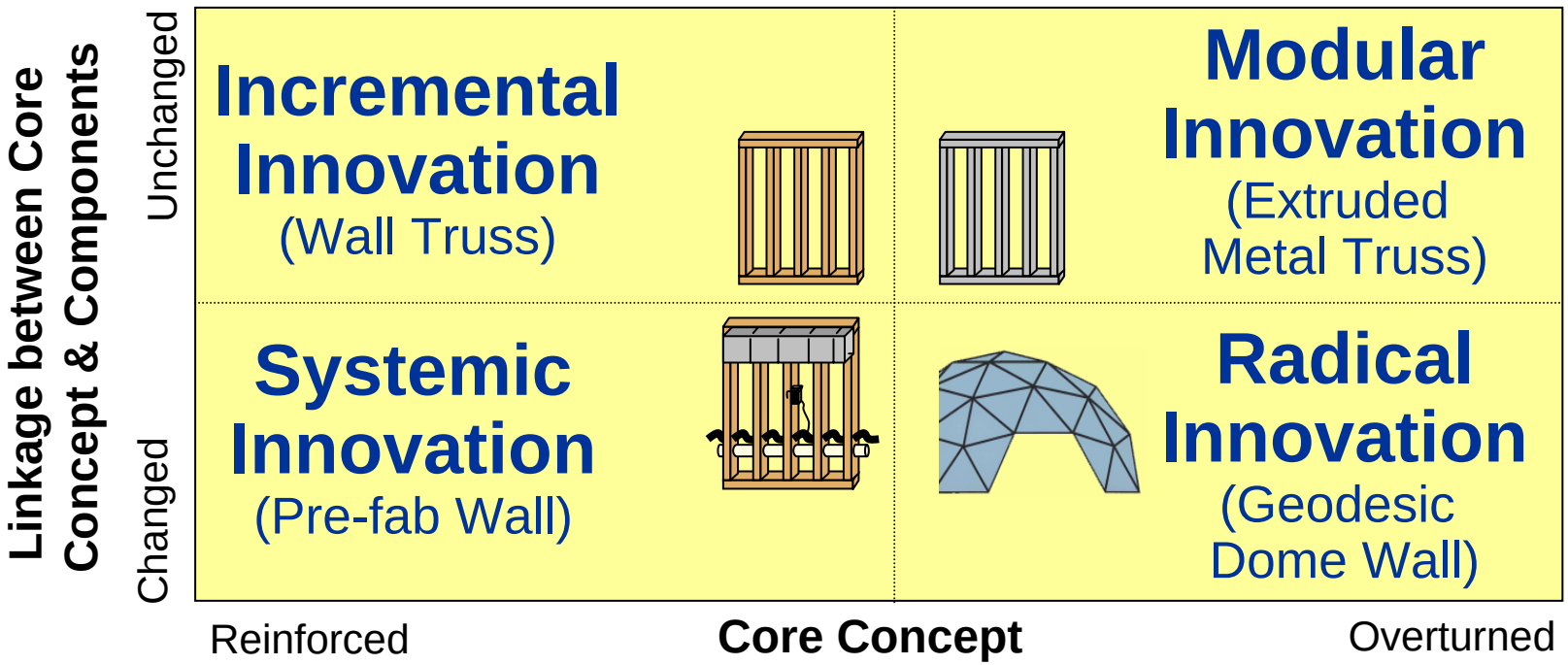
Andrei Villarroel

Best Paper Award – 2006 NAACSOS Conference

Understanding, Modeling and Simulating: Diffusion of Innovations in Global Firm Networks

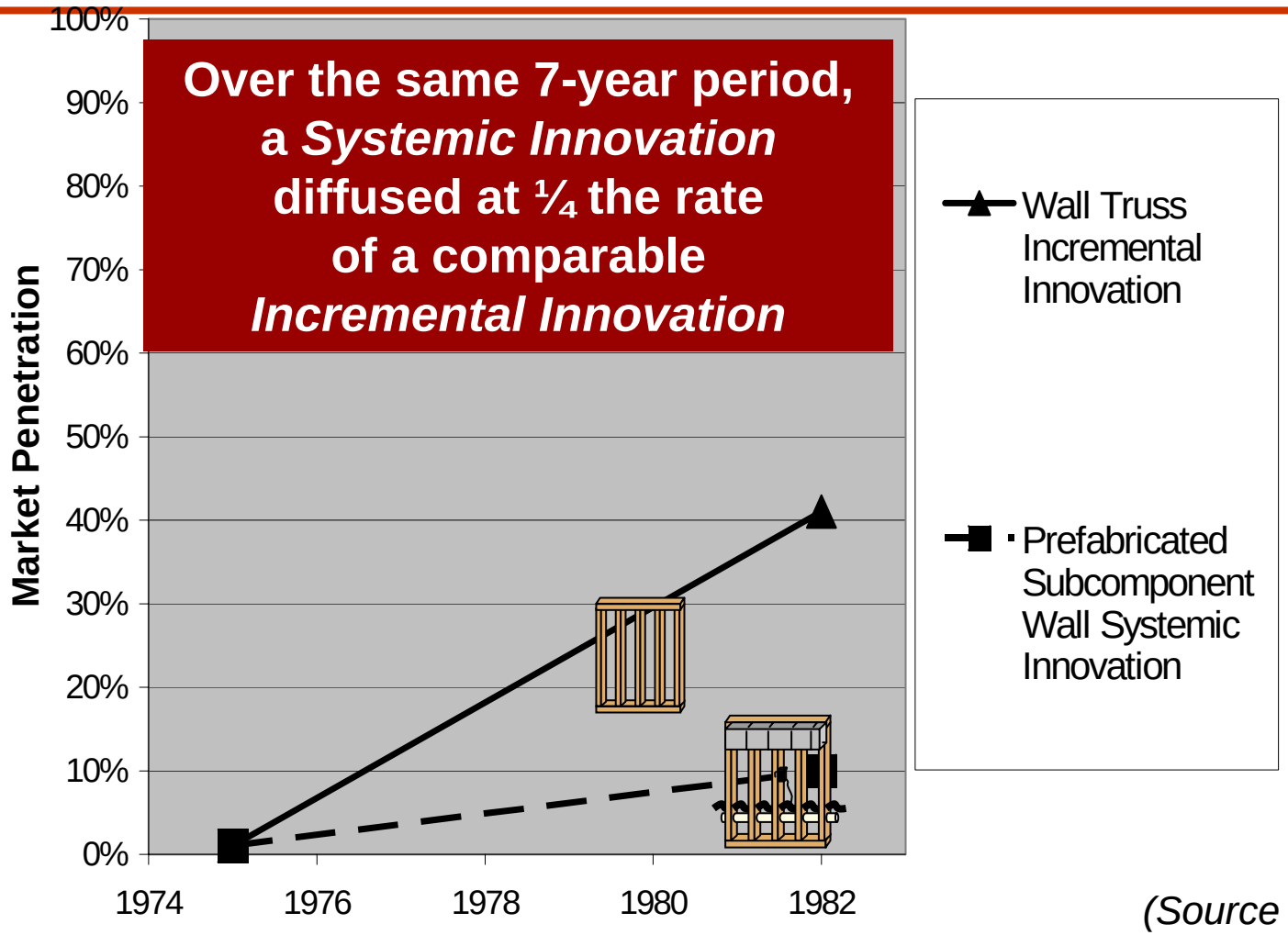
- 1 PhD student and 1 post doc, 4 years
- 12 Empirical Case Studies
  - Homebuilding innovations
  - Office building innovations
  - Building material supply chain solution (“Dot-Com”)
  - BIM Software tools
  - Includes several cases conducted in Finland with assistance from VTT
- Data Analysis and Development of Hypotheses
- Computational Modeling and Simulation

Point of Departure:
Innovation Framework



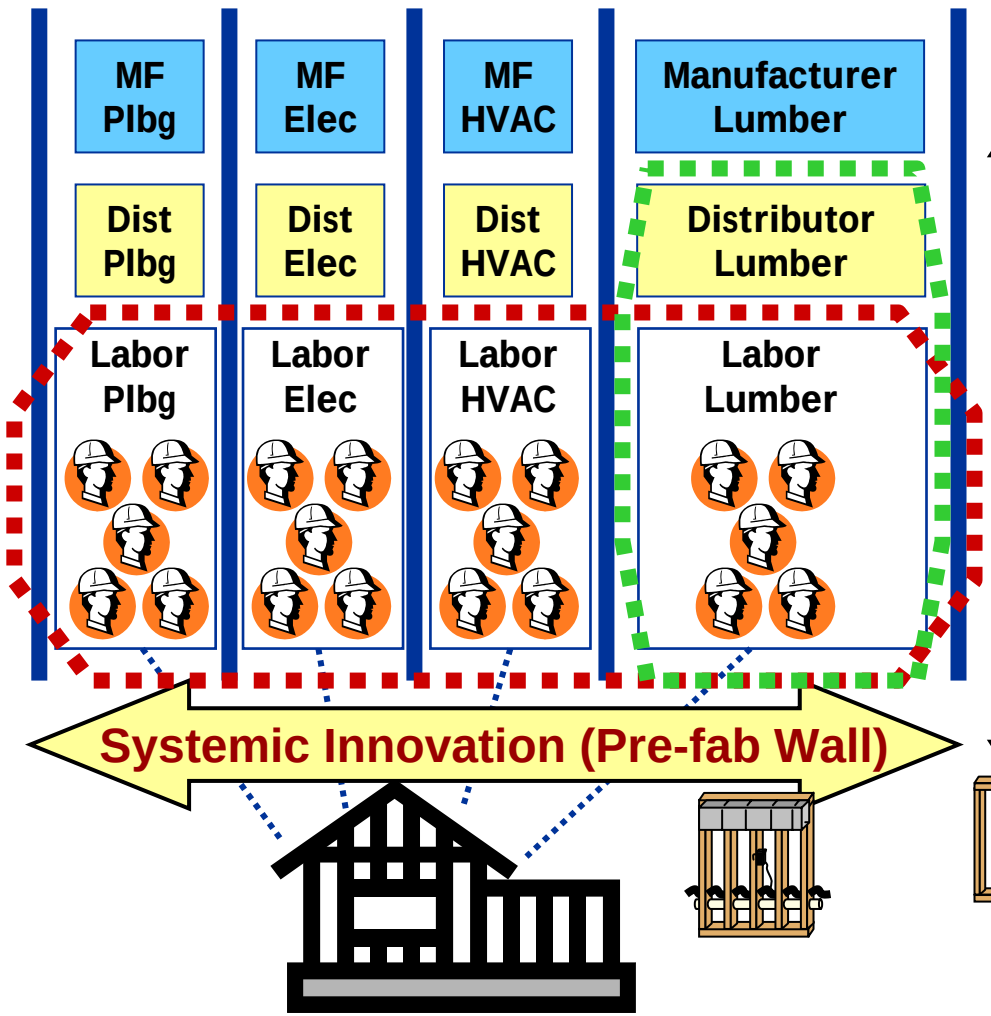
Systemic Innovations have the greatest impact on productivity with only a modest impact on the existing product

Observation: Systemic Innovations Diffuse Slowly in Project-Based Industries



(Source US NAHB)

Insight:
Why do Systemic Innovations Diffuse more Slowly?



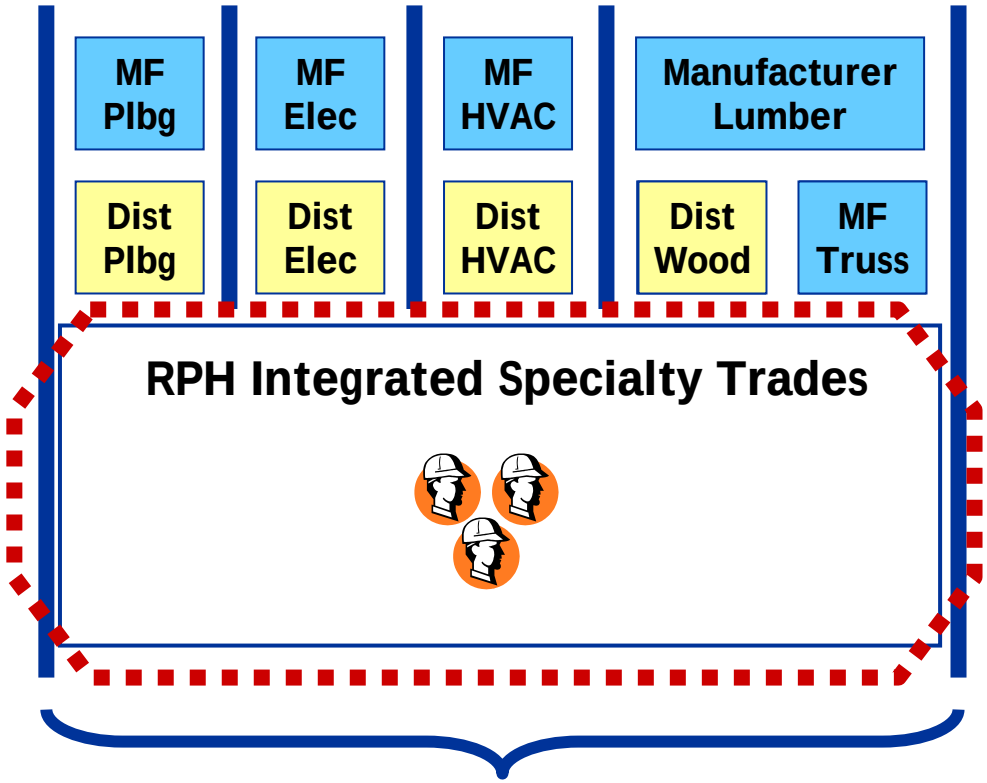
↓ Distribution Channel

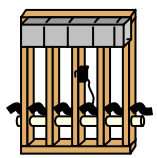
↔ Trade Labor Groups

Boundaries between trades a function of:
- Distrib Channels
- Differing Trades
- Union Jurisdictions
- MasterSpec

Research Constructs (Structural Mechanisms):
- Innovation Scope
- Supply Chain Stability
- Span
- Degree of Interdependence
- Boundary Strength

Motivating Case 1:
Prefabricated Walls for Homes





Pre-Fabricated Wall

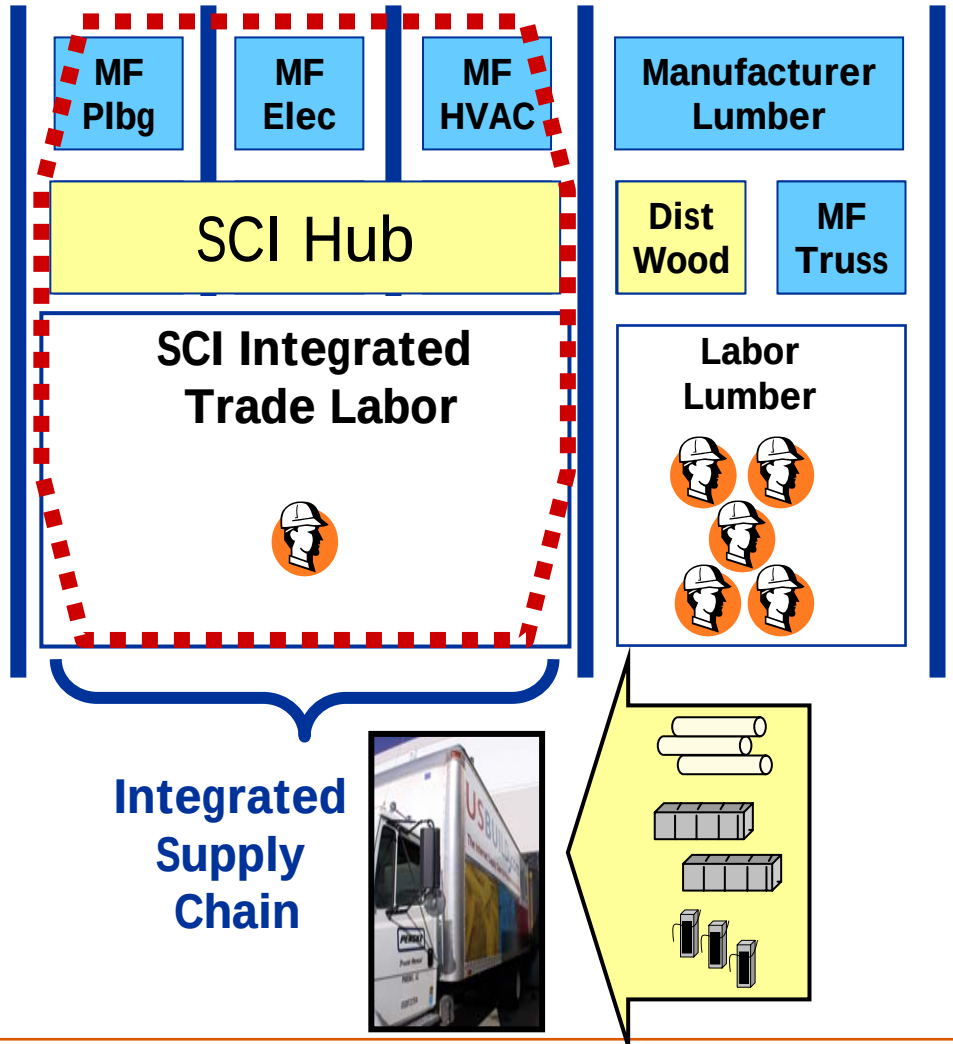
BACKGROUND:

- US National Public Homebuilder (**NPH**) Builds ~30,000 Homes/Yr
- Purchased Regional Private Homebuilder (**RPH**) to capture profitable build process
- **RPH** improved **OVERALL** productivity significantly by prefabricating walls in plant
- Multiple trades required to change… therefore **RPH** integrated trades.
- **NPH** did not integrate trades

RESULT:

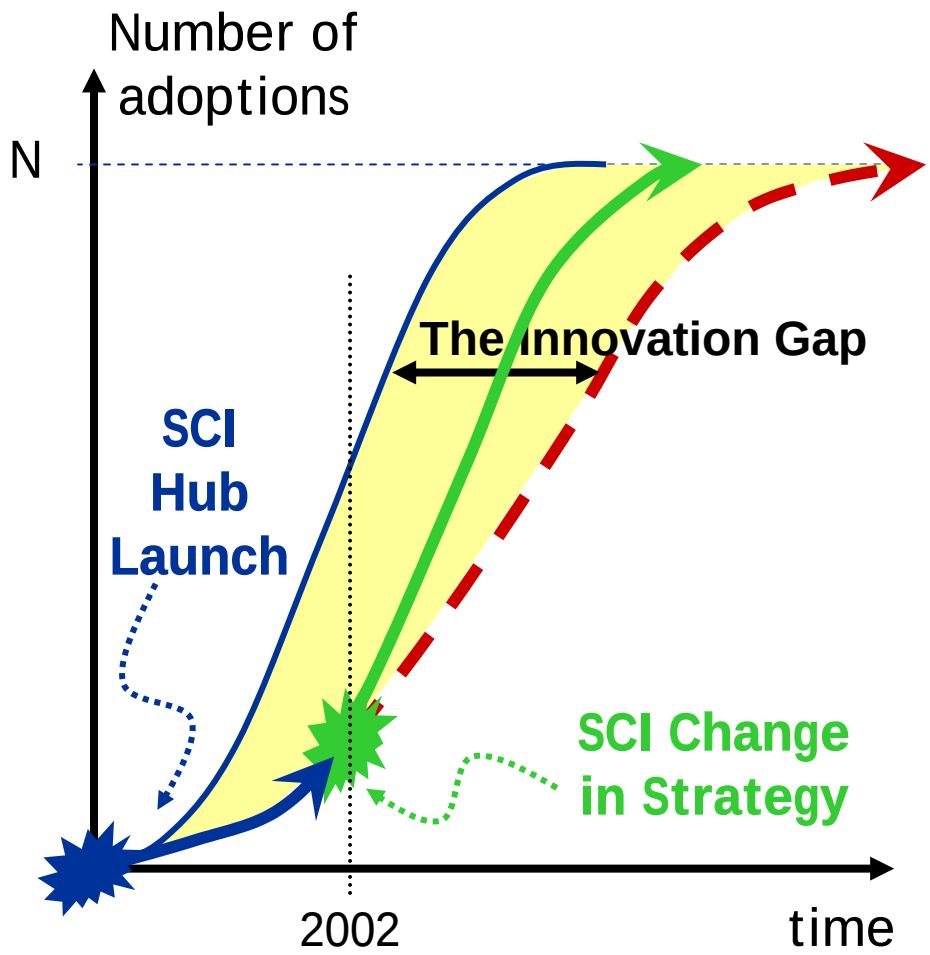
- **NPH** was unable to diffuse **RPH** pre-fab wall innovation

Motivating Case 2:
"Supply Chain Integrator"



- **Supply Chain Integrator (SCI) integrated supply chain for production homebuilders**
  - Increased Logistics Efficiency with Plbg/Elec/HVAC Hub
  - Strong overall productivity gains
  - Multiple specialty trades required to change procurement processes
- **RESULT:**
  - Very slow diffusion of innovation!

Motivating Case 2 (continued):
Effects of SCI Change in Strategy



Integrated Supply Chain for Production Homebuilders

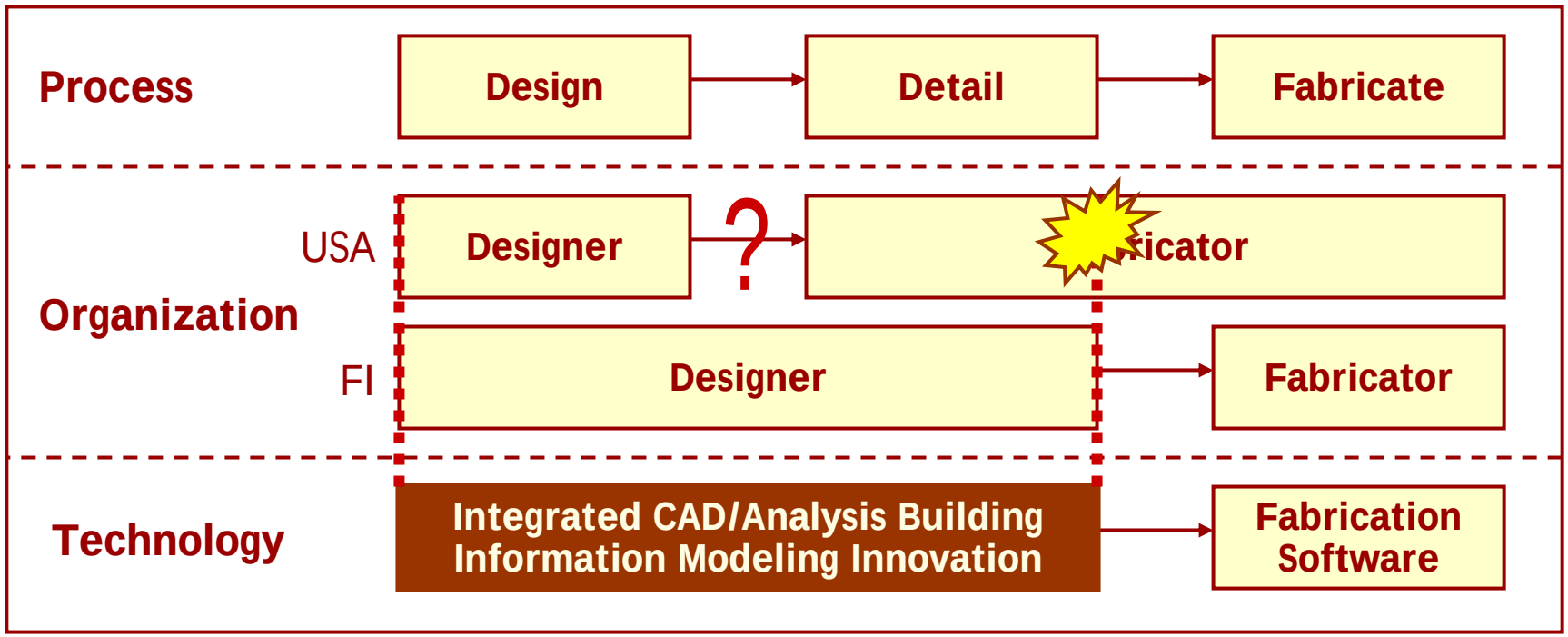
- SCI changed strategy in 2002 and integrated trade labor
- Diffusion rate increased markedly

An "Innovation Gap" Exists for Systemic Innovations

Academic & Business Literature Do Not Address this Problem

Strategy Can Positively Influence Diffusion

Motivating Case 3:
Integrated CAD-Analysis-BIM Software



Outcome

- Finland: ~100% market penetration within 10 years
- USA: product wasn't accepted until it was dis-integrated to match interfaces in the market structure

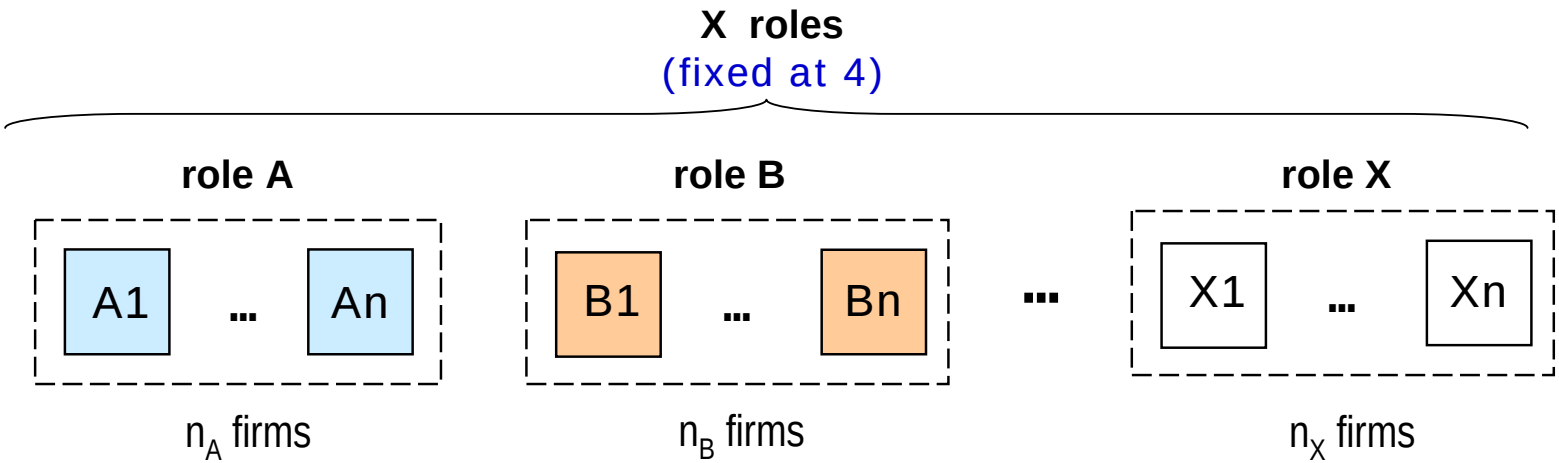
Basis for Computational Model

- Learning in our model is based on the equation introduced by Wright (1936)

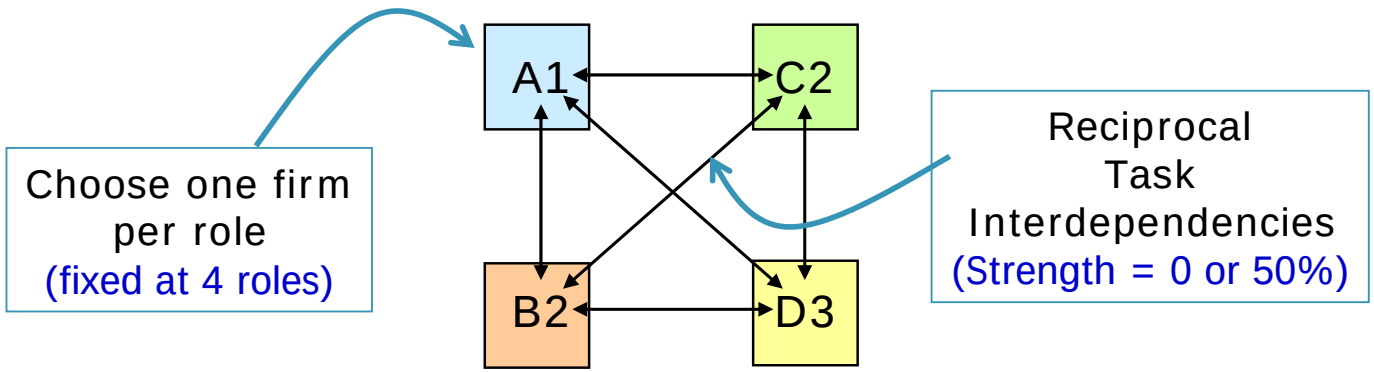
$$\text{Productivity Trial Period} = \text{Productivity Modification Factor} * e^{-(\text{Learning Rate} * \text{Learning Trial Period})}$$

- Assumed simulation values
  - *Learning Rate = 0.8*
    - *industry values range from 0.7 to 0.9*
  - *Productivity Modification Factor = 1.5*
    - *productivity loss immediately following a change requiring learning*

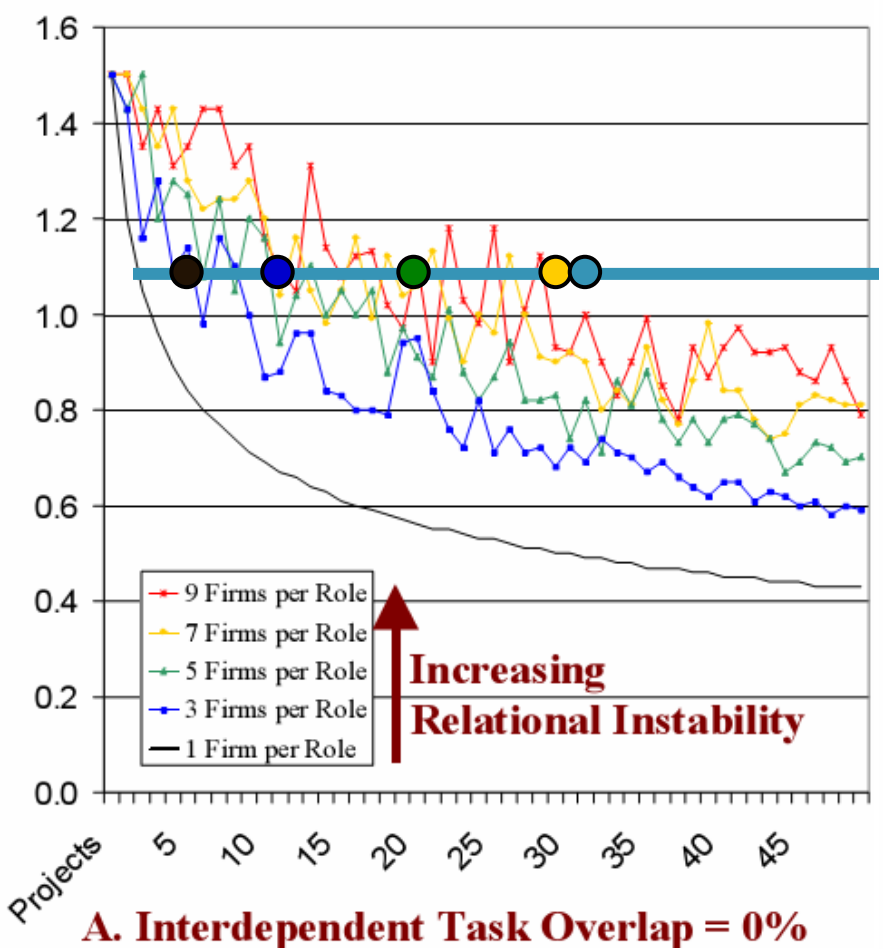
Model (Cont')



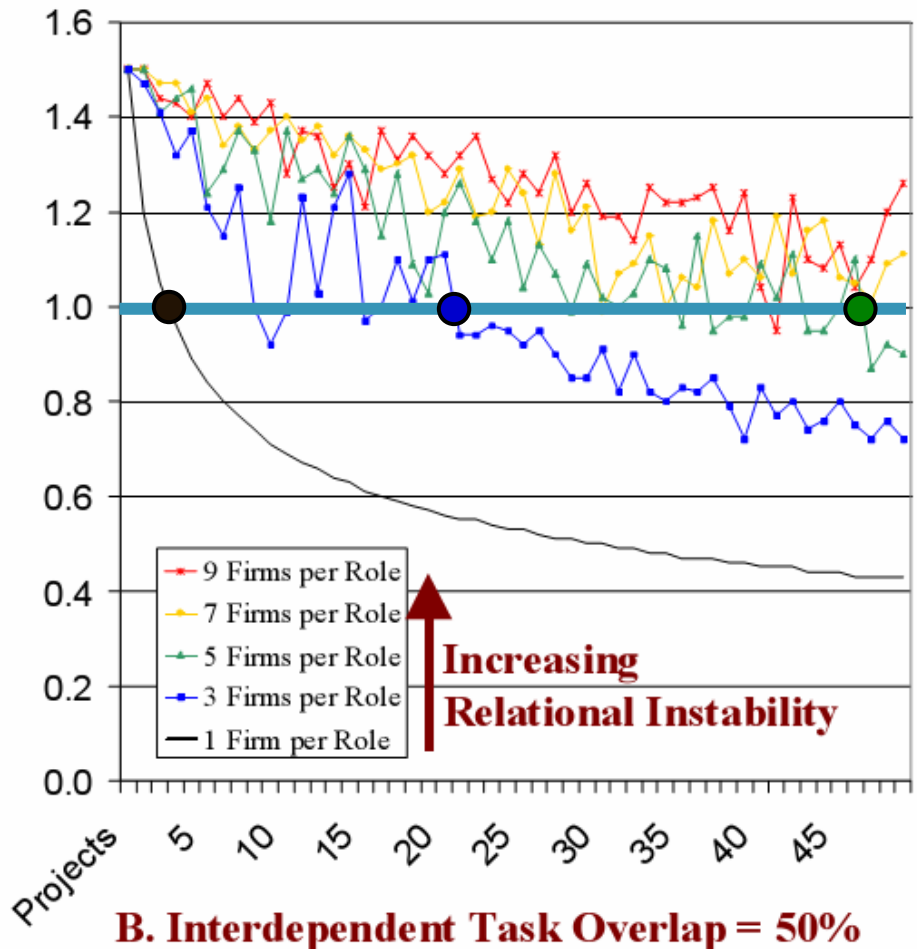
Typical Project Setup



Results



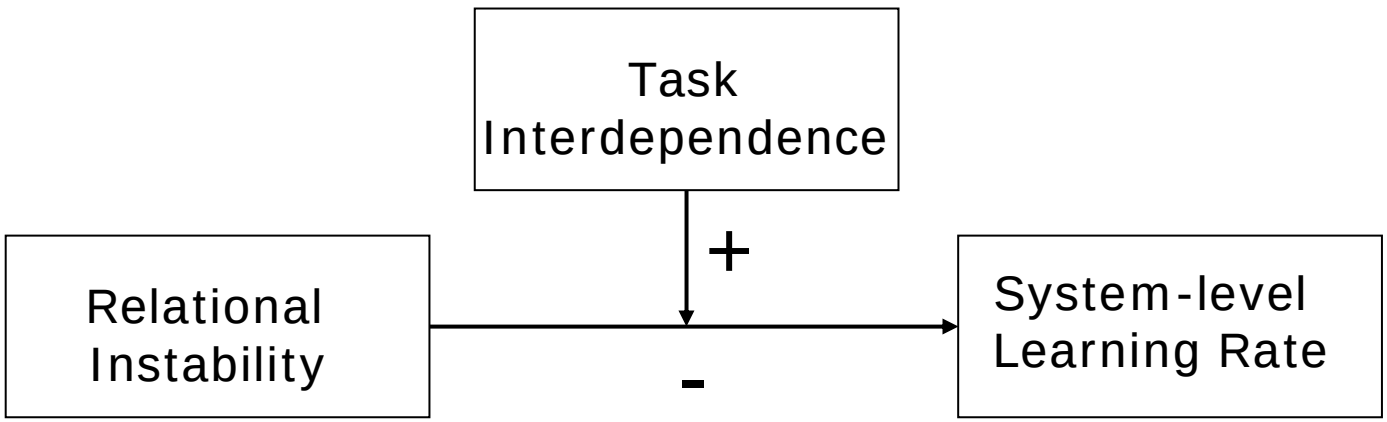
A. Interdependent Task Overlap = 0%



B. Interdependent Task Overlap = 50%

Theoretical Contribution

- Proposition: "Learning Disability" of a network of firms depends on:
  - Degree of the Interfirm Relational Instability,
  - Exacerbated by Degree of Task Interdependence



Practical Contribution

- Results can guide innovation strategy for designers, builders and software developers
  - Compare innovation boundaries to boundaries of firms in each target country's industry supply chain
  - Rescope innovation as needed
  - Merge or demerge firms to match innovation boundary to facilitate initial diffusion
- Nominated by AOM for best paper award in 2006

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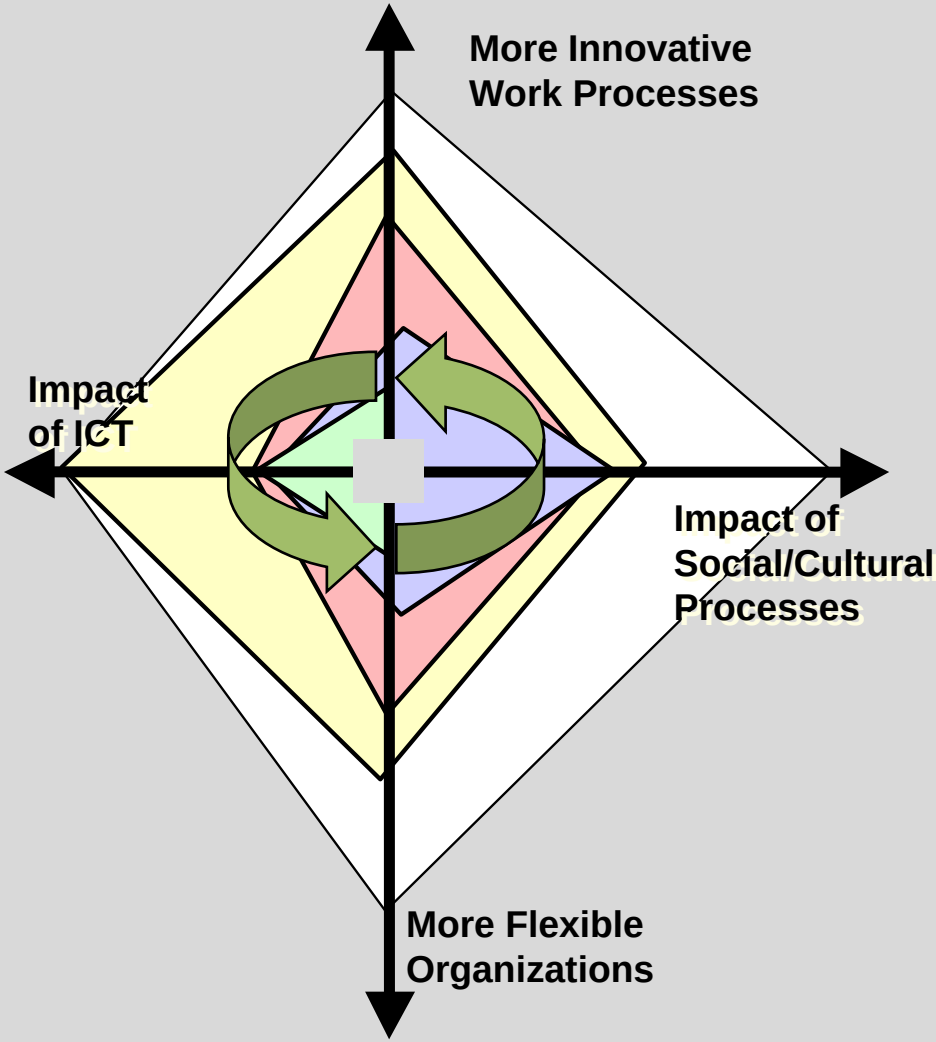
- **Wrap-up**

VDT ➔ SimVision ➔ POW-ER Research Program Trajectory



Past Work

VDT 1,2: Coordination Costs
88-94: Cohen/ Christiansen

VDT 3: Diff't Goal Emphases
95-99: Thomsen,Kish

VDT-4: Dynamic Work Proc.
96-99: Fridsma/Cain

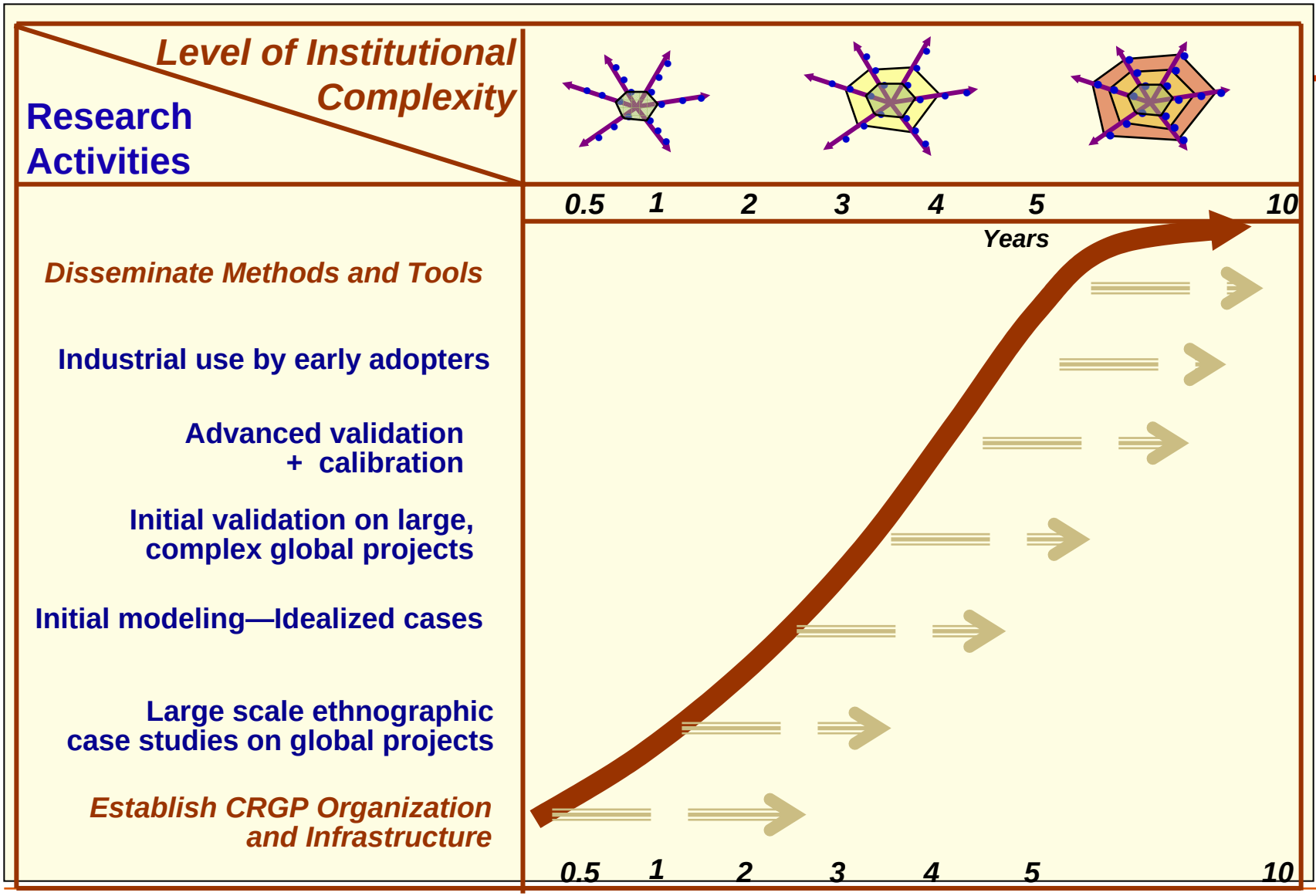
VDT-5: Knowledge Networks
99-02: Lambert/ Buettner

Ongoing Work

POW-ER Institutional Costs
03-07 Mahalingam /Horii/ Orr/Taylor/Ramsey

03-06 Design Optimizers
Murray/KHosraviani

CRGP Implementation Program



Status of Ongoing CRGP Research http://crgp.stanford.edu

- Project Ethnographies—initial results in summer 2005
- Project and Firm Case Studies—2004 - 2007
- Computational Modeling
  - *First cross-cultural simulations completed by Horii in 2005*
  - *Firm learning model prototyped by Taylor in 2006*
- Education/Outreach started 2005 (CEM, CRGP & APM)
- Initial model-based "organization design" consulting for global projects could start by mid-2007
- Robust organizational risk engineering tools for end users are about 3-5 years out