# Innovation Trap: Can Your Innovation Strategy Cripple Your Product Development?


by

**Jeffrey Manning**

Bachelor of Arts, Mathematics
Boston College, Chestnut Hill, Massachusetts


Submitted to the System Design and Management Program
in Partial Fulfillment of the Requirements for the Degree of

**Master of Science in Engineering and Management**

at the
Massachusetts Institute of Technology
May 2008
[June 2008]


© 2008 Jeffrey Manning
All rights reserved

The author hereby grants to MIT permission to reproduce and to distribute publicly paper and electronic copies of this thesis document in whole or in part in any medium known or hereafter created.


Signature of Author

Jeffrey Manning
System Design and Management Program
May 2008

Certified by

Brad Morrison
Thesis Supervisor
Engineering Systems Division

Certified by

Patrick Hale
Director
System Design and Management Program


MASSACHUSETTS INSTITUTE OF TECHNOLOGY
JUL 0 3 2008
LIBRARIES

ARCHIVES

This page is left intentionally blank.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

# Innovation Trap: Can Your Innovation Strategy Cripple Your Product Development?

by

**Jeffrey Manning**

Submitted to the System Design and Management Program on May 9, 2008 in Partial Fulfillment of the Requirements for the Degree of Master of Science in Engineering and Management

## ABSTRACT

Innovation is a hot topic; innovation is happening everywhere. Innovation is "romantic", reaching for the stars, against all odds, solving the problem no one thought possible. Most CEOs would not characterize survival as "romantic". Innovate or perish; the mantra, the truth, plain, stark, cold and naked. It gets worse; the environment is rapidly changing. Sophisticated customers are demanding quick responses with low cost, high quality products. What once worked with brilliant success is now failing. If innovation is happening everywhere, it is increasingly not happening here.

During the past two years, a multi-vendor government project consisting of two vendors geographically segregated across three regions has seen tremendous success followed by almost total collapse. Initial program status and progress indicate near exponential trajectory: ahead of schedule, under budget and all functionality present. However, collapse was not too far off. The integration effort was a complete failure. Key schedule milestone dates were continuously missed. The gap between functionality believed completed and really completed widened. The story reads like a classic runaway project. Worse, the budget was near exhaustion.

The central contribution of the analysis is the identification of the innovation trap. The innovation trap identifies conflicting corporate objectives governing the innovation strategy for new business development and the product development strategy of existing programs in the product pipeline.

This study examines the innovation trap by applying System Dynamics techniques to develop a set of heuristics not only to identify collapse conditions but also how to address the problem. The goal of this study is to develop a concept for an improved organization and structure for today's high technology product companies where innovation is crucial for corporate success.

Thesis supervisor: Brad Morrison
Title: Professor of Engineering Systems



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

# BIOGRAPHICAL NOTE

Jeff Manning has a passion for building systems. He enjoys the many challenges that accompany complex systems. From the hard work, sweat and tears of despair ("will it ever work?") slowly turning way to a quality product is an awesome experience. Jeff has been architecting, designing and developing software for close to twenty years. Through the years, he developed software across a wide range of applications including but not limited to device drivers for a variety of hardware platforms, health care applications, real time embedded solutions. In addition, he has witnessed huge changes in the software industry from the arcane methods of the earlier 80's to the boom of the 90's to the crash of the millennium.

Jeff Manning joined the System Design and Management (SDM) program to augment his knowledge of software/product development. After twenty years, he wanted to be involved in all aspects of system design - to learn to architect/design complex systems with proven (and often evolving) project processes maintaining a system wide vision, to master the process of taking corporate strategy to functionality and the skills of identifying and understanding key value propositions required to exceed customer's expectations.

Through SDM, Jeff obtained the skills required to bridge the gap between strategy and the building of the product; providing the instrumental leadership in determining what product is built. Equally important to the technical underpinnings of project design is leadership and management skills. The ability to align corporate, strategic objectives with the delivery of software is a crucial skill for the software industry or for that matter, any industry. One step further, Jeff mastered strategic management, how companies are organized to solve complex problems and how companies fund these efforts.

Jeff Manning graduated in 1986 from Boston College (BC) with a Bachelor of Arts in Mathematics. This thesis work completes the requirements for his Masters of Science in Engineering and Management from the Systems Design and Management Program at the Massachusetts Institute of Technology.



© Jeffrey Manning- All Rights Reserved 

# ACKNOWLEDGEMENTS

Cambridge, Massachusetts Jeff Manning
May 9, 2008

First, I would like to thank Dr. Brad Morrison, my supervisor, for his patience, insight, and constant guidance during this research.

In addition to Professor Morrison, I also had tireless support from industry. Special thanks go to Lt. Col. Pettyjohn – whose constant advice, guidance and positive attitude made this research effort real and a valuable learning experience. Next, Major Braddock, Lt. Col Krawczyk, Lt. Col Eisenbies and Dr. Kuschel, I thank for thank for their help in support of my research efforts.

It's been a long road! One I never regretted for an instance. MIT was an awesome experience – a place of challenge and growth. I have also been blessed with a great cohort. It is difficult to single out any peer for fear of leaving one out – you were all truly great. Nate Minami, Michael Visee, Roberto Acosta, Jess Kopczynski, and Luis Mesada without your kindness and patience I doubt I would have survived. Your tireless efforts on all of the team projects have made the effort worth the entire wait.

Finally, and clearly most important, I am grateful for the continuous love and support of my family; my beautiful wife Jennifer, and my wonderful children Ryan and Patrick John (PJ). They are my inspiration. I hope to provide you, as high school students yourself, with an example of the required hard work and commitment to succeed in school! If not, I am going for my PhD while you attend college – roomies!



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

# PART I Background

*"The beginning is the most important part of the work" (Plato 4th cent. BC)*

## Chapter 1*: Introduction*

Innovation, the first reduction of a concept to useful practice in a culture, is a hot topic; innovation is happening everywhere. Seldom has a day expired without innovation being a key theme for corporate America. It is a subject of endless debate among executives. Good innovation differentiates, separating a company from its competition. Many companies have integrated innovation into key strategic initiatives.

Innovation is "romantic", reaching for the stars, against all odds, solving the problem no one thought possible. It is the motivated team; the team performing and executing to the impossible. The bonding and the lab camaraderie develops a spirit overpowering any weakness. To work on problems previously deemed impossible creates excitement, transforming the work place into a learning environment. Today's work force is different, hungry and looking for opportunity. People not only want to express themselves, they want to make a difference. But there is a catch; people rarely perform at this level. People must be challenged. People must feel some pain, a sense of urgency, fear, before this level of performance is reached. Innovation requires never ending high levels of execution – difficult to sustain even in the most pristine of conditions.

Innovation is survival. Most CEOs would not characterize survival as "romantic". Innovate or perish; the mantra, the truth, plain, stark, cold and naked. It gets worse; the environment is rapidly changing. Sophisticated customers are demanding quick responses with low cost, high quality products. What once worked with brilliant success is now failing. Fierce competition quickly imitates best practice eroding margins further stretching innovation resources. The bar has been raised; who is going to blink first? Unfortunately, companies fail to adapt to these emerging trends; corporate inertia is difficult to change. More often than not, companies are not only unable to make change they are unwilling, burying their heads in the sand longing for a yesterday long since expired. Is it an illusion, a nightmare? If innovation is happening everywhere, it is increasingly not happening here.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

For every innovator, there is an innovative strategy. Every day more innovation methods appear to discover customer needs creating the next wave or buzz: Voice of the Customer (VOC), Ethnographic Research, Zaltman Metaphor Elicitation Technique (ZMET), House of Quality, TQM. The list of acronyms is dizzying. To develop the product there are equal methodologies: waterfall, staged gate, iterative, rapid prototyping, extreme programming. The list is endless.

In today's challenging economic environment, the only way to survive is to innovate. Innovate is more than new products, it encompasses innovating strategies and business models. Unfortunately there are many obstacles to innovation[1] [2] including but not limited to:

- Slow Development Times
- Lack of Coordination
- Metrics/Measuring Innovation
- Incentives

More interesting, a recent market survey[3] based on follow-up interviews with executives "reveals the importance of aligning innovation initiatives with corporate strategy and of in-depth customer understanding."[4] Corporate strategy and customer understanding are connected to innovation strategy. In a similar McKinsey Report[5] 70% of the executives surveyed named innovation as one of their top three priorities for driving growth. "Although more than a third of top managers (senior VP level and higher) say innovation is part of the leadership team's agenda, an equal number say their companies govern innovation in an ad hoc way."[6]

---

[1] Business Week Online. April 24, 2006. The Worlds Most Innovative Companies. < http://www.businessweek.com/@@5hfAgocQ0SPwNx4A/magazine/content/06_17/b3981401.htm>
[2] Andrew, James P. et al. "Innovation 2007: BCG Senior Management Survey." The Boston Consulting Group, August 2007.
[3] Business Week Online. December 19, 2007. "The State of Innovation." < http://www.businessweek.com/innovate/content/dec2007/id20071219_302022_page_2.htm>
[4] Jaruzeleski, Barry and Kevin Dehoff. "The Customer Connection: The Global Innovation 1000." Strategy + Business, Booz, Allen, Hamilton. 12/10/07 < http://www.strategy-business.com/resiliencereport/resilience/rr00053>
[5] "How Companies approach innovation: A McKinsey Global Survey"." McKinsey Quarterly. Oct. 2007
[6] Ibid, p6



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

This is not surprising. CEOs understand that innovation is a critical success factor for their organizations. They can recite the key subtleties of aligning innovation with corporate strategy and the critical role of understanding the customer. They just do not understand how to manage the innovation process. When pressed, these very managers responded "while 40% of top managers say the problem is they don't have the right employees, only 31% of other executives agreed. And among executives who said they did have the necessary talent, less than a quarter of top managers felt corporate culture inhibited progress, while almost a third of lower-ranked executives thought culture was a problem."[7]

Is it the talent of the employees? Is it culture? Can my manager's even manage? Am I building what the customer's even want? More importantly whom haven't I blamed for my failure? Attribution error is a misused weapon; easy to do, seldom bears fruit until one looks into the mirror. Reminiscent of a childhood cartoon "We have met the enemy… and he is us."[8]

The central contribution of the analysis is the identification of the innovation trap.

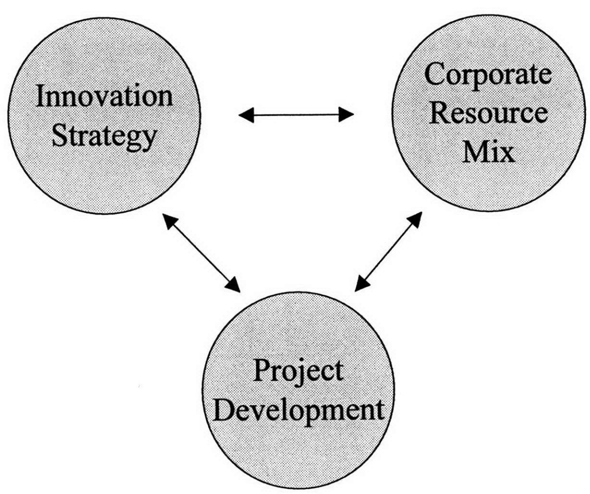



**Figure I-1 Innovation Triangle**

---

[7] Business Week Online. December 19, 2007. "The State of Innovation." < http://www.businessweek.com/innovate/content/dec2007/id20071219_302022_page_2.htm>
[8] From the foreword to <u>The Pogo Papers</u>, Copyright 1952-53. See Pogo Cartoon strip < http://www.igopogo.com/we_have_met.htm>



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

The innovation trap is a delicate balance of a globally optimized innovation strategy across all projects (as well as future new business) and the product development strategy of existing programs in the product pipeline. Each strategy is governed by the current corporate resource/skill mix.

## Section 1.1 Motivation

During the past two years, a multi-vendor, non-equity alliance[9] government project consisting of two vendors geographically segregated across three regions (CT, FL and CA) has seen tremendous success followed by almost total collapse. Initial program status and progress indicate near exponential trajectory: ahead of schedule, under budget and all functionality present. Awards were won (Program of the Year, Best Practice etc)! Promotions given out! Staggering award fees resulting in tens of millions of dollars were earned by the vendors.

However, collapse was not too far off. The integration effort was a complete failure. Key schedule milestone dates were continuously missed. The gap between functionality believed completed and really completed widened. Management instituted mandatory six-day weeks. The story reads like a classic runaway project. Worse, the budget was near exhaustion. The only funding left to complete the program was the management reserve (MR).

Why does it take so long to complete technological development? Why is it so difficult to create a feasible schedule and "march" to it? When asked, companies site exogenous factors – events beyond their control -- as the source of the delays. When asked for a root cause analysis of three consecutive schedule slips, program management cited[10]:

- Delay(s): Hardware, dependent sub-systems and integration
- "Infant mortality of third party test environment"
- Stability of the infrastructure

[9] Farok J. Contractor and Peter Lorange eds., Cooperative Strategies in International Business. Lexington, Mass.: Lexington Books, 1984. P56. A Nonequity alliance are agreements between partners to cooperate in some way (to jointly carry out a research project) but they do not involved the creation of a new firm nor does either partner purchase equity in the other. Killing further delineates "Shared-activity alliance" as an agreement between firms to work directly together to achieve a common objective.

[10] These "root analysis" findings were revealed during in depth interviews



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

- Added capability

Interesting what was NOT noted in any root cause analysis - the role the organization played in creating the delays and cost overruns. When specifically asked about the role of the organization including the protection of proprietary information, each vendor vehemently denied its role in the current collapse. It was the strong denial that sparked an interest and created a hypothesis – could the organization itself with its two-year evolution foster the current culture and inertia resulting in the staggeringly poor performance? Initial research into this question proved fruitful.

Not "satisfied" with contractor (industry team) analysis, the customer management through its own expertise initiated an internal self assessment into what prevented the industry team from achieving the established base line (schedule) goals. The effort was to identify reasons for the delay (from original delays through current delays) and provide guidance as to what other areas might emerge as high risk.

## Section 1.2 Problem Definition

Organizational evolution has long been studied. The associated challenges are not new. Several scholars have presented the notion of organizational behavior as a "near irreversible momentum of increasing bureaucratization and goal displacement"[11,12,13] others argue that "organizations become more stable until replaced during 'gales of destruction'".[14] Authors have even argued and focused on "the heroic executives radically transforming their organizations as environmental conditions changed."[15] In all, opinions regarding organization evolution span the gambit from the inevitable, to the external forces of destructive gales to the super human heroics of key executives.

---

[11] Tushman, M. and E. Romanelli (1985) "Organizational Evolution: A metamorphosis model of convergence and reorientation", in L.L. Cummings and Barry Straw (Eds), Research in Organizational Behavior, 7: 171-222. Greenwich, CT: JAI Press.
[12] Weber, M. The protestant ethic and the spirit of capitalism. New York: Scribner, 1952
[13] Merton, R. K. Social theory and social structure. New York; The Free Press, 1968.
[14] Schumpeter, J. A. The Theory of Economic Development, Cambridge, MA: Harvard University Press, 1934
[15] Chandler, A. D. Strategy and Structure: Chapters in the history of American Industrial Enterprise. Cambridge, MA: MIT Press 1962.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

Three organizational evolutionary frameworks are generally agreed upon:

- Ecology Models[16]
- Adaptation Models[17]
- Transformational Models[18]

This paper leverages a punctuated equilibrium model where organizations progress through convergent periods punctuated by periods of reorientations[19]. An attempt is made to understand the roles that performance and the role organizational evolution plays during both convergent periods as well as during periods of reorientation. Our research attempts to understand:

- How and why the organization evolved?
- Why the organization seemingly failed overnight?

The basic problem of this thesis is to better understand the nature and characteristics of organizational evolution and its delicate interplay with larger corporate dynamics including a company's resource mix, its innovation strategy and its risk policy. Even more important, this research attempts to understand patterns in organizational evolution that discriminate between the success and failure of companies.

This paper models (using causal loops) the organizational evolution of a government program. The paper focuses on change with the initial introduction of the concept followed by a series of convergent steps and strategic moves that ultimately lead to the collapse and failure of a development organization. Failure was measured by a two-year slip and a seventy million dollar budget overrun.

## Section 1.3 Framework

The following sections detail the investigation, research and analysis to build a causal loop model.

Section II details our methods of data collection and analysis

---

[16] Freeman, J. Organizational life cycles and natural selection process. In B Staw & L. L. Cummings (Eds), Research in Organizational Behavior (Vol 4). Greenwich, CT: JAI Press, Inc. 1982

[17]

[18]

[19] Tushman and Romanelli, p 173.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

Section III presents the basic hypothesis/findings
Section IV develops a dynamic, causal loop model detailing the innovation trap
Section V explores the implications of the innovation trap



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

# PART II Literature Research

## Chapter 2 *Organization*

The project team is a DoD acquisition consisting of a joint effort combining the efforts of industry teams (contractors) and government management - System Program Office (SPO). DoD acquisitions are loosely characterized by[20]:

- A unique set of Government and contractor organizations and personnel
- A large diverse set of policies, strategies and processes
- A large unique set of political, management, and technical activities
- A dynamic political, budgetary, and technical environment
- One chance to succeed

Acquisitions are complex, dynamic, and interconnected socio-economic systems[21]. The team spanned several disciplines including, but not limited to, hardware (mechanical, electrical), software, quality assurance, integration, logistics and safety. The industry team consisted of approximately eighty (80) software engineers and their managers (including program managers) from three unique organizations. In addition to the actual development team, the overall effort was lead by government management (the customer, SPO). The customer organization was lead by a Colonel (responsible for several programs) who left the day-to-day project management of this specific project to a Lieutenant Colonel. The Lt. Col had a team size of approximately twenty people spread out across three flights (sub teams) mirroring some of the aforementioned industry disciplines.

---

[20] Abelson, L., R. Adams and S. Eslinger. "Acquisition Modeling: The Key to Managing Complex Acquisition Complexity." 3rd OSD Conference on the Acquisition of Software Intensive Systems, January 2006.
By and large the model here is a glorified Undiscovered re-work model trying to account for both SPO and non SPO personnel. For more details into the Undiscovered Re-Work loop please see: **"The Rework Cycle: Benchmarks for the Project Manager"**, Project Management Journal, Volume XXIV, March 1993 as well as **"Swords and Plowshares: The Rework Cycles of Defense and Commercial Software Development Projects"** American Programmer, May 1993.

[21] Ibid, p3



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

For the purposes of this paper, the focus is on the trials and tribulations of the software development effort. By and large this effort is responsible for the majority of the delays (original and current) of the program. The author maintained a leadership position on the overall software team.

# Chapter 3 *Non-equity Alliance*

The central theme underlying any alliance (joint venture, non-equity alliance, minority alliance) is complexity[22]. It is simple: complexity can lead to failure or great success. Alliance complexity is defined by two concepts: task complexity and organizational complexity. The skills in terms of cognitive ability and leadership required to manage a complex task using a complex organization are very different from the simple case. To succeed, it is important for executives to understand the differences. A complex alliance is doomed to fail without the correct resource.

## Section 3.1.1 Task Complexity

Three criteria are used to gauge task complexity[23]:

1. **Scope of Alliance Activities**. This includes but is not limited to the number of objectives, the duration and the number of business functions the alliance encompasses
2. **Environment Uncertainty**: This includes overall demand, customer preferences, government actions and supplier competence
3. **Relevant Partner Resources and Skills:** This addresses if the partners have the resources and skills necessary for the alliance to succeed.

For the project under research, the task complexity was moderate to great. The task is a next generation sensor (radar) program. Not only is the number of requirements high but the need for tight business alignment is great. Success is mutually coupled. The current duration of the project is in excess of five (5) years. Significant effort is involved in prototyping and bringing a small volume of sensors to market is significant. The environment is dynamic; the project has seen significant leadership change at both the contractor as well as the government sides.

---

[22] Ibid, p 57.
[23] Ibid, p58.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

Although some aspects of the technology are rooted in legacy programs, the program effort is a full life-cycle modernization effort. The complexity of the effort stems from the increased unprecedented scale of the program, to the updated cutting edge massive parallel processor platform. At the time the contractors involved in the program were considered world-class operations with significant expertise. Here expertise is defined not only in years of experience but significant prior artwork from legacy systems. Unfortunately, this assumption proved wrong. The experts from the previous generation of technology and innovation began to move on, and in some cases retire. This left the corporate asset of algorithms and designs without the key design engineers.

| Task Complexity Factors | |
|---|---|
| **Alliance Scope** | |
| Alliance Objective | Deliver Complex Product, Make Profit |
| Number of business functions | Many |
| Number of business products | Many |
| Number of markets | One |
| Intended Duration | Very Long |
| **Environmental Uncertainty** | Medium |
| **Relavent partner resources/Skills** | Low |

## Section 3.1.2 Organizational Complexity

Organizational complexity is the result of how decisions are made. Complexity is generated when personnel from one firm make and implement decisions that affect both firms.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

| | | | |
|---|---|---|---|
| Nature of Interaction | Nonroutine | **Moderate Complexity** | **Great Complexity** |
| | Routine | **Low Complexity** | **Moderate Complexity** |
| | | Low | High |

Frequency of Interaction

**Figure II-1 Organizational Complexity**

In its basic diagnosis, organizational complexity can be captured with two key parameters: nature and frequency of the interactions[24]. Interaction can be difficult. Personnel from differing firms do not share the same incentive systems, attitudes, and possibly beliefs. This is a direct ramification of the corporate culture of the firms involved. Worse, it should not be a surprise that the alliance firms may have differing objectives. These differing objectives are subtle, often lurking below the surface. Only when joint decision-making is required do these differences surface. Additional communication can also interfere with progress. When "stuck", decisions must be elevated to higher-level authority (executives) split across both firms. The roles firms play: Prime/Sub, 50-50 split control, shared management and independent all impact performance. Specifically, resolution times can be further impacted if partner firms have equal influence (50-50) in decision making. Building consensus, with differing objectives can be an arduous process. It stands to reason that the more routine and less frequent the interaction, the more simple the organization.

Besides the interaction complexity, four criteria affect organizational complexity:

1. **Number of Partners**: The more partners, the greater potential for organizational complexity. Well defined roles and spheres of influence can mitigate risks

[24] Ibid, p 59



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

2. **Role of Each Partner**: The more partners seeing themselves as equal roles in managing the alliance, the more potential for organizational complexity. Building consensus is both time consuming and difficult. Interestingly, the role played by the partners reflects the quantity and similarity of skills and resources brought to the team. "The more similar the skills, the more likely for shared decision making alliance"[25]
3. **Level of Trust:** Dysfunctional interaction can result is the alliance lacking trust.
4. **Task Complexity:** The simpler the task, the simpler the organization. Alliances requiring the combined skills and resources of partner companies need additional complex organizational arrangements.

For the project under research, the alliance was formed as a shared management effort with split (50-50) control both in size of effort, scope of work as well as financial rewards. Additionally, each company brought in unique skills and resources required to complete the product. Although there are two corporations involved on the balance sheet, one of the companies is segregated into two divisions from an earlier acquisition strategy. This had the effect of create three (3) "virtual" companies.

By and large, the companies trust (or "mutual forbearance"[26]) each other. One issue governing trust is the role of proprietary information. If the joint effort requires "proprietary" information to complete the task, trust is a key issue. Proprietary technology represents a significant competitive advantage. These technologies are fiercely defended and carefully, methodically protected. The effect of proprietary information is hard line emphasis on well-defined roles.

[25] Ibid, p62

[26] The term mutual forbearance was a term taken from chapter 2 Buckley, P.J and M. Casson. "A Theory of Cooperation in International Business". It capture the notion that alliance partners would "deliberately pass up short term advantage" which they could take at the expense of their partners, in the interest in keeping the alliance alive.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

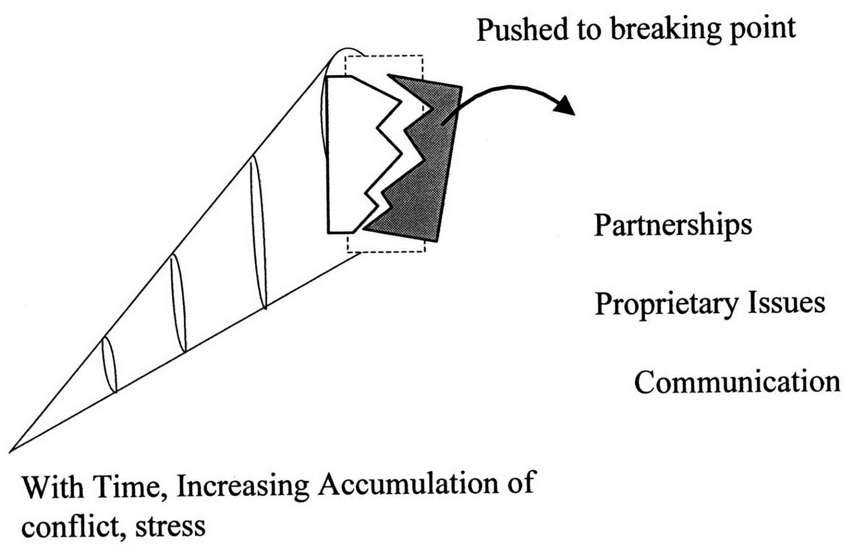



**Figure II-2 Pushed to Breaking Point**

System Proprietary Information (SPI) also became a weapon/escape as needed. As a weapon, engineers could immediately claim the technology was proprietary. The effect was reduced openness and visibility. In fact, the only means of one partner communicating with another's proprietary technology was through a well-defined interface. The interface was maintained in a non proprietary documented called the Interface Control Document (or ICD). The ICD published the interfaces and data structures used to solicit services from the technology. These interfaces can range from simple asynchronous calls to very complex, state based calling mechanism with stringent timing requirements.

Even with the ICD, the net effect was to squelch communication and increase stress levels. Due to the layered, modular architecture of the product, higher-level functionality is often layered on lower level (closer to the hardware) constructs. Services were "opened" by service calls to the lower layer documented by the ICD. An arbitrary layering mechanism is presented in the following figure. In an ideal world, this is a sound practice. However, this mechanism can quickly break down and all but reduce communication and harden positions.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

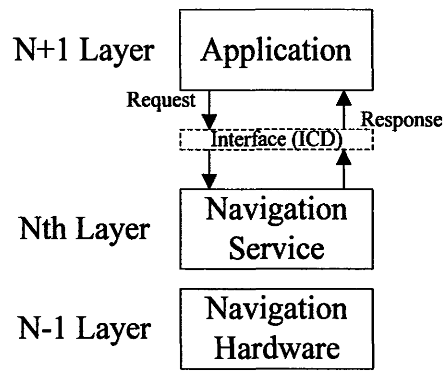



**Figure II-3 Interfaces**

To illustrate this claim (there are many other similar cases). Consider an application required NAVIGATION services. The low level NAVIGATION service wrapped a proprietary hardware solution for the navigation instrument of an airplane. The navigation system is responsible for determining the plane location, its heading, altitude speed (there are other features but these are beyond the scope of the discussion). The application leverages and exposes interface data (location, heading, speed etc).

The issue is subtle, but one that causes accumulating stress and significant communication overhead. Both of these issues can impact the performance of the team. If there is a problem (bug), the application team writes up a problem report and submits the issue to the Navigation team requesting additional information. The Navigation team responds with a possible solution. This repeats until the problem is solved (see below figure).



© Jeffrey Manning- All Rights Reserved
jwm@sloan.mit.edu

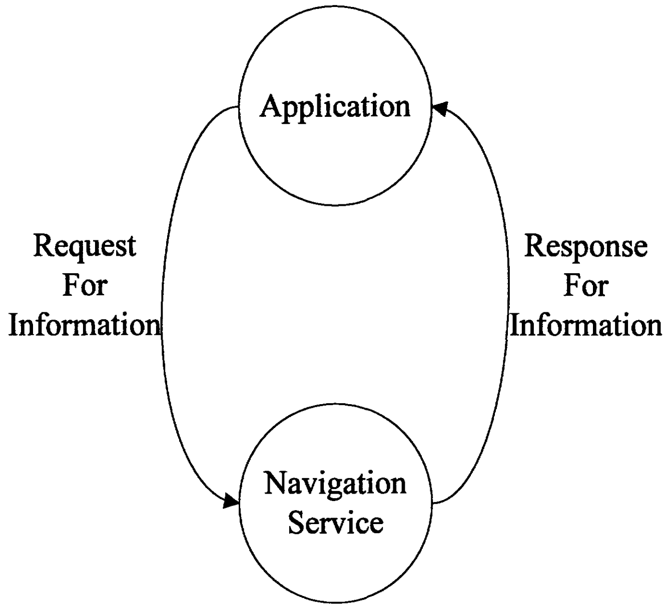



**Figure II-4 Request(s) For Information**

This "request for information" model is a low bandwidth, high involvement, effort which can quickly escalate high pressure, high stress environments. The application began realizing schedule pressure and started to report the Navigation services as blocking their forward progress. In response, the Navigation services team responds, "We have answered all of the questions." Not only that, in our lab, "our solution checked against the truth data (a known test bed with an agreed upon, known truth) proved out correctly". We are being blamed for their inability to deliver their functionality. There is no trust; the alliance is broken.

To break this attribution error chain, program management must get involved to expose the internal workings. In our example, the navigation service was modified to expose the raw stream of data it captures from the hardware (the proprietary information) to the application. As it turns out, the issue was not in the navigation services at all, rather, it was in the application's use of the data in combination with another service. However, without exposing this data, the problem was in communication, not in engineering. All told, this problem burned eight weeks of schedule initially expected to last only three. People can hide ignorance behind a proprietary wall in hope of a sunny day – in short, they are buying themselves time at the cost of their partner.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

Note: It is not possible for the application team to obtain the source code, compile the code into a locally debugged version of their product and debug the problem. All debug information (most importantly the symbols) is stripped out of the code. In theory, the application team can step through the binary, proprietary service code in an attempt to reverse engineer the problem. This is an extremely tedious and time-consuming task. Additionally, this type of activity was prohibited in the alliance.

| Organization Complexity Factors | |
|---|---|
| **Number of Partners** | 3 |
| **Roles of Partners** | Shared Management, 50-50 split |
| **Level of Trust** | High |
| **Task Complexity** | Great |

**Figure II-5 Organization Complexity**

In conclusion, our organizational design will be complex.

## Section 3.1.3 Combining Complexities – Alliance Envelop[27]

Killing[28] constructed the alliance envelop as a tool for understanding the complexities of alliances. As previously proposed, our project is concerned with high task complexity endeavor. Additionally, our organization is a shared management, split control (50-50) alliance where the skills of all both partners is required in order to complete the product.

[27] Ibid, p64

[28] Farok J. Contractor and Peter Lorange eds., Cooperative Strategies in International Business. Lexington, Mass.: Lexington Books, 1984. Chaper 3 – Understanding Alliances. Killing studied several alliances. Based on the data, he devices the Alliance Envelop. The relationships realized a non-linear plot.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

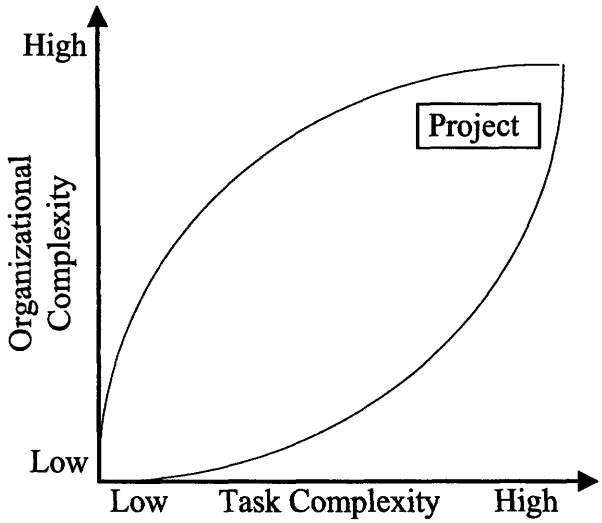



**Figure II-6 Alliance Complexity Map**

Despite the great challenges, many companies successfully use joint ventures. Managers quickly discover there is a lot to learn in the design and management of a joint venture. Unfortunately, joint ventures do have a "high overall failure rate and many of the failures are very costly for the partner companies."[29] Business leaders must constantly think about effective ways of managing a joint venture and tailor a unique specific management approach to the alliance envelope. "Knowledge of what to expect with different types of joint ventures – even the recognition there are different types – is a key to prevention of failure."[30] It gets worse, the inter company reliance can change dramatically over time. As circumstances change, the venture must adapt. Flexibility to meet inevitable challenges is critical; maintaining the status quo is not always a successful play.

## Chapter 4 *Team Performance*

Organizational failures are rooted in flawed data analysis that is used to guide corporate decisions. At its core, flawed analysis results in poor decisions with unfortunate consequences. Teams and team members provide analytical work integrating multiple sources of data and draw conclusions. Teams are responsible for the analysis from which managers and executives must

[29] Killing, Peter J. "How to make a global joint venture work." Harvard Business review, May-June 1982, p 120-7
[30] Ibid, p 127



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

use to execute actions. Research[31] indicates there are two robust factors in shaping analytical work: raw cognitive ability and collaborative planning. In other words, successful analysis requires both "cognitive and social processes"[32].

Analytic work is defined as work involving several steps[33]:

- Recognition of the situation in need of assessment
- Definition of the problem
- Creation/Selection of the information to be considered
- Pooling knowledge and coordinating member input
- Decision making

Literature suggests team analytical performance in accomplishing these "steps" is poor. Good team processes (needed to accomplish these steps) does not necessarily lead to good team performance. Teams combine information poorly often omitting critical data and generally do not coordinate expertise resulting in biased weight to the strongest voice (or most convincing or person in leadership). Worse, a team can always get "lucky" – a team with terrible processes somehow manages to generate a solid solution.

Research indicates that a combination of both raw cognitive ability as well as group strategies can greatly improve team effectiveness. The aforementioned dysfunctions can be eliminated with a well-designed team implementing a group performance strategy that is consistent and aligned to current environment activities.

## Section 4.1 Cognitive Ability

Cognitive ability and team effectiveness are directly connected. Considerable evidence supports the notion that cognitive ability shapes team effectiveness. The intelligence of team members has been show to predict team effectiveness[34,35], team learning[36], and in cases of unfamiliar tasks[37],

---

[31] Hackman, J. Richard (2007). "What does it take to figure out what is going on?", Tech Report No. 4, http://groupbrain.wjh.harvard.edu
[32] Ibid, p3.
[33] Ibid, p 4.
[34] LePine, J. A. (2005). Adaptation of teams in response to unforeseen change: Effects of goal difficulty and team composition in terms of cognitive ability and goal orientation. *Journal of Applied Psychology, 90,* 1153-1167.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

good performance. Furthermore, team's use of cognitive ability is based on two criteria: task requirements and clear member ability definition[38]. If a solution is required, members will quickly identify who has the necessary skill set to complete the job.

Unfortunately, for analytical work, neither task requirements nor member abilities are clear. Operating in this environment requires collaborative planning. Collaborative planning helps teams to deal with ambiguity. Collaborative planning helps team members identify capabilities within the group. Knowing this information helps the team to leverage these skills necessary for team success. Teams are given the opportunity to "converse about their work strategy for enhanced team performance only when members had been assigned roles that were incongruent with their abilities."[39] Conversely, collaboration did not help when task and ability are closely aligned. Rather, in this condition, collaboration impedes "performance when critical expertise was on the team."[40] As such, research indicates "interaction of team ability and collaborative planning more strongly predicts performance than team ability alone."[41]

## Section 4.2 Collaboration

Even in the direst of conditions, collaboration rarely occurs spontaneously. Collaboration requires intervention on the part of management (and or leadership). Intervention allows for team members to engage in "strategizing". The process has been shown to improve team performance. Yet, collaborative planning is not a cure all. In high performance teams, collaboration impedes team progress. Here teams focus their abilities to complete the job done. In addition, collaborative planning cannot make up for lack of raw cognitive ability or poorly formed teams. In these cases, collaboration is useless.

---

[35] Neuman, G. A., Wagner, S. H., & Christiansen, N. D. (1999). The relationship between work team personality composition and the job performance of teams. *Group & Organization Management, 24*, 28-45.
[36] Ellis, A. P. J et. al (2003). Team Learning: Collectively connecting the dots. *Journal of Applied Psychology, 88*, 821-835.
[37] Devine, D. J., & Philips, J. L. (2001). Do smarter teams do better: A meta-analysis of cognitive ability and team performance. *Small Group Research, 32*, 503-528.
[38] Faraj, S., & Sproull, L. (2000). Coordinating expertise in software development teams. *Management Science, 46*, 1554-1568.
[39] Hackman, p 7.
[40] Hackman, p.7
[41] Hackman, p. 7



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

## Section 4.3 Correlation of findings

These findings are consistent with our qualitative research. Typical organizational practice involves the process of assigning individuals with special expertise that a team task requires. Their assigned team role is based on their specific abilities; they receive the optimum position. This has the added effect of eliminating any need to communicate with team members. "I am an expert, I know what I am doing – full speed ahead." This behavior allows for isolationism (away from the team) concentrating only on my task at hand. There are several problems with this typical practice. Because of the isolation, team members are generally unable to draw upon these capabilities. Teams that rely on these pockets of isolated excellence often experience poor overall team performance. Unless the team used collaboration planning and intervention, others may have difficulty leveraging the pockets of expertise and the overall program may suffer as a consequence. Based on our qualitative research, this is similar to our 'A' player and team definition.

In a slightly worse case, teams can be poorly formed with little raw cognitive ability and lacking in leadership/management. Here no amount of collaboration can save the day. As part of the innovation strategy (see next section), 'A' players and leadership are replaced with cheaper, less capable 'B' players. This approach can quickly erode team effectiveness. Worse, the team cannot solve its problems without external intervention.

However, research into team effectiveness identifies a combination of raw cognitive ability and collaborative leadership skills required for optimal chances of success. Again, qualitative research provides a glimpse of this behavior. Unfortunately it is only an unintended side effect of the innovation triangle. For a brief time, through sub optimal processes, the team is effective. During a "transition" period, the team is built with both the cognitive ability and great leadership. Unfortunately, this is short lived.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

# PART III Research Method

*"Remember, it took only one apple hitting Newton on the head for him to have some pretty profound insights"* (Dr. Harry West, Guest Lecturer, MIT, Listening to the Customer 15.821, September 19, 2007)

## Chapter 5 *Research Approach*

To understand this incredible run up of success followed by incredible collapse our research efforts focused on three distinct fronts: ethnographic[42] research, metrics/archival data and qualitative research. Leveraging these three tools allowed the author to triangulate to an emerging theory. Additionally, the multi-faceted approach allowed for more substantiation constructs and resultant theory.

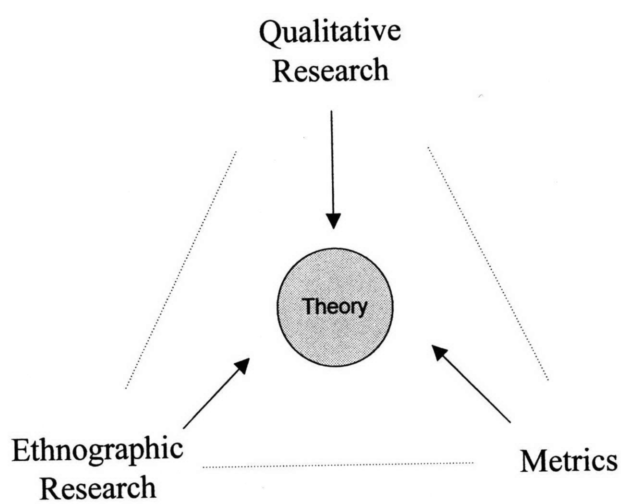



**Figure III-1 Research Approach**

As cited, why two qualitative methods? Simple, this problem is happening in real time. Not only do we not known the answer, we do not know the questions to ask. We only understand the current trend – incredible collapse as detected by extremely poor performance. To learn, we must engage in conversation with relevant subjects. Our situation is worse – sometimes the answer is not know or cannot be articulated by the subjects. The ethnographic tool derives its solutions by inference from observed behavior. Observation identifies questions that can be

[42] Glauser, G. G and A. L. Strauss. 1967. The discovery of grounded theory: Strategies for qualitative research. Chicago: Aldine.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

checked with qualitative methods, our second research tool. Ethnographic research also has an emotional feel to an issue. The research can see the pain in its very context as it is happening in real time. This allows the researcher to develop this "pain" context into their qualitative questioning.

Cornerstone to the investigation is ethnographic research. Ethnographic graphic research starts with a conscious attitude of almost complete ignorance. Rather than study people, ethnography is motivated to experience the environment; learn by observing, learn from people. Without observing the complex project dynamics, critical information necessary for profound understanding could be missed. Developing without observation implies: I am hoping I am clever, I am hoping I am smart, I am hoping I am insightful knowing a priori the critical issues. Developing solutions based on hope is a risky endeavor. By observing, one is less hopeful and clever by being wise; let the environment tell us the issues.

This type of research technique is especially helpful in tracing complex activities and processes as well as detecting new, emerging "trends". Ethnographers make key inferences from three sources: from what people *say*, from the way people *act* and from the artifacts people *use*[43]. The goals of the ethnographic research were threefold:

- **Validate scope and problem frame:** Our observation strategy set out to investigate the problem scope. Challenges were discussed, where to start looking and our critical anchor features. Analyzed high level issues: create initial criteria/assumptions to test by observation.
- **Discovery of key criteria:** discover additional criteria – new observed information. Categorized into three "levels": SHAZAAM (this is an epiphany), Wow! (excitement) and interesting.
- **Embodiment:** As our research and observation bore onward, the author attempted to understand the "what," or in other words, the embodiment: develop a vocabulary to speak with the subjects, develop what the issue might look like (mental models, visual aids), the operating environment, current perceptions.

The author was a member of project team consisting of a joint effort combining the efforts of industry teams (contractors) and government management. The author had direct exposure to all

[43] Spradley, James P. Ethnographic Interview. Wadsworth Publishing. 1979



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

industry personnel: program management, team leads/mangers and to the individual engineers assigned to specific subsystems. Direct exposure to all the weekly activities, organizational behavior dynamics, the schedule and progress was a critical component to the research effort. In addition, the author had the same direct exposure to the customer, the government leadership.

To investigate the issues raised from the ethnographic research, several interviewing techniques are available: Laddering (Gutman 1982)[44], Benefit Chains (Morgan 1984)[45] and Echo techniques (Barthol/Bridge 1968)[46]. In addition, there are several different applications (including the above models) of interviewing including but not limited to focus groups, 1:1 interviews, and 2-3 customers. The author used a combination of interviews following the Zaltman Metaphor Elicitation Technique (ZMET)[47] and in-depth semi-structured interviews.

Human knowledge of issue or needs lies deeply embedded in our brains rarely surfacing. Unfortunately, our native tongue is powerless to coax it out of its mental hiding. People are more comfortable expressing themselves through images[48]. The interview tools previously mentioned are tools using words, relying on surveys, questionnaires and focus groups. With the emphasis on word, these tools are limiting. Rather better techniques to get at our hidden knowledge are required to: tap nonverbal reactions, probe below the surface for deeper feelings and resonate with the subject on an emotional level[49]. The author needed to get at information the subjects don't know that they know. The solution is a metaphor. In ZMET, images are metaphors for thought[50].

---

[44] Gutman, Jonathan (1982), "A means-End Chain Model Based on Consumer Categorization Processes", Journal of Marketing, 46 (Spring), 60-72

[45] Morgan, Anthony I. (1984) "Point of View: Magic Town Revisited (A Personal Perspective)," Journal of Advertising Research, 24, 4 (August/September), 49-51

[46] Barthol, R. P and R. G. Bridge. (1976), "The Echo Multi-Response Methods for Surveying Value and Influence Patterns in Groups," Psychological Reports, 22, 1345-1354.

[47] Christensen, G and J. Olsen. (2002) "Mapping Consumers' Mental Models with ZMET", Psychology & Marketing, Vol 19(6)477-503 (June 2002)

[48] Yin, S. (2001) "The Power of Images", American Demographics, November 2001 p.32-3

[49] Ibid, p32

[50] Ibid, p32.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

ZMET is a technique for eliciting constructs that influence our thought and behavior[51]. The goal is simple: to uncover the mental models that guide behavior by eliciting real-life from subjects about how they behave and what they truly feel[52]. ZMET is a hybrid methodology that employs a broad framework rather than a single method[53]. The framework integrates the visual projection technique, in-depth personal interview and a range of qualitative data processing techniques such as categorization, abstraction of categories, comparisons of instance of data and dimensionalisation of the data[54].

Finally, backing up all of the research methods are metrics. Metrics include leading progress indicators of schedules, EVMS[55] and traditional test results. The metrics used are measured results.

# Chapter 6 *Application of Methods*

## Section 6.1.1Initial Steps

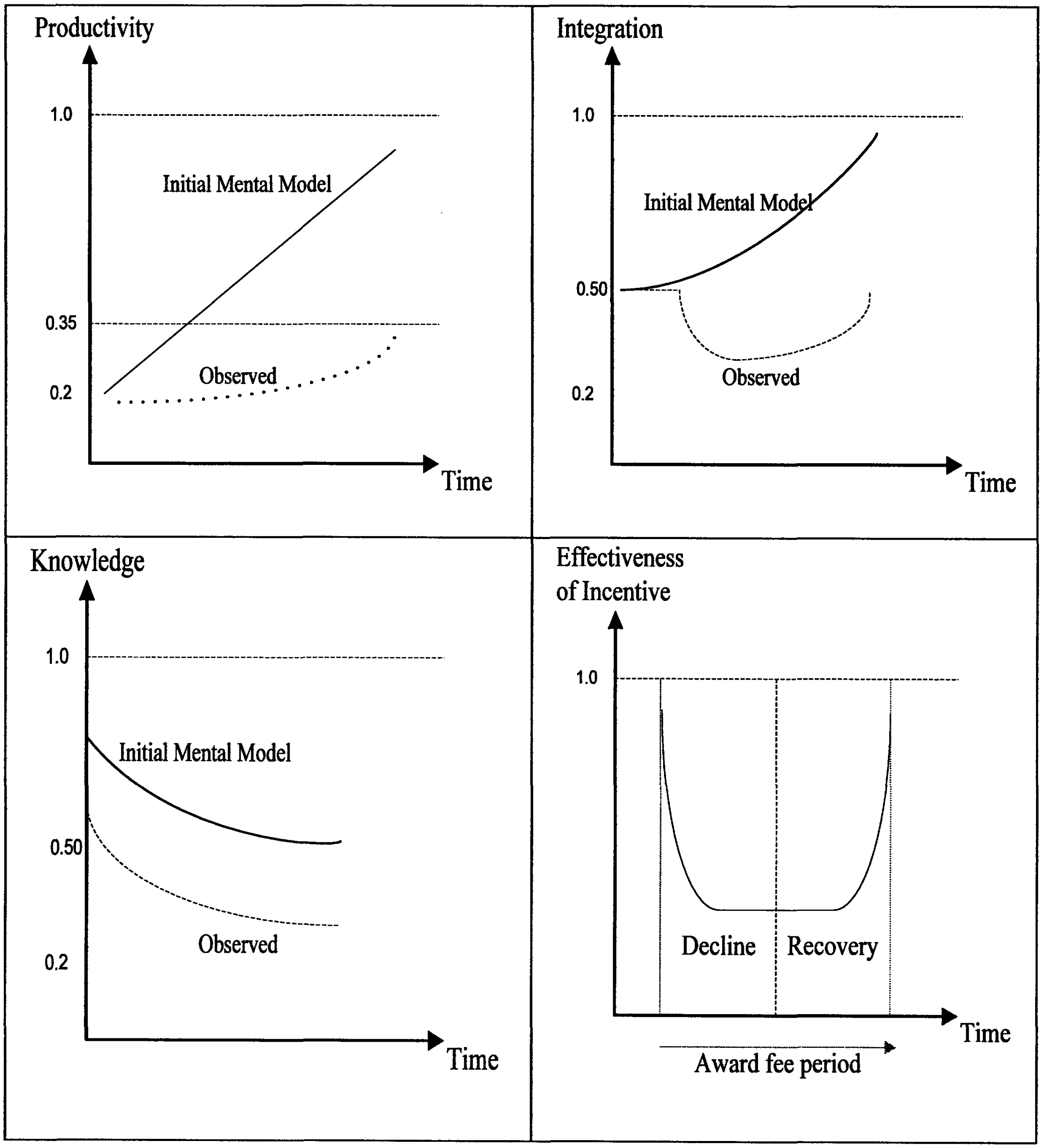
The research plan was iterative and incremental. During the early investigation, only an emerging trend or poor performance as exhibited by significant schedule delay directed the research plan. The initial steps of the research were to define the research problem in broad terms. The research effort began by defining several mental models of the current environment: productivity, integration progress, knowledge on the program, effectiveness of incentive and experience. These mental models where collected from observation and an informal, semi-structured interview process of key leadership/stakeholder positions.

---

[51] Christensen, G and J. Olsen. (2002) "Mapping Consumers' Mental Models with ZMET", Psychology & Marketing, Vol 19(6)477-503 (June 2002)
[52] Ibid, p499
[53] Lee, M et al. "Using ZMET to explore barriers to the adoption of 3G mobile banking services". International Journal of Retail & Distribbution Management; 2003; 31 6/7, p 340-8
[54] Spiggle, S. "Analysis and interpretation of qualitative data in consumer research", Journal of Consumer Research, VOL 21, December 1994, pp 491-503
[55] ANSI/EIA-748-1998, Earned Value Management Systems



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu






© Jeffrey Manning- All Rights Reserved

jwm@sloan.mit.edu

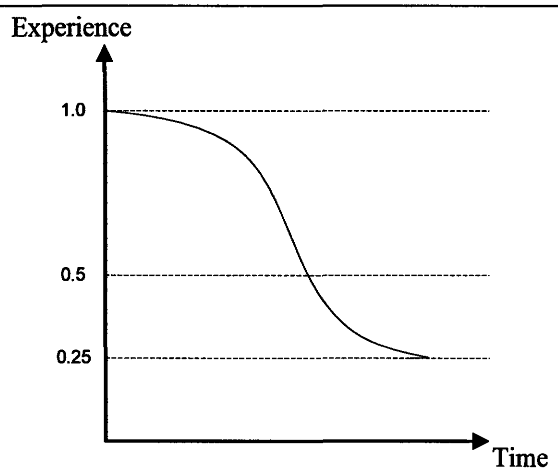
| | |
|---|---|
|  | Intentionally Left Blank |

**Table 1: Mental Models**

Interesting, everything seemed to be negative! The project was neither producing nor integrating what we produced. Worse, our knowledge and experience (as measured by both skill level and work rate) gained on the project was eroding. The "Award Fee" was not having the intended effect in changing contractor behavior.

Next, an analysis of collected metrics of program performance initiated including both the financial data though monthly reported Earned Valued Management System (EVMS)[56] and software progress metrics.

[56] ANSI/EIA-748-1998, Earned Value Management Systems



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

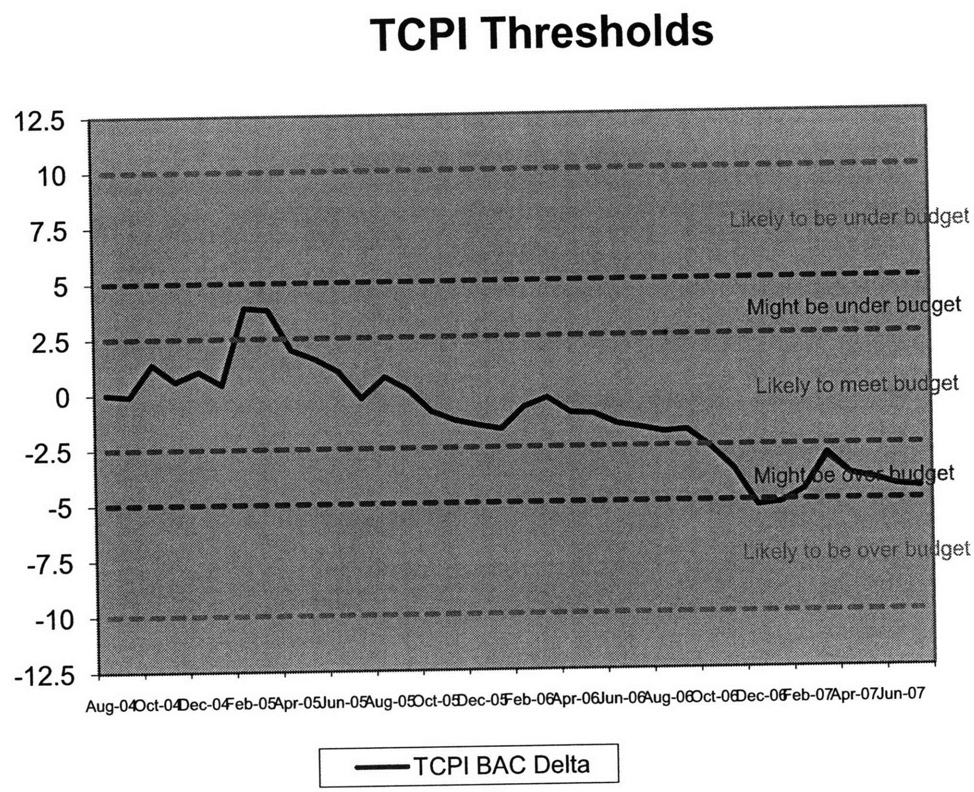



**Figure III-2 EVMS Data**



© Jeffrey Manning- All Rights Reserved

jwm@sloan.mit.edu

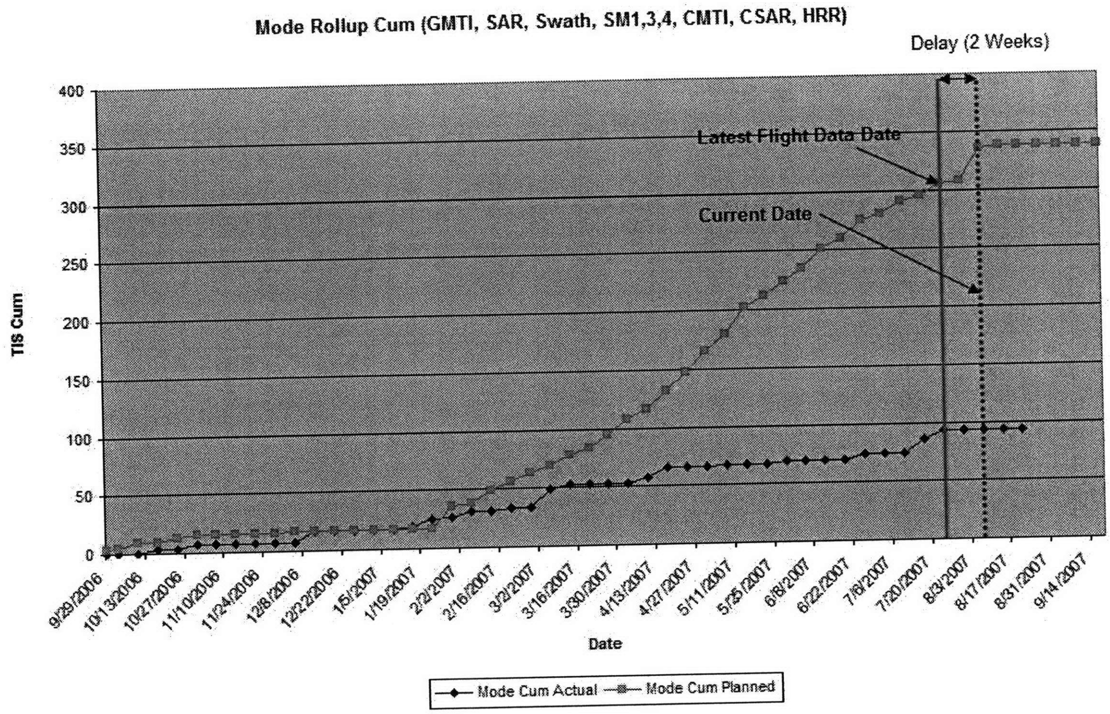



**Figure III-3 S/W Integration Progress Inchworm**

As visualized, EVMS data clearly shows a poor performance; in fact, the program was over budget. Worse, the program was over budget with very little progress to show for the money sunk into the program.

Over budget, under performing with lack of progress towards measured (non subjective) objects, schedule over runs, performance and quality issues – sounds very familiar! These problems persist despite best efforts and "blue ribbon" initiatives to address these identified issues. These deficiencies are the norm for software intensive systems even with significant advance in systems and software engineering techniques, tools and process. Why do these problems continue to exist?

## Section 6.1.2 Stakeholder Analysis

The next critical parameter is determination of the number of subjects. Qualitative research methods rely on a small base, high quality subject. The true measure of subject number is the



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

resulting confidence that you have interviewed enough customers to reveal the most applicable issues. Therefore, research focused on quality and depth within a small user population in lieu of broader based interviews with a larger population. Based on the Griffin and Hauser (1993)[57], interviewing 20 customers identifies 90% of the needs provided by 30 customers. These authors also indicate that interviewing 2-12 customer's is optimistic, with anything over 12 a good fit (identifying customer need/issue). Dr. West[58] presented statistics showing that 7 customers should reveal the benefits required by the majority of the users. In general, if the phenomena are important to many people, a segment of seven to ten subjects will uncover 80% of the issues. Initially, a segment size of twelve was identified. Due to scheduling issues and time pressures, only eight interviews were conducted. Five interviews were face-to-face, 1:1 interviews, recorded and transcribed. These five subjects represented key stakeholders from SPO leadership (the customer). Due to privacy issues, three interviews were not recorded. These unrecorded interviews represented key contractor management positions. These three interviews were scheduled as the last three interviews and were largely used to validate the key findings from the recorded five. None of the final three interviews revealed any new issues.

### Section 6.1.3 Crafting an Instrument

## ZMET

At its core, ZMET is based on concepts derived from mental images as selected by the subject. ZMET stresses the role metaphors play in learning and communicating. Most people are more comfortable expressing themselves through visual images than words. Using photographs to represent their thoughts has been well documented (Zaltman and Coulter 1995[59], Zaltman 1997[60], and Denzin 1989[61]).

---

[57] Griffin, A. and J. Hauser. "Voice of the Customer." Marketing Science, Vol. 12, No. 1 (Winter, 1993) 1-27. The article is focused on NEEDS with respect to a product development effort. We have extrapolated the same contextual data for defining "pain" or issues.
[58] Dr. Harry West, Guest Lecturer, MIT, Product Design and Development ESD.40, September, 2006
[59] Zaltman G. and R. Coulter. "Seeing the voice of the customer: metaphor based advertising research", Journal of Advertising Research, Vol. 35, No. 4, July/August, pp 25-51
[60] Zaltman G. "Rethinking market research: putting people back in", Journal of Marketing Research, November, pp 424-35



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

The ZMET research instrument followed the following process[62]:

1. **Initial Framing/Seed Question:** acts as a foundation for the visual response.
2. **Visual Response:** Draws metaphors out of the subjects by asking them to spend a few weeks (2 weeks in our case) thinking about how they would visually represent their experience.
3. **Interviews:** Spend a few hours telling stories about all of the images they chose and the connections between them. Use pictures as visual clues to trigger associations, anecdotes or explanations
4. **Collage:** Construct a summary collage from the interview

## In-Depth Interview Questionnaire and Protocol

With the ZMET instrument defined, focus turned to the interview protocol and questionnaire instrument (post ZMET). Once the ZMET portion of the interview completed, the research effort focused on an in-depth interview process. The process followed the following steps:

1. **Greeting and Explanation:** Covers the ground rules of the interview. Its purpose and who authorized it, how the recording will be handled. Details of how subject was selected, how the information will be used and why information is important – there are no wrong answers.
2. **Opening:** Build rapport. Start with interesting easy questions that require some elaboration – description and experiential in nature.
3. **Central Part:** Where most of the work gets done. Here probe tenaciously with descriptive probes leveraging back to ZMET if required. Probes for content.
4. **Closing:** Hand over reins to subject – the subject is the research collaborator. Looking for anything missed that is important to the subject.

The starting point was to seed the questioning with the information collected from the observation phase in combination with the metrics collected. The goal was a series of questions designed to allow the interviewee to "open up". General questions were devised and a loose

[61] Denzin, N. K. The Research Act: A theoretical Introduction to Sociological Methods. 3rd ed., Prentice Hall, Englewood Cliffs NJ, 1989

[62] Both the framing question and interview protocol are documented in questionnaire appendix.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

schedule of questions mapped. The questions formed a based document called the questionnaire guide.

In general, the interviews were planned to last on average about 2 hours. Interview length was based on three criteria: how well engaged the potential subject, the synergy in the problem space, and finally if a previous relationship existed. In addition, whenever possible, all interviews were recorded. The subjects did not receive any compensation for their time spent as a subject.

Our questionnaire was an evolving, fluid document. As our interviews bore onwards, we recorded new "issues" previously unknown or missed associations actively learned. By taking advantage of serendipitous findings, emerging insight can be recorded and further tested. The questionnaire was modified with these new issues and associations. Additionally, prior to any interview completion, the author requested follow-on contact to further sanitize other subject issues (not mentioned by the actively interview person).

## Interview Results

All recorded interviews were transcribed into a word document. The raw transcriptions seeded the data analysis phase.

# Chapter 7 *Analysis*

Data analysis started with traditional methods for induction (Miles and Huberman 1984[63]). The author reviewed all photographs, interview transcriptions, notes from interviews and collected metrics. Evidence from each transcription, the author melded all the sources into detailed interview cases. Across all cases, the author constructed a summary collage (see appendix). All interviewers were given their respective "case" vignettes with augmented information to be reviewed for accuracy. Once approved by the subject, the detailed case transcription was not allowed modification.

[63] Miles, M. and A. Huberman. Qualitative Data Analysis. Newbury Park, Ca. Sage.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

Interview scripts were quite large. As the author re-read the augmented documents, a case outline was generated picking out the key information from each interview. Several benefits have been realized from the mini-case outlines:

- Case write ups were central to the generation of insight
- Cases helped in coping with the large volumes of data (especially early in the process)
- Allowed the author to become familiar with each case as a standalone entity
- Allows for unique case patterns to emerge before generalizing across multiple cases

Humans are poor processors of information. Biases, whether explicit or implicit, almost certainly find their way into analysis. Bias can results from any number of unexplained reasons including but not limited to incentives of the researcher, influence by the vividness of the data, leaping to conclusions based on limited data or worse dropping conflicting information. This can result in an investigator reaching premature or even incorrect conclusions. To overcome these deficiencies, the author leveraged several techniques to force analysis beyond initial impressions. Specifically, the outlined cases from each interview were analyzed across each other creating a composite case. The author looked for similarities and differences among the cases. This view represents the composite outline case. This composite case outline was used to not only provide a description[64] but to generate[65] and eventually test a hypothesis[66].

Our analysis processes followed an incremental and iterative approach (see Glauser and Strauss[67]). In some cases, data collection and data analysis overlapped. This happened in several cases where serendipitous findings were discovered late in the interview process. Prior subjects were contacted for brief "mini" interviews investigating the new insight. These conversations were not recorded. There are several motivating benefits for this approach:

- Gives the researcher a head start in the analysis
- Allows researchers to take advantage of flexible data collection mechanism
- Freedom to make adjustments
- Data might unexpectedly turn interesting.

[64] Kidder, T. Soul of a Machine. New York: Avon
[65] Gersick, C. "Time and transition in work teams: Toward a new model of group development." Academy of Management Journal, 1988 31, 9-41
[66] Pinfield, L. Organizations and organization theory. 1982, Marshfield, Ma.: Pitman
[67] Glauser, B. and A. Strauss The discovery of grounded theory: strategies for qualitative research. Chicago, Aldine.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

This additional flexibility "is not a license to be un-systematic; rather this flexibility is controlled opportunism."[68] This flexibility manifested itself in two ways. First, it was built into the very research instruments used during the interview process allowing the author to probe emergent themes. Secondly field notes created a "running" commentary combined with post interview analysis (on transcripts) to push thinking by noting future questions to ask (serendipitous findings). This is particularly germane in the case of new learning and how this differed from previous interviews.

From this analysis, cross reference tactics and overall impressions, themes, concepts and relationships between identified variables began to emerge. In addition to identifying the variables, mental models also emerged describing the variables. Together, these two formed the basis for patterns of interest. These patterns of interest were systematically compared with evidence from each case. An assessment was made on how well or poorly it fit with the case data.

To generate a dynamic explanation for the evolving relationship between variables, causal loop diagramming[69] from system dynamics was leveraged. The author developed causal loop diagrams describing particular episodes – or "mini" causal loops. As our knowledge accumulated, the author further integrated episode specific diagrams into a unified framework to address the problem. Causal diagramming has a rich history in organizational studies and provides a convenient and precise technology for articulating process theories[70]. By using this method, targeted at the identified variables from both the mini-cases as well as composite case, the resultant causal loop is tightly integrated and internally consistent with the interactions leading to the incredible success followed by the incredible collapse.

---

[68] Eisenhardt, K. "Building Theories from Case Study Research", Academy of Management Review, 1989, Vol 14, No. 4, 532-550
[69] Sterman, J. D. Business dynamics: Systems thinking and modeling for a complex world. Boston: Irwin/McGraw-Hill 2000
[70] Perlow, L., G. Okhuysen and N. Repenning. "The Speed Trap: Exploring the Relationship Between Decision Making and Temporal Conext", Academy of Management Journal, 2002, Vol 45, No. 5, 931-955



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

Like all methods, there are limits to this approach. By using collected, measured metrics in conjunction with the causal loop diagramming, the author is able investigate the interactions manifested in this problem. However, the ethnographic nature our research limits the generalization of our findings. The utility of this approach "lies not in the direct transferability of our findings, but in the ability to produce grounded theory that could not be identified with a broader-brush data collection method."[71]

[71] Ibid, p934.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

## PART IV Hypothesis

Our research augments the work of punctuated change with an archetype approach[72] to understand the strategic orientation of the organization. Unlike the prescribed approach, this approach leverages the following techniques:

- **Holistic**: Organizational structures and management systems are best understood in terms of overall patterns[73] rather than by analysis of narrowly drawn sets of organizational properties.[74]
- **Interpretive Schemes**[75]: organizational patterns are provided by ideas, values and beliefs embodied within structure and systems.[76]

By following the archetype approach, our research aims at identifying and interpreting overall patterns of organizational orientation among key design variables. As visualized in the innovation triangle, our variables include New Business Development, Corporate Skill Mix and Project Management. By taking a broad research approach, we limit the effects of the "Parist"[77,78] bias. According to Miller, the "Parist" approach selects limited numbers or organizational variables which are analyzed in a discrete fashion. Our approach to eliminating this bias was not to include all variables, rather, a careful selection of variables chosen to be consistent with the archetype modeled in a continuous system dynamics model. By focusing on a general set of possible variables rather than narrow set, our research attempted to avoid isolating possible patterns causing the poor organization performance.

After reviewing the cumulative case, several insights were discovered:

1. Complex Corporate Skill Mix
2. An Innovation Triangle exists coupling a company's
   a. Innovation Strategy
   b. Corporate Skill Mix
   c. Product Development Capability
3. A company's innovation strategy directly effects the success (or failure) of its project pipeline

[72] Hinings, Royston and Greenword. The Dynamics of Strategic Change. Basil Blackwell Ltd. Oxford, UK
[73] Miller, D. and P Friesen. Organizations: A Quantum View. New York: Prentice Hall. 1984
[74] Hinings, p.7
[75] Ransom, S. et al. "The Structure of organizational structures." Administrative Science Quarterly, 25: 1-17. 1980
[76] Hinings, p. 7
[77] Miller D. "Towards a new contingency approach: the search for organization gesalts." Journal of Mangement Studies, 18: 1-26.
[78] Hinings, p. 9



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

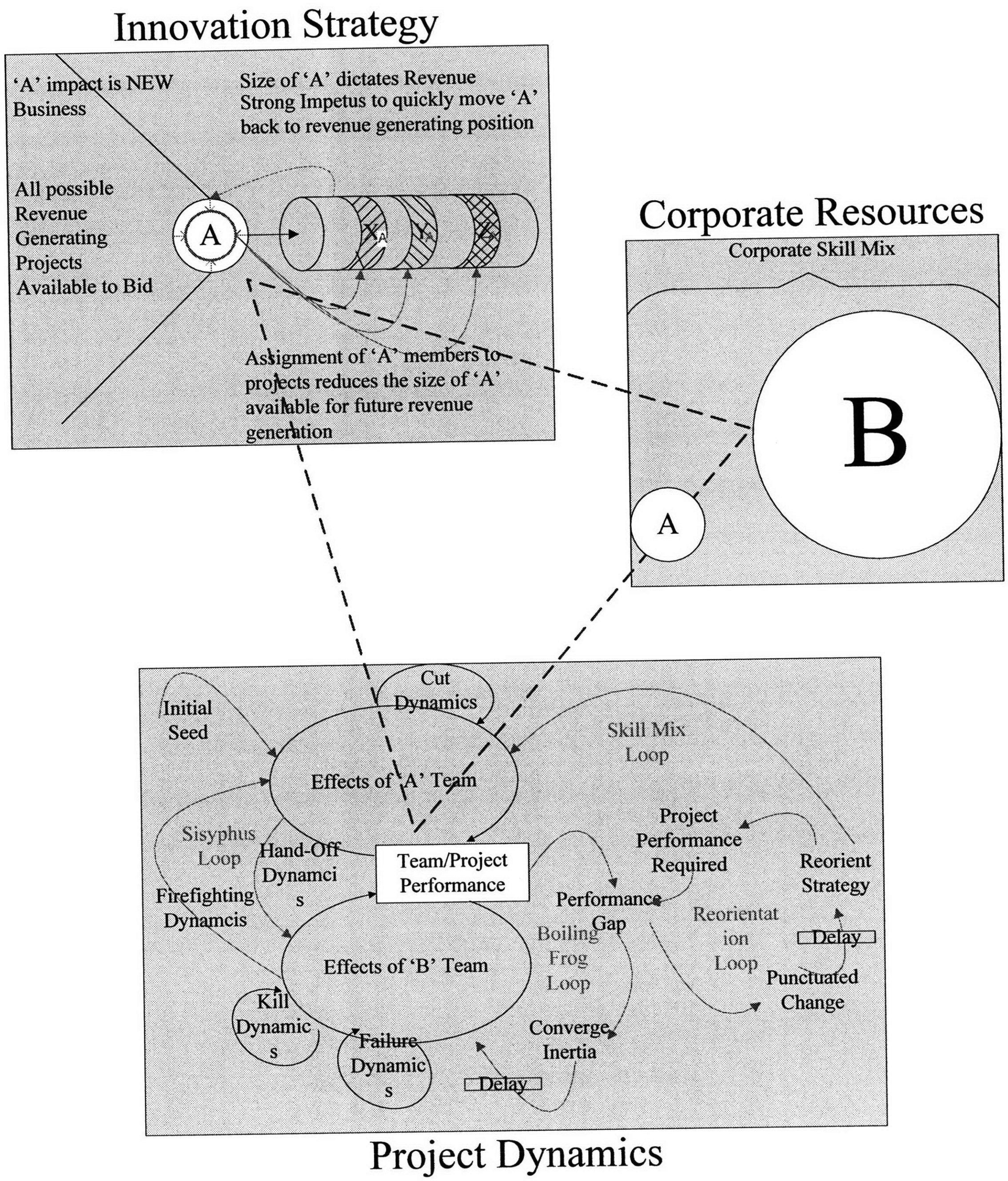



**Figure IV-1 Innovation Triangle**



© Jeffrey Manning- All Rights Reserved

jwm@sloan.mit.edu

## Chapter 8 *Team Definitions*

Central to the model is the notion that corporate resources (engineers) are not all alike. The mix of skills in any corporation is dynamic. For this thesis, this concept is identified as the A/B teaming skill mix (or teaming). Some employees have a commitment, passion and excellence few others exhibit. The 'A' player represents this small, precious corporate resource.

Research clearly defines three (3) key skill attributes in determining a person's "type":

- **Technical Ability:** "raw" technical, cognitive ability. The go to technical expert who solves problems when the chips are down. The corporate gatekeepers[79].
- **Leadership Ability**: Mobilizing people to face adaptive changes[80]. It requires other people to take on responsibility; pushing work back into the organization and getting people to do the work only they can do.
- **Foresight**: ability to scan the "project" horizon looking for trouble and detecting the icebergs. More importantly is to understand and interpret how things should unfold and making the necessary, easy corrects at the earliest opportunity

No single type alone makes an 'A' player. It is a blend of all three attributes with proven experience that determines status. Research data clearly defines experience with both leadership and technical ability as the first order differentiator. In each case, all analysis reveals the need to exceed the notion of expert. Expert level is different for each attribute. Additional insight from research dictates a notion of time. Here time refers to two (2) subtle aspects. First, time it takes to understand to the physics of the technology as well as time required to become a solid leader. Secondly, there is a notion of longevity with the company. Longevity of the company is weighted hire (by reference count across interviews). Navigating the modern day, cross matrix organization is a complex activity. Success is solely based on how long you have been with the company dictating who you know in the company.

[79] Allen, T. Managing the Flow of Information. MIT Press Cambridge Ma, 1977 Here the author presents the role of the corporate gatekeepers.
[80] Heifetz, Ronald and Laurie, Donald. "The Work of Leadership", Harvard Business Review; Dec2001, Vol. 79 Issue 11, p131-141 and Heifetz, R. (1994). Leadership Without Easy Answers. Belknap/Harvard, 1994



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

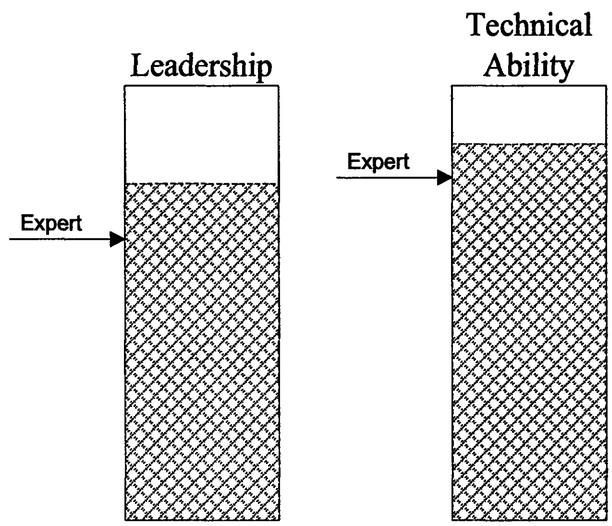



**Figure IV-2 Key Attributes of Personnel**

## Leadership and Technical Ability

Leadership was further defined with the following attributes:

- Identifying Adaptive Challenge
- Regulating Distress
- Maintaining Disciplined attention
- Giving work back to people
- Protecting "voices of leadership" from below

Research also indicates there is a big difference between leadership and management. Leadership has a notion of vision – laying out the strategy "kind of the forward looking stuff"[81] – proactive, steering the project. A person who is a manager – "fix the problem kind of guy" – is more day to day, reactive task master.

Cognitive ability and team effectiveness are directed connected. Considerable evidence supports the notion that cognitive ability shapes team effectiveness. The intelligence of team members has been show to predict team effectiveness[82,83], team learning[84], and cases of unfamiliar tasks[85].

[81] Pettyjohn, Eric. From qualitative interview. See p7 of Pettyjohn interview.
[82] LePine, J. A. (2005). Adaptation of teams in response to unforeseen change: Effects of goal difficulty and team composition in terms of cognitive ability and goal orientation. *Journal of Applied Psychology, 90*, 1153-1167.
[83] Neuman, G. A., Wagner, S. H., & Christiansen, N. D. (1999). The relationship between work team personality composition and the job performance of teams. *Group & Organization Management, 24*, 28-45.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

Furthermore, team's use of cognitive ability is based on two criteria: task requirements and member abilities are clearly defined[86]. If a solution is required, members will quickly identify who has the necessary skill set to complete the job.

Unfortunately, for analytical work, neither task requirements nor member abilities are clear. Operating in this environment requires collaborative planning. Collaborative planning helps teams to deal with ambiguity. Collaborative planning helps team members identify capabilities within the group. Knowing this information helps the team to leverage these skills necessary for team success. Collaborative planning gives team members the opportunity to "converse about their work strategy for enhanced team performance only when members had been assigned roles that were incongruent with their abilities."[87] Conversely, collaboration did not help when task and ability are closely aligned. Rather, in this condition, collaboration impedes "performance when critical expertise was not on the team."[88] As such, research indicates "interaction of team ability and collaborative planning more strongly predicts performance than team ability alone."[89]

## Scanning Horizon – Foresight

Foresight was further delineated with the following characteristics:

- Strategic – vision/mission
- Internal "test result" generator
- Metronome

Foresight is a specific skill only of the 'A' player. Foresight has a strategic element. Here the 'A' player can see a problem "1 mile off"[90] . The leader can see a problem six months out and put minor corrections to avoid the issue – a very proactive approach.

---

[84] Ellis, A. P. J et. al (2003). Team Learning: Collectively connecting the dots. *Journal of Applied Psychology, 88*, 821-835.

[85] Devine, D. J., & Philips, J. L. (2001). Do smarter teams do better: A meta-analysis of cognitive ability and team performance. *Small Group Research, 32*, 503-528.

[86] Faraj, S., & Sproull, L. (2000). Coordinating expertise in software development teams. *Management Science, 46*, 1554-1568.

[87] Hackman, p 7.

[88] Hackman, p.7

[89] Hackman, p. 7

[90] Ibid p8.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

> ***"It's huge. Because, I mean, it's like – it's like driving a ship. You see something a mile off, and you make a one degree correction, you can miss it by 100 feet. If you see something 100 yards off, now you've got to make an 80° correction."***

To juxtapose, without this proactive approach, a "would be" leader is reactionary ('B' rating). In reaction mode (80° correction), I have to throw a lot of resources (people and money) at the problem. Schedules may have to slip in order to get around the problem. Worst case scenario, the project has stalled, dead in the water, until this problem is resolved. Secondly, strategy also has a sense of vision and mission in shaping the culture of the team.

On a technical slate, foresight allows the 'A' player to generate "accurate" or near accurate test results. This is achieved with the significant experience and expertise in a given technology. The 'A' player has proven "design patterns" or mini architecture that can be analyzed in real time to produce results. These internal results "validate" progress or highlight deficiencies. There is a notion of a metronome- a project rhythm - an internal clock tracking the project timing and success to date. This internal clock is a sanity check: "if we are not here by X, we are in trouble."

The last notion of foresight is time horizon. How far into the future measured in order effects. 'A' players can see issue far before they come to fruition. In addition, they can analyze to accurate measures the 2$^{nd}$, 3$^{rd}$, and 4$^{th}$ order effects their decisions have not only of the project but the team as well.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

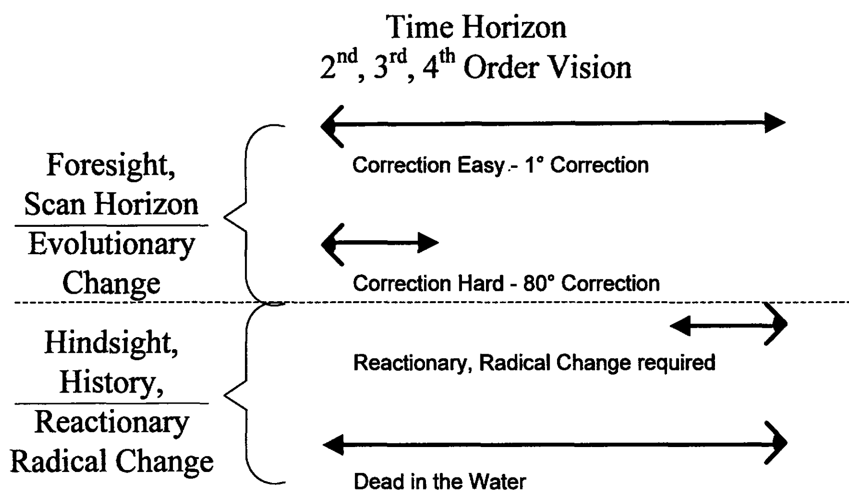



**Figure IV-3 Time Horizon**

These "order effects" are best visualized in the above figure. On the top is the 'A' player – scanning the horizon, making the easy, one degree evolutionary effects. Without this skill, vision or horizon scanning turns into hindsight. It is not until poor performance of the project does an analysis take place. Unfortunately, the event has already taken place.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

## A Team

**Figure IV-4 George Washington Crossing the Delaware**

Qualitative research uses George Washington crossing the Delaware River as the mental model of the 'A' player. Brilliant leadership, raw cognitive ability and distance horizon scanning[91] is a single, expensive package. The 'A' player is not cheap by any means.

[91] Manning, Jeff. Summary collage of qualitative research. See appendix xxx



© Jeffrey Manning- All Rights Reserved

jwm@sloan.mit.edu

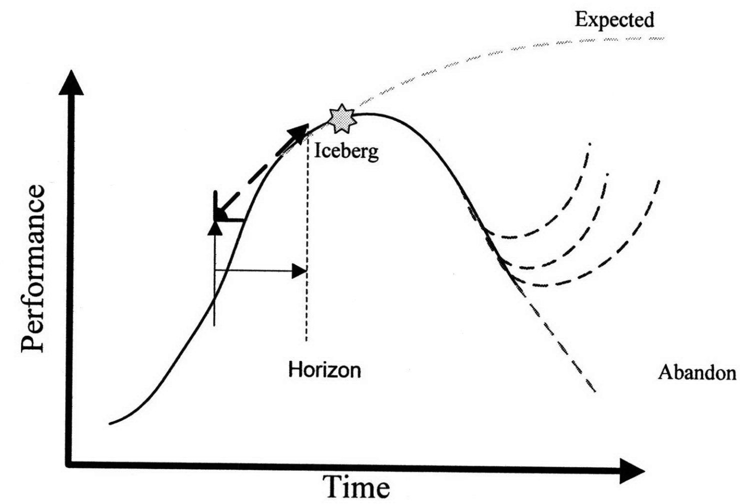



**Figure IV-5 'A' Horizon Scanning**

The 'A' player knows his environment, knows where to be to maximize success and to avoid failure. Essentially, the 'A" player is the total package. Unfortunately, there are very few George Washington's. Research has shown the 'A' player is a scarce resource. Often is the case in which the demands of the projects in the pipeline outstrip an organization's total capacity. As such, companies leverage this precious resource very carefully.

Research has indicated there is a "sweet spot" for maximizing the effectiveness of the 'A' player for a company. For the purposes of this research, the product life cycle is a staged gate, waterfall model with four stages: requirement, architecture/design, implementation (and unit test) and integration testing.[92] Our research has shown that the 'A' player with their significant experience is maximized in the early stages of the product life cycle (requirement and architecture). The "sweet spot" of influence is dictated in coordination with a validated and accepted design. During implementation and integration test, the 'A' player plays little role other than the possible, periodic request for clarification.

This is visualized in the following figure:

---

[92] Ulrich, K. and S. Eppinger. Prodcut Design and Development. 3rd Edition. McGraw-Hill, New York, 2004



© Jeffrey Manning- All Rights Reserved

jwm@sloan.mit.edu

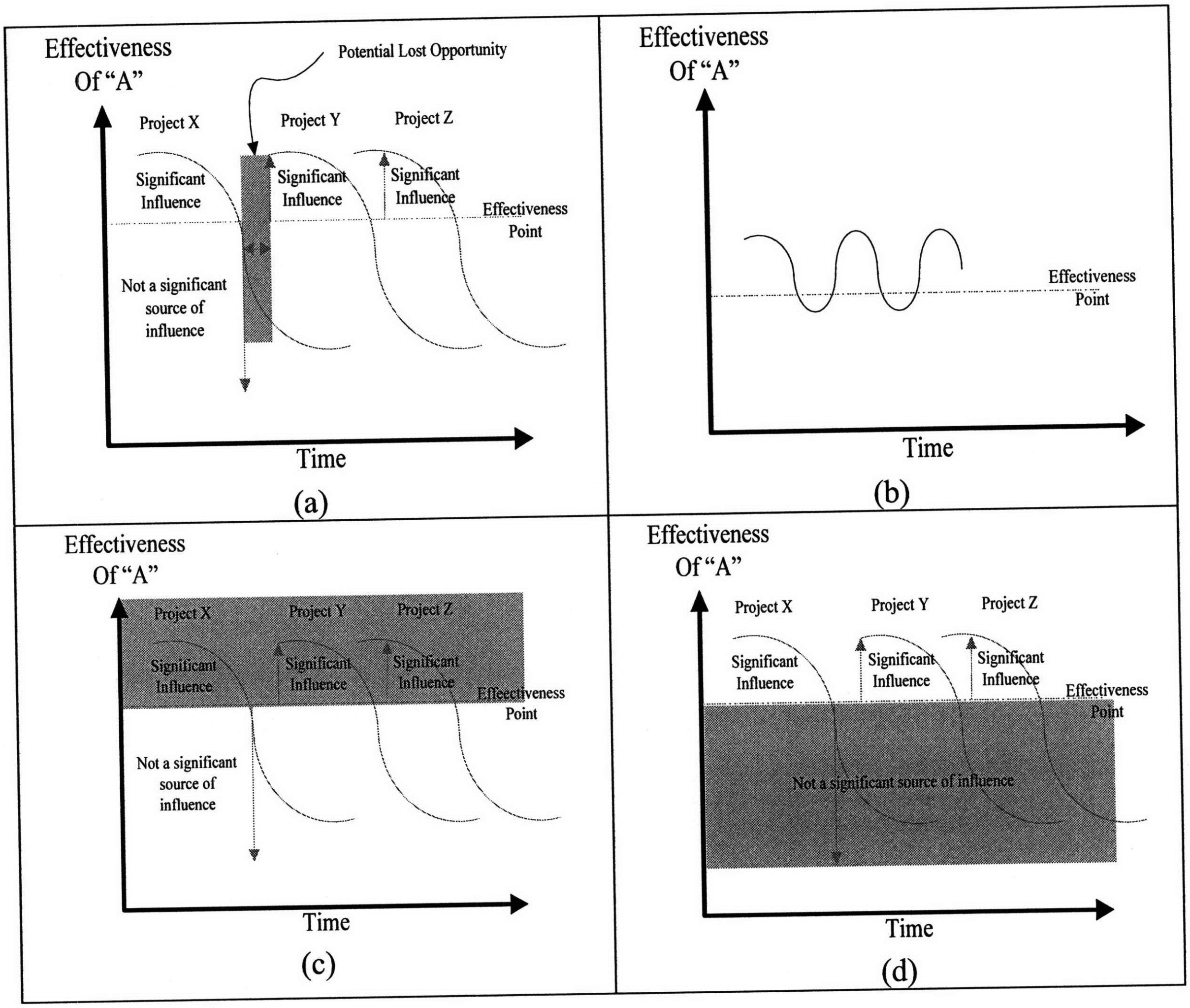



**Figure IV-6 "A" Member Effectiveness**

As visualized in all figures, there is an effectiveness point beyond which the effectiveness of the 'A' player is not a significant source of influence or competitive advantage. This is clearly shown in the (c) where the 'A' player is maximizing their influence and benefit to company and (d) figure where the 'A' player does not provide a significant source of influence on a project. Again the point in time where the Effectiveness curve crosses the critical threshold is at the validated design (more on this later).

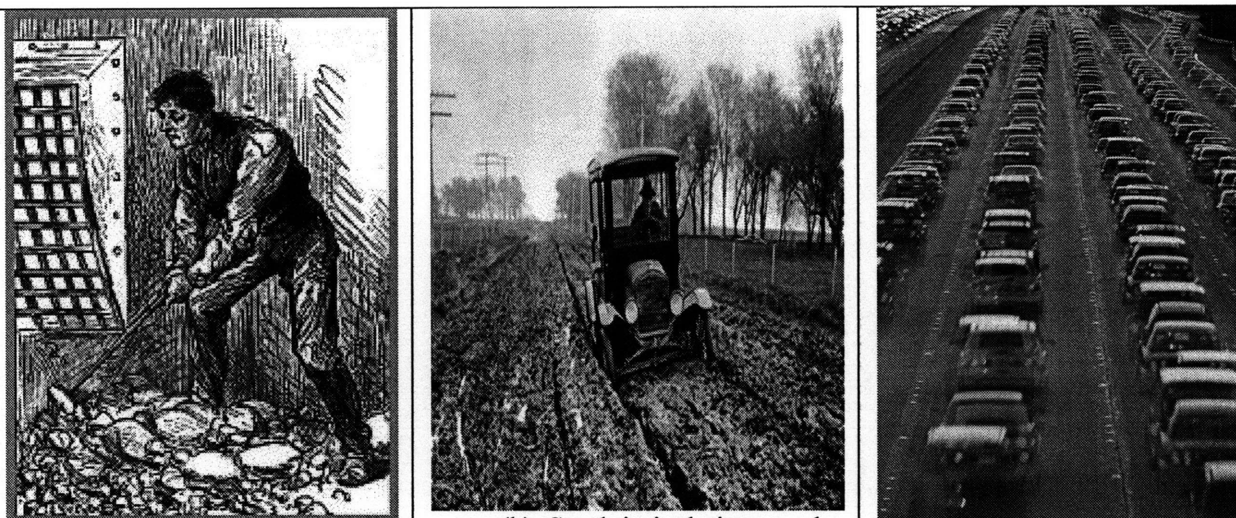
Additionally, from a revenue generating perspective, there is a possibility of lost opportunity (see figure (a)). During the project periods of significant influence, the 'A' player is shaping the



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

architecture and team dynamics for successful project implementation. Once properly transitioned to the implementation team, effectiveness begins to erode (as does the motivation and moral). Therefore the effectiveness of the 'A' player can be model as an oscillation as shown in figure (c).

## B Team



(a) Stone crusher | (b) Stuck in isolation, mud | (c) Stuck in unison

**Figure IV-7 'B' Member Mental Models**

Research[93] paints a bleak picture for the 'B' player. In general, 'B' players are perceived as having less experience and cost. 'B' players run the gambit, but in general are lacking in more than one attribute. For instance, they can have significant technical expertise but little in the role of leadership (and vice versa). As shown in the above figure is both the isolation and futility. In the (c) image, a similar sense of quagmire: cannot go forward, backward, left or right without a kind act from a fellow 'B'. Even the off-ramp is jammed. This is not a great place.

The next major driver of 'B' status is the lack of foresight. The 'B' player is reactive, day to day. Get up in the morning to pound rocks, get stalled in the mass commute or stuck in the mud of a dead end endeavor.

---

[93] Krawczyk, Peter. ZMET images from the qualitative 1:1 in-depth interview. See appendix XXX



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

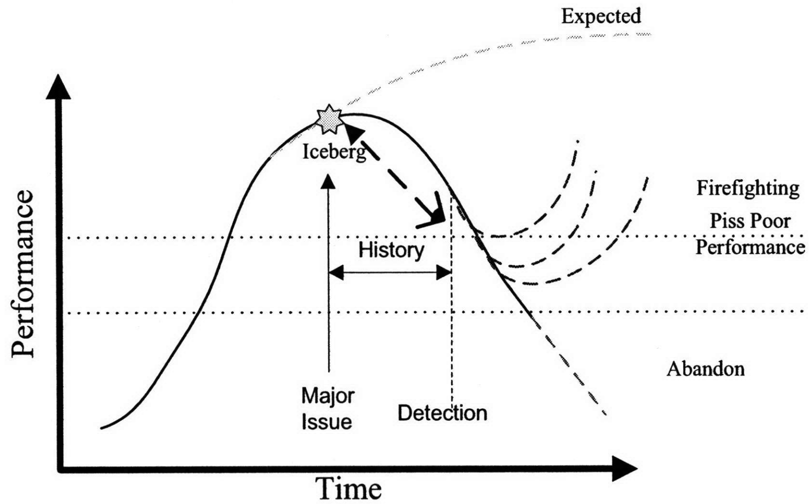
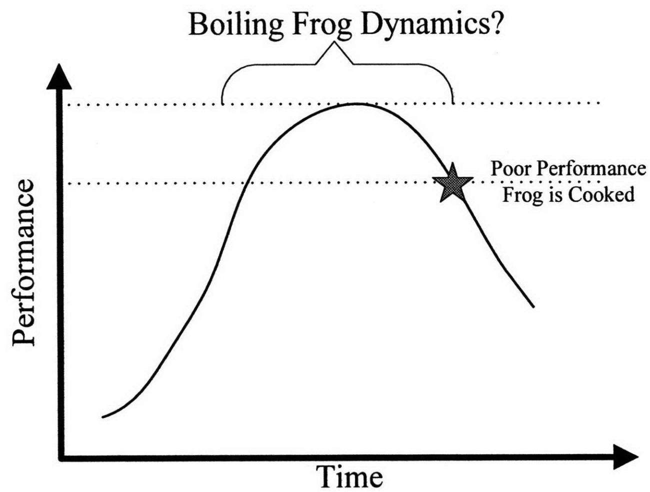



**Figure IV-8 'B' Member Horizon Scanning**

As shown, 'B' has difficulty peering into the future unable to see the 2nd, 3rd or 4th order effects of their actions. They see problems only 100 yards away or worse. They make a decision and run until a roadblock then look to the past to see what caused their current situation. They cannot see "results" ahead of time only the poor performance of their prior decisions. This delay is a source of penalty. This mode of operation creates the "boiling frog" dynamic.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu




## Chapter 9 Innovation Triangle

### Section 9.1New Business Generation

Whether we like it or not organizations are political machines. It is the expressed goal to sustain and even advance your claim to scarce resources[94]. This creates patterns of advantage and disadvantage in today's corporations. These advantages and disadvantages are sustained by the organizational structures (arrangements) which support them. These "arrangements" become regarded as norm – constructing a corporate culture. Therefore the few selected "privileged" projects maintain their status and interests by denying "structural" change maintaining the status quo. Any reorientation is difficult requiring significant pain of crisis to alter.[95] Crisis is generated by two forces: poor performance and or a disrupting force (market or technology for example).

One very obvious pattern creating advantage for any company is new business development. Without new business there is no growth. Research revealed the 'A' team members play a critical role in the development of new business. New business development is a highly technical job requiring the ability to evangelize corporate technology but to shape senior customer leadership thought processes. It requires years of technical and leadership experience

[94] Henings, p. 21
[95] Henings, p. 21



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

with exposure to the protocols governing new business with the government. There is a very strong force to keep the pool of available 'A' players large to aid in the generation of new business.

Research has also revealed the need for the 'A' player to provide technical expertise and leadership in the delivery of the earned project. It is a wide held belief that an 'A' player's impact of project completion is during the early project deliveries. Their impact is greatly reduced during the large time spent implementing the architecture/design.

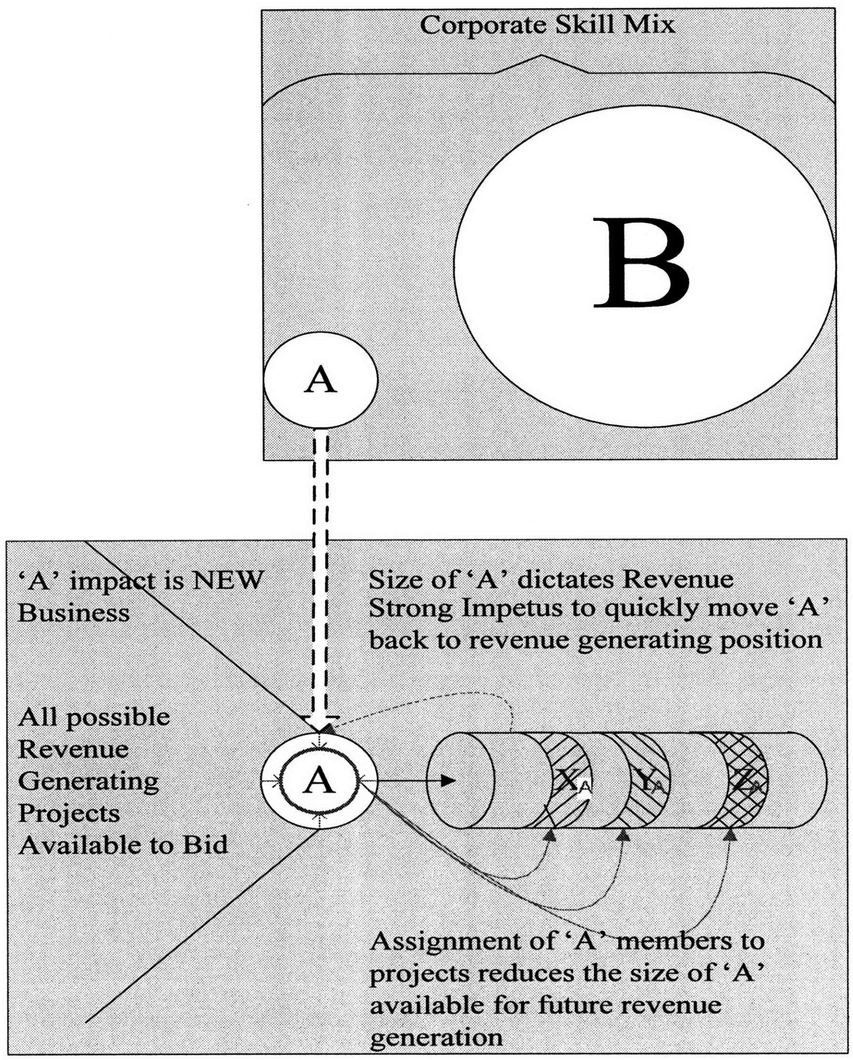



**Figure IV-9 New Business Generation**



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

Logically, to promote growth, the 'A' player is a significant asset. For successful project implementation, the 'A' player is also a significant driver. Senior leadership faces a dilemma – competing and conflicting drivers for the critical 'A' player resource. Corporate leaders must create a strategy balancing the needs of delivering success programs and creating new business.

## Section 9.2 Innovation Strategy

Thesis research and follow on analysis revealed a key mental model and organizational archetype. Initially, project team composition is laden with 'A' players, followed by a transition period including a team laden with both 'A' and 'B' players and ending up in a squeeze profit mode with teams saddled largely with 'B' players. There are three key drivers to this philosophy:

- **Cut vs. Kill Dynamics**: In the early stages of a program's life cycle, it is easier to cut a project than to kill it (after it has been approved). Any time before the program has been "approved"; a project can be terminated with very little effort.
- **Make it right**: During this cut dynamics period, the bidding process needs its best talent (both cognitive ability and leadership) to get the program to the fully funded stage. It is a show of strength and commitment.
- **Build performance credibility**: During this "make-it-right" stage, the team builds credibility and momentum of performance and success. Early success is a significant factor (among many) to project approval.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

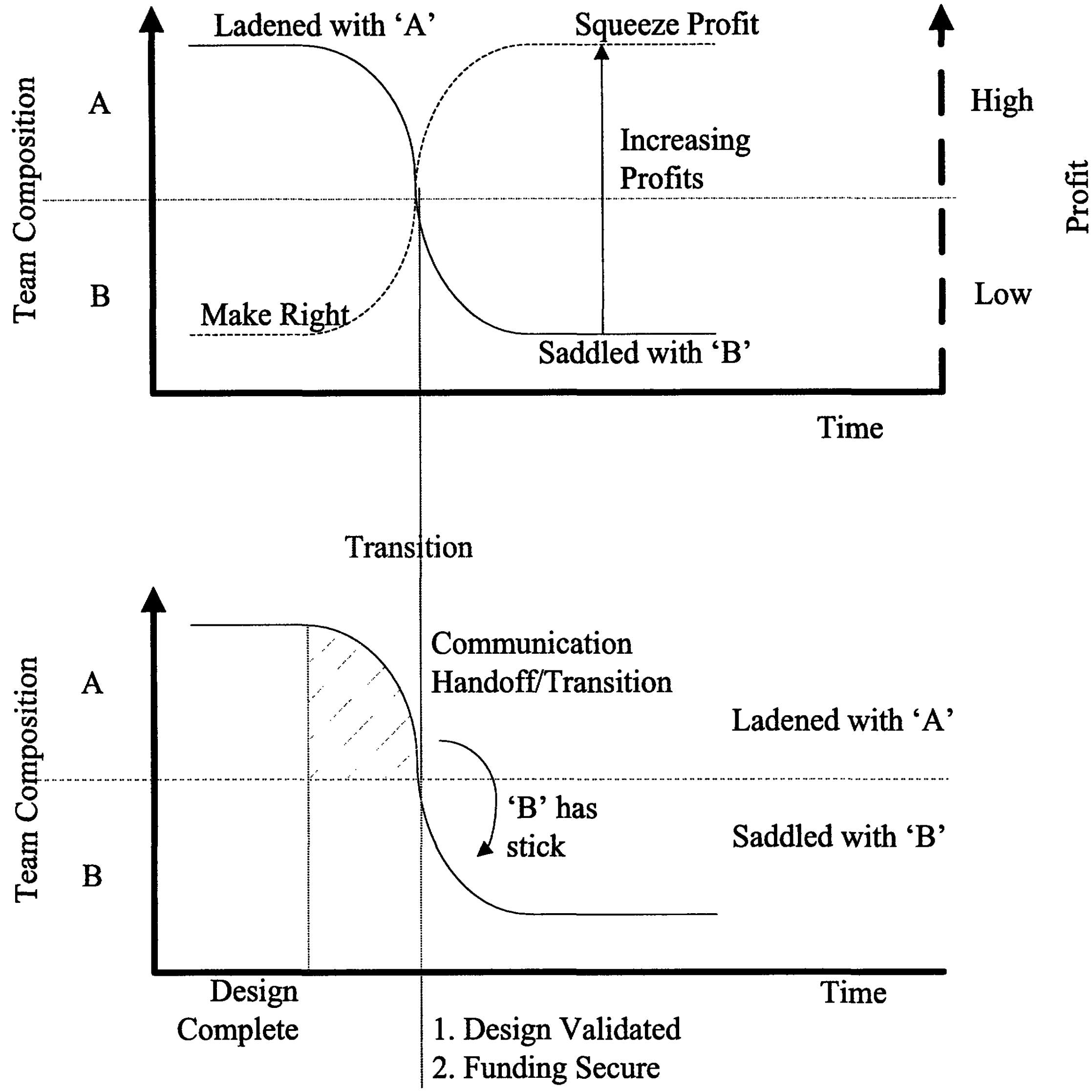



**Figure IV-10 Transition**

As visualized, the "make-it-right" phase is defined as everything to the left of the transition period while squeeze profits is loosely defined to include everything to the right. For the purposes of our thesis, the transition phase is defined with respect to the product life cycle. In the project under analysis, the life cycle was a staged gate effort consisting of four (4) stages: requirements analysis, architecture and design, implementation and unit test and finally integration testing. The transition is defined as the point of design validation, the end point of the design and architecture phase. The transition period begins with the completion of the design.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

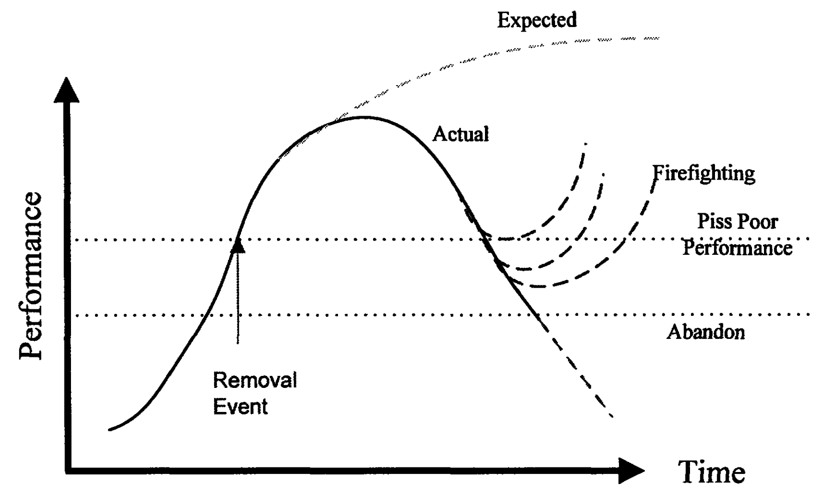



**Figure IV-11 Removal Event**

With design validated and the funding secure, the 'A' player's effectiveness is believed to diminish. As visualized, we remove these 'A' players placing them back to the new business generation. With a proper hand-off and capable engineers, the expected green curve will be followed. Statistics prove this to be exception rather than the rule. More often than not, the "actual" curve is followed (results). It is even worse, not only are we following the "actual" curve, project leadership believe it is still on the "expected" curve. Eventually, poor performance is detected leading to extensive firefighting or even the possibility of abandonment.

## Section 9.3 Project Management[96]

The last leg of our innovation triangle is project management. Beyond the scope of the thesis research, the project management component leverages the seminal work of the rework cycle[97]. The key finding of the rework cycle is the concept of rework. Rework is generated in a project

[96] Lyneis, J. MIT, System Project Management ESD.36, September, 2006. The Rework Model utilized in this course builds upon the model Prof. Lyneis used in ESD.36.
[97]Cooper, K.G. The Rework Cycle (a series of 3 articles): Why Projects Are Mismanaged; How It Really Works … And Reworks …; Benchmarks for the Project Manager. PMNETwork Magazine, February 1993 for first two articles; Project Management Journal March 1993 for third article. Additionally, the interested reader can also reference:
Cooper, K.G. and T. W. Mullen. "Swords and Plowshares: The Rework Cycles of Defense and Commercial Software Development Projects," American Programmer, May,1993.
Lyneis, James M., Cooper, Kenneth G., and Els, Sharon A., "Strategic Management of Complex Projects: A Case Study Using System Dynamics." System Dynamics Review 17(3), 237–260.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

and remains largely undiscovered or hidden until later stages of the development cycle. As such a gap exists between what is believed to be completed (perceived) and the real work accomplished. The rework cycle focuses on assessing the impacts of factors including but not limited to work quality, productivity, time to discover rework and work done correctly. Additionally, the model focuses on management tools including schedule pressure and its impact on quality, moral and productivity. Our work layers and extends over this work to include the innovation trap. We extend this model to include the pressures of new business development in conjunction with the necessary transition policy of a corporation to meet these needs at the expense of the existing project.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

# PART V Analysis of the Innovation Triangle

## *Chapter 10 System Dynamics*

First introduced by Forrester[98], System Dynamics (SD) has emerged as a methodology for modeling the behavior of complex systems. The SD approach is based on a holistic perspective modeling real world systems. Grounded in mathematical discipline of control theory, SD is "a practical tool that policy makers can use to help them solve the pressing problems they confront in their organizations."[99] Because of this emphasis, SD has been used in many fields and applications including but not limited to corporate policy, to the study of fisheries and software development. More importantly, SD allows the modeler to consider different system attributes or factors such as complexity, quality, time to discover rework and leadership. Several software application and or packages exist for creating and running System Dynamics models. This study uses Vensim® software.

## *Chapter 11 Description of System Dynamics Model*

The following system dynamics model is composed of three sections: skill mix, policy and rework cycle. The first section deals with aspects that affect the internal composition of the team with respect to our A/B team definitions. The second section addresses aspects that affect the specific policies affecting the transition and leaning out of the project team. Finally, the third aspect of the model leverages the seminal rework cycle[100] as the core project management engineer. Appendix A shows detailed definitions and explanations of what each variable represents and the equations of the model.

---

[98] Forrester (1961) *Industrial Dynamics*. Cambridge Mass, The M.I.T. Press.
[99] Sterman, John , *Business Dynamics: Systems Thinking and Modeling for a Complex World*, Irwin/McGraw-Hill, 2000. p. ix.
[100] Cooper, K.G. The Rework Cycle (a series of 3 articles): Why Projects Are Mismanaged; How It Really Works … And Reworks …; Benchmarks for the Project Manager. PMNETwork Magazine, February 1993 for first two articles; Project Management Journal March 1993 for third article. Cooper, K.G. and T. W. Mullen. "Swords and Plowshares: The Rework Cycles of Defense and Commercial Software Development Projects," American Programmer, May,1993. Lyneis, James M., Cooper, Kenneth G., and Els, Sharon A., "Strategic Management of Complex Projects: A Case Study Using System Dynamics." System Dynamics Review 17(3), 237–260.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

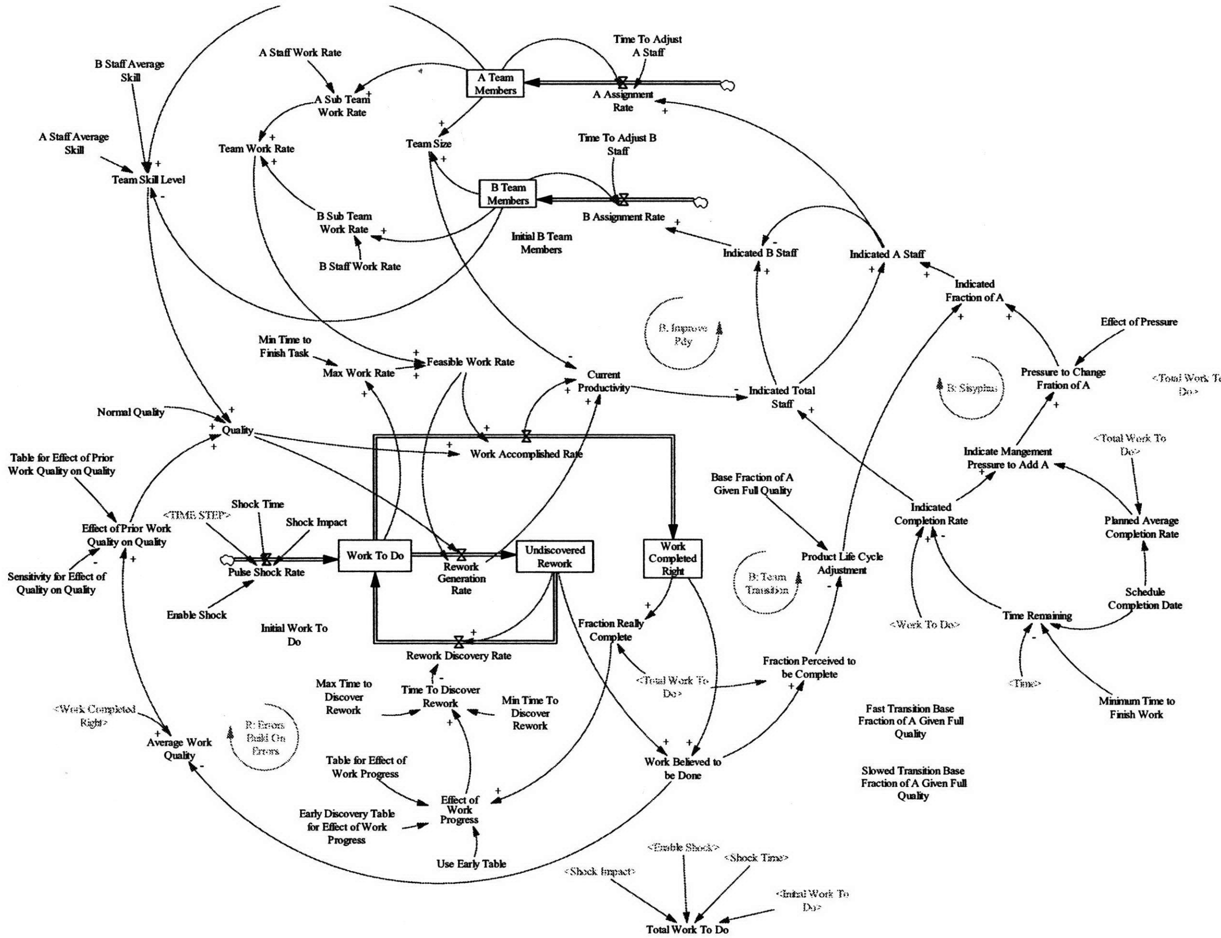



**Figure V-1 Full System Dynamics Model**

## Section 11.1 Skill Mix

The skill mix flow portion of the model is comprised of two important stocks, which are "B Team Member" and "A Team Members". Critical endogenous variables are pool of available "Indicated A Staff" and "Indicated B Staff". The analysis section will focus on how changes in these two critical variables affect the stocks in the system as well as the critical variables "Team Work Rate", "Team Size" and "Team Skill Level". The model maintains several calibration constants:

- **Initial A/B Team Members**: Initial seed of team composition.
- **A/ B Staff Skill Level**: Aids in the overall determination of project quality
- **A/B Staff Work Rate**: Determines the overall project productivity
- **A/B adjustment Times**: Determines the amount of time to hire/transfer team members.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

The feedback depicted in this dynamic sub-model is straightforward. At its core, as the team skill mix is altered by corporate transition and firefighting policy our quality and productivity as dynamically adjust.

## Section 11.2 Policy

Necessary to understand the "Indicated Fraction of A" (IFA), two separate and parallel dynamics must be understood: "Pressure to Change Fraction of A" (PCFA) and "Product Life Cycle Adjustment" (PLCA). This section exposes the details of these feedback mechanisms.

### Section 11.2.1 Pressure to Change Fraction of A (aka Firefighting)

***B: Sisyphus:*** This is a balancing loop. As "Indicated Management Pressure to Add A" (IMP) is translated into pressure by "Effect of Pressure. This increases the "Indicated Fraction of A" increasing the amount of "A Team Members". An increase in "A Team Members" increase "Team Skill Mix" (quality) and "Team Work Rate" (productivity) reducing the "Work To Do" by completing more work correctly (via "Quality"), thereby increasing the "Indicated Completion Rate" to finish schedule and thus reducing the "Indicated Management Pressure to Add A."

First, PCFA tells management how good (or bad) we are doing to our initial schedule (estimate). PCFA generates "management pressure" to bring back additional 'A' team members. This pressure determines whether or not the project has crossed the "poor performance" marker. The poor performance marker is a point in which without a major staff re-orientation, the project will not meet its schedule. Research indicates that adding additional "A" staff required executive decisions. In crossing the poor performance marker, the project is in peril, forcing executive management to respond with additional 'A' resource.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

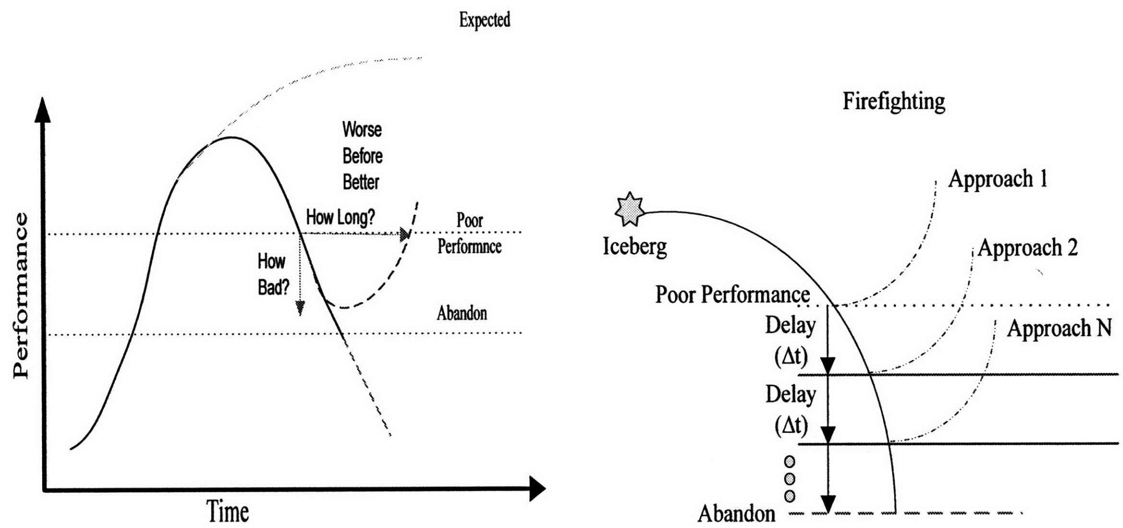



**Figure V-2 Firefighting**

The Sisyphus loop adds 'A' players from corporate resources in an iterative and incremental approach. Due to the nature of the team composition (B players), the issue driving the poor performance often has occurred in the past.

To translate "Indicated Management Pressure to Add A" (IMP) into action, the model uses a lookup table: "Effect of Pressure" (EP) such that as our performance deteriorates, we exert pressure to bring on additional "A" staff to improve our chances of success or at least attempt to get back on schedule.

## Section 11.2.2 Product Life Cycle Adjustment

***B: Team Transition:*** This is a balancing loop. As the "Fraction Perceived to be Complete" increases throughout the project, using "Base Fraction of A Given Full Quality" (BFAGFQ), we adjust our "Indicated Fraction of A" (IFA) to a smaller percentage. This change results in a reduction in the IFA, resulting in a smaller percentage of "Indicated A staff". "Indicated A Staff" reduces the "A team Members". A reduced A team reduces both the skill and productivity of the team. This in turn has the negative effect on both quality and potential work rate. A decrease in team skill erodes "Quality" and "Feasible Work Rate" which in increases the "Undiscovered Rework" and "Work Complete Right". But "Work Believed to be Done" still increases as nothing happens artificially increasing "Fraction Perceived to be Complete".

"Product Life Cycle Adjustment" (PLCA) is responsible for managing the "transition" policy. As the innovation triangle suggests, there is corporate, executive pressure to return the "A"



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

member to new business development. Based on research data, several definitive, endogenous events occur which trigger transition decisions: design complete and design validation (and funding). Design complete and Design Validate are project events matching a specific completion fraction from the "Fraction Perceived to be Complete" (FPC). The FPC is the value managers believe accurately reflects the fraction of the project complete. Being a staged gate project, design complete (and design validation) matches a fraction of the total project complete.

Project life cycle completion events are represented in the "Base Fraction of A Given Full Quality" (BFAGFQ). Key events are at twenty and forty percent complete. Based on research, twenty percent logically represents the design complete while forty percent represents the design validation. At design complete we slowly start to degrade our fraction of "A" players. At forty percent, we accelerate the transition returning "A" players to the new business development.

## Section 11.3 Adjusting Team Size

The adjustment of team size is a middle management policy used to improve productivity. Unlike firefighting, the ability to obtain 'B' level corporate resources does not require executive level leadership approval. It is assumed project will ebb and flow as time erodes.

Adjusting team dynamics requires one stock, "Work To Do" and the "Current Productivity" variable. "Work To Do" represents the amount of work outstanding measured in tasks. "Current Productivity" is our current productivity as measured in task per person month. In our research, the schedule is fixed to the initial "Schedule Completion Date". We calculate an "Indicated Completion Rate" required to complete the project on schedule. To convert work rate into staff resources, we require the current productivity the project is realizing.

***B: Improve Pdy:*** This is a balancing loop. "Time Remaining"(TR) is calculated from the static variables of "Schedule Completion Date" and "Time". TR feeds into "Indicated Completion Rate" (ICR) along with "Work To Do" (WTD). ICR determines the amount of work that needs to be completed in task per month to stay on schedule. "Indicated Total Staff" (ITS) derives the total staff required given the "Current Productivity" of the team. The ITS staff is proportioned to A and B staff members based on the "Indicated Fraction of A" (see above loops, held constant in this loop). ITS has a positive effect on "Indicated B Staff" driving it higher, which in turn reduces the team skill and work rates. This in turn has the negative effect on both quality and



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

potential work rate. A decrease in team skill/work rates erodes "Quality" and "Feasible Work Rate" which in positively effects the "Undiscovered Rework" and "Work Complete Right". These causes "Current Productivity" to drop continuing the cycle of B staff build up.

## Section 11.4 Rework Cycle

Cooper's seminal rework cycle is the core project management engine. These dynamics are extended to meet the needs of our Innovation Triangle. There are many complete feedbacks or causal loops in this model. One is important to understanding the dynamics involved in this study: R: Errors Build on Errors. A thorough understanding of this loop is critical to understanding the dynamics involved in the model as values are changed as related to the A/B teaming policy.

***Loop R: Errors Build on Errors:*** This is a reinforcing loop. "Quality" and "Feasible Work Rate" determines the amount of "Work Competed Right" as well as "Undiscovered Rework". These two stocks positively effect "Work Believed to be Done". "Average Work Quality" (AWQ) uses this perceived work done and creates a ratio to the "Work Completed Right". Because of the inherent delays in "Rework Discovery Rate" via "Table for Effect of Work Progress" and "Time to Discover Rework", some work is built upon mistakes (as of yet undetected). This errors built on errors is calculated by "Effect of Prior Work Quality on Quality" (EPWQQ). EPWQQ uses AWQ as in index into the "Table for Effect of Prior Work Quality on Quality" (TEPWQQ). This fraction positively affects "Quality", as the errors build, the quality is eroded further.

# *Chapter 12 Analysis of System Dynamics Model (Simulation)*

This study will follow an approach of using different scenarios to determine the full range of implications. A total of six (6) major scenarios are investigated:

1. **Successful A Team Only Project Analysis**: The model is investigated using a pristine, theoretical version of an all "A Team Member" approach. The all "A Team Members" will give a deterministic best case analysis.
2. **Successful A/B Team Only Project Analysis**: The model is investigated using a pristine, theoretical version of an A/B Teaming approach. Here, we intrinsically show that the A/B teaming approach does in fact work when everything is expected.
3. **Researched Project Team Analysis**: The model is programmed with the research collected. This analysis will reflect the current DoD program environment. Here the



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

project team faced a tighter deadline the prior case. Additional schedule pressure impacts this test case.

4. **Additional Test Insight:** Research data revealed one mitigating step in the default project management processes is to add additional testing with measureable results. This test case analyzes this condition.
5. **Design Flaw Discovered:** Design flaws do happen. This test case mirrors the conditions of an unexpected design flaw discovery. This is modeled by injecting at a pre-specified month an unexpected increase in tasks. This test case analyzes these conditions.
6. **Innovation Strategy Variation**: Our analysis will extend the initial concept of A/B teaming to reflect potential Corporate Skill Mix scenarios as dictated by market research.

## Section 12.1.1Simulation Assumptions

Central to this analysis is defining both the skill and work rates for the "A" and "B" team members.

| | | | |
|---|---|---|---|
| Work Rate | Fast | **Avg. B** **55%, 5 Tasks/Month** | **A** **95%, 10 Tasks/ Month** |
| | Slow | **Weak B** **35%, 2 Tasks/Month** | **Weak A** **75%, 7 Tasks/Month** |
| | | Sloppy | Precise |

Quality/Skill Level

**Figure V-3 Attribute Map**

An important note is the amount of time required to find the relative team members. Based on market research, "B Team Members" are readily available with a minimum time of a week (.25) to worst case a month (1). Unfortunately, "A Team Members" are not ranging from a month (1) to three months (3). As such, the "Time to Adjust Staff" will vary for each sub-team.

The rework cycle requires some initial conditions. First, is to define the Initial Work to Do. The "Initial Work to Do" represents the total pool of tasks needed to be completed before the project



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

can be considered complete. In addition to the number of task, a "Schedule Completion Date" needs to be defined. "Scheduled Completion Date" represents the amount of time required to complete the "Initial Work to Do". The "Rework Discovery Rate" can be adjusted. For our analysis, these values will be held constant until the test results scenario.

Finally, there are several innovation triangle policy variables that can be modified. The two key variables are lookup tables: "Effect of Pressure" and "Base Fraction of A Given Full Quality". The effects of these variables will be analyzed in the last section of testing.

This study determines a success project meets (+ 3 months) or beats the schedule. Both customer and contractor alike consider success in terms of windows. The three month buffer is based on project research data[101]. A failure was considered late by 6 or more months.

## Section 12.1.2 Output Analysis

Several custom Vensim ® graphs have been constructed to capture critical feedback variables. These custom graphs will be used to present the analysis findings.

- Team Graph: Depicts both the A and B Team Sizes
- Work Graph: Depicts the rework cycle "Work Believed to be Done", "Fraction Perceived to be Complete", "Fraction Really Complete" and "Indicated Completion Rate"
- Quality Pressure: Depicts "Indicated Management Pressure to Add A", "Work Completed Right", "Indicated A Staff", "Indicated B Staff", "Quality".

## Section 12.2 Successful Project Analysis – Optimal Conditions

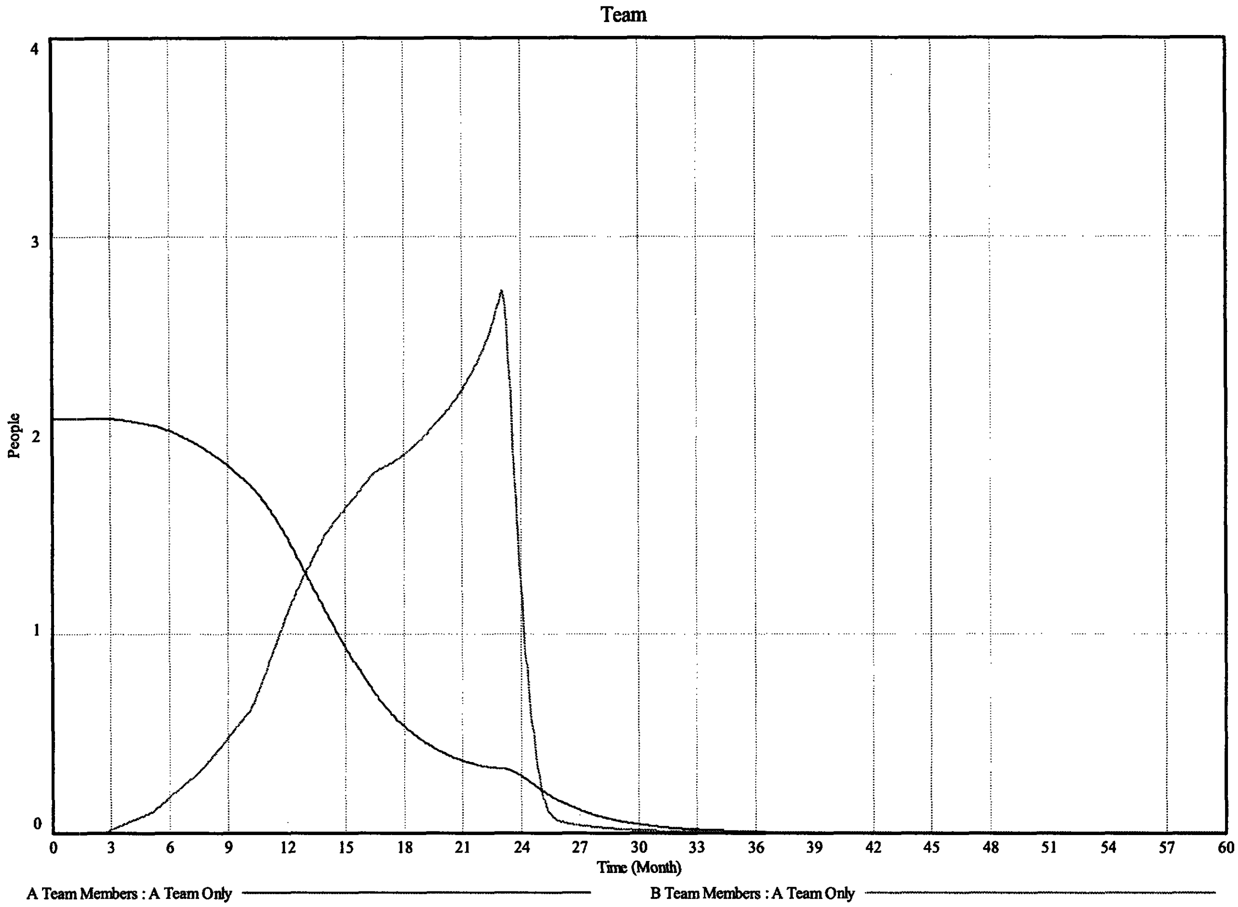
This test scenario represents the optimal conditions. Team Members are of "A" caliber defining all team members as both fast in completing 10 tasks and precise in that 95% of the tasks are completed correctly the first time (top right in our attribute map). The following parameters are used: "Scheduled Completion Date" is set to 24 months. The following charts show the impact of leveraging the all A team.

---

[101] Based on in depth research, success was defined in a "window". Specifically, when analyzed across both customer data and cross checked against the non recorded contractor the following scale was derived:
Success: Meet the schedule +2/3 months. Considered a failure 6 months or greater. Between 3-6 months the success/failure was mixed, however, most leaned toward failure. For our analysis, we will use schedule + 3 months as success, anything else is considered a failure.



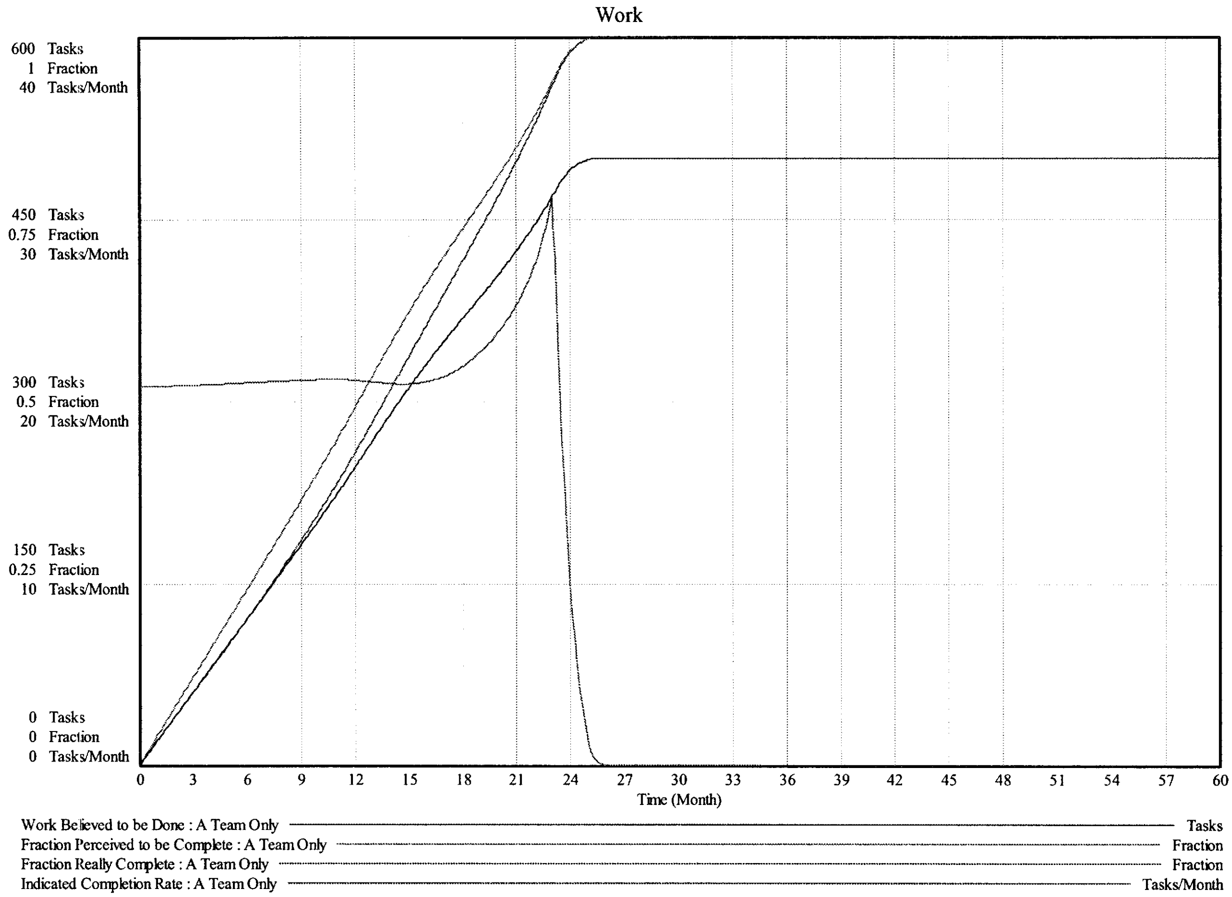
© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu




Here the project completes on time and requires just over two B player with an initial A team just over one team member. This figure represents the typical X (transitioning off the "A" members and transitioning on the "B" members) seen during a transition phase due to design complete and design validate being met.



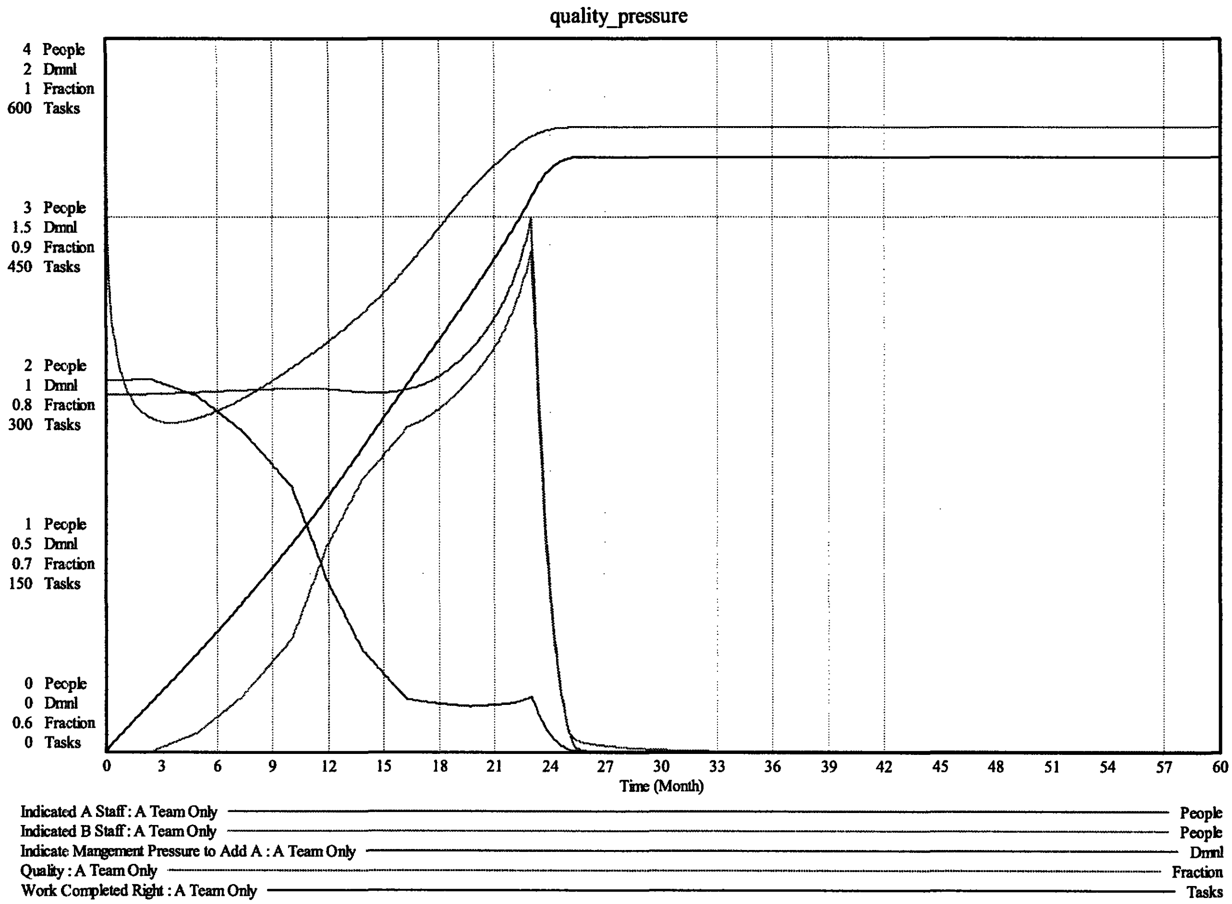
© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu




For the work related effects, the graph shows the strong influence of the skill and work rate of the A team. All work is done correctly, with only a small decrease in the "Work Believed to Be Done" based on the rework generation. In looking at the "Fraction Really Complete" (FRC) and "Fraction Perceived to be Complete" (FPC) we see only minor deviation. Therefore staffing decisions have essentially mirrored the real conditions.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu




There is no quality effect pressure placed on the "Indicated Fraction of A". The project got off to a strong start and transitioned smoothly and the B team finished off the effort. During the transition period, quality does indeed dip (from 95% to ~80%), yet does not trigger a pressure effect to increase the size of the A Team Members. Analysis will name this "dip" as the transition dip.

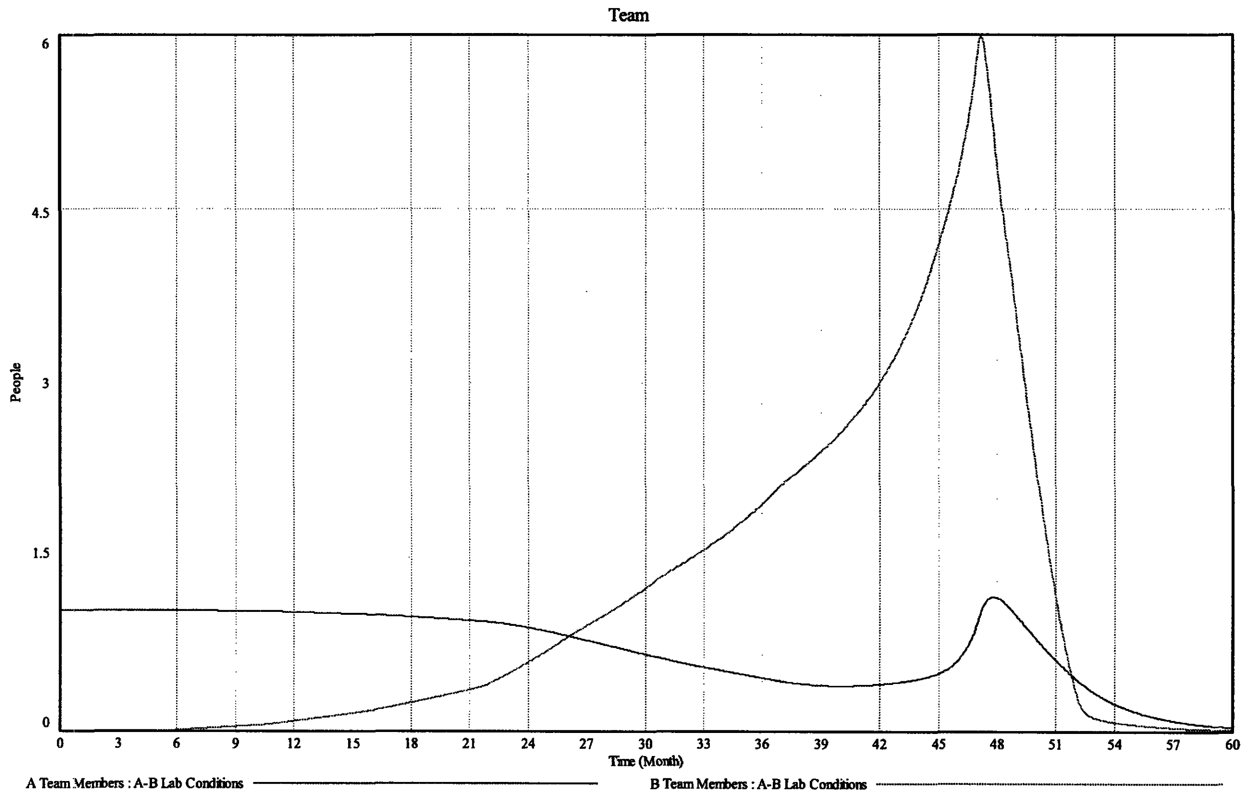
## Section 12.3 Successful A/B Team Only Project Analysis

The model is investigated using a pristine, theoretical version of an A/B Teaming approach. Here, we intrinsically show that the A/B teaming approach does in fact work when everything is expected. Typical projects are not blessed with the ability to have all 'A' players (fast and precise) available for a single project. Project research from in depth interviews reveals the average "B" team member is "sloppy" but "fast" (top left, attribute map). Management knowing a prior of the transition pads the schedule. The following parameters are used: "Scheduled



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

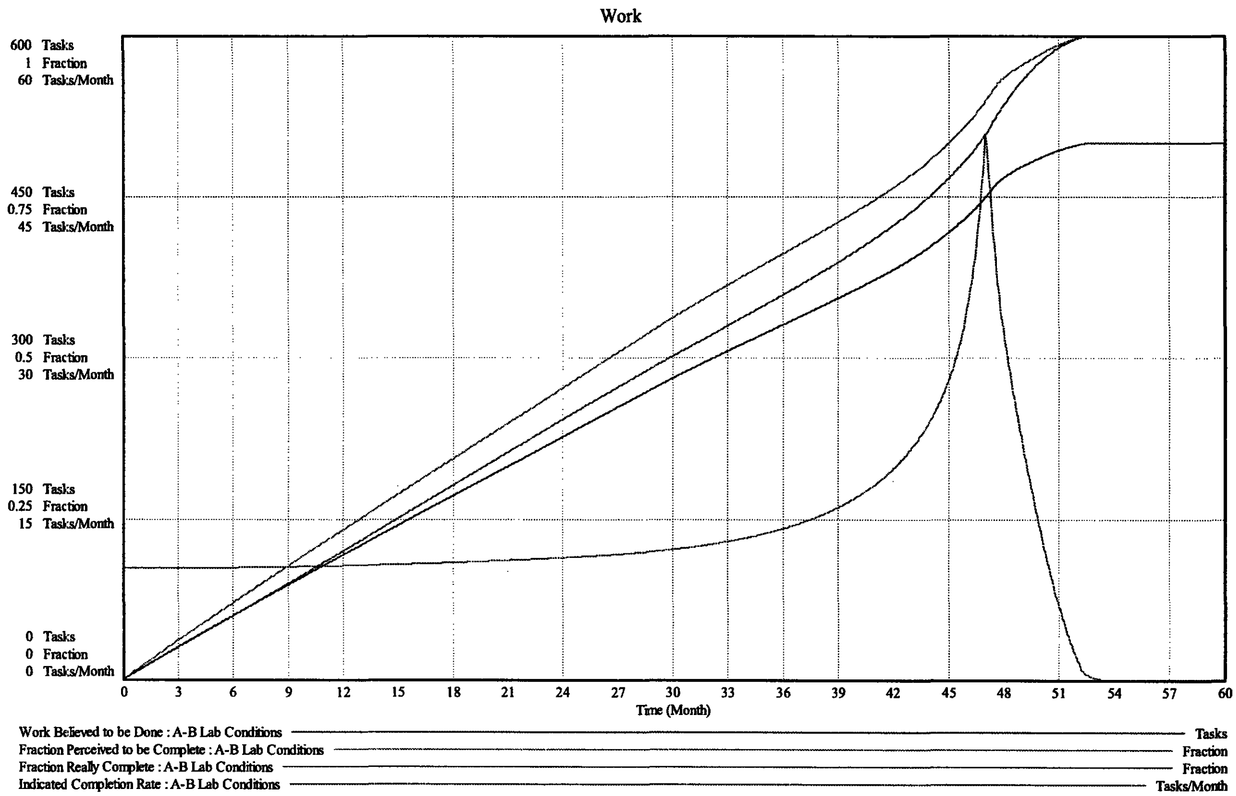
Completion Date" is set to 48 months. . The following charts show the impact of leveraging the all pristine, A/B Teaming strategy.




Again, we see the trade mark X in transition between the A and B member mix. Here a very small amount of trouble towards the end of the project, resulting in less than a approximate month schedule slip (making our success window). The response from the 'B' team growth is delayed followed by a very sharp increase towards the end (month 36) of the project. Additionally, we see a small spike in 'A' team personnel (less than one person ~.5 person).



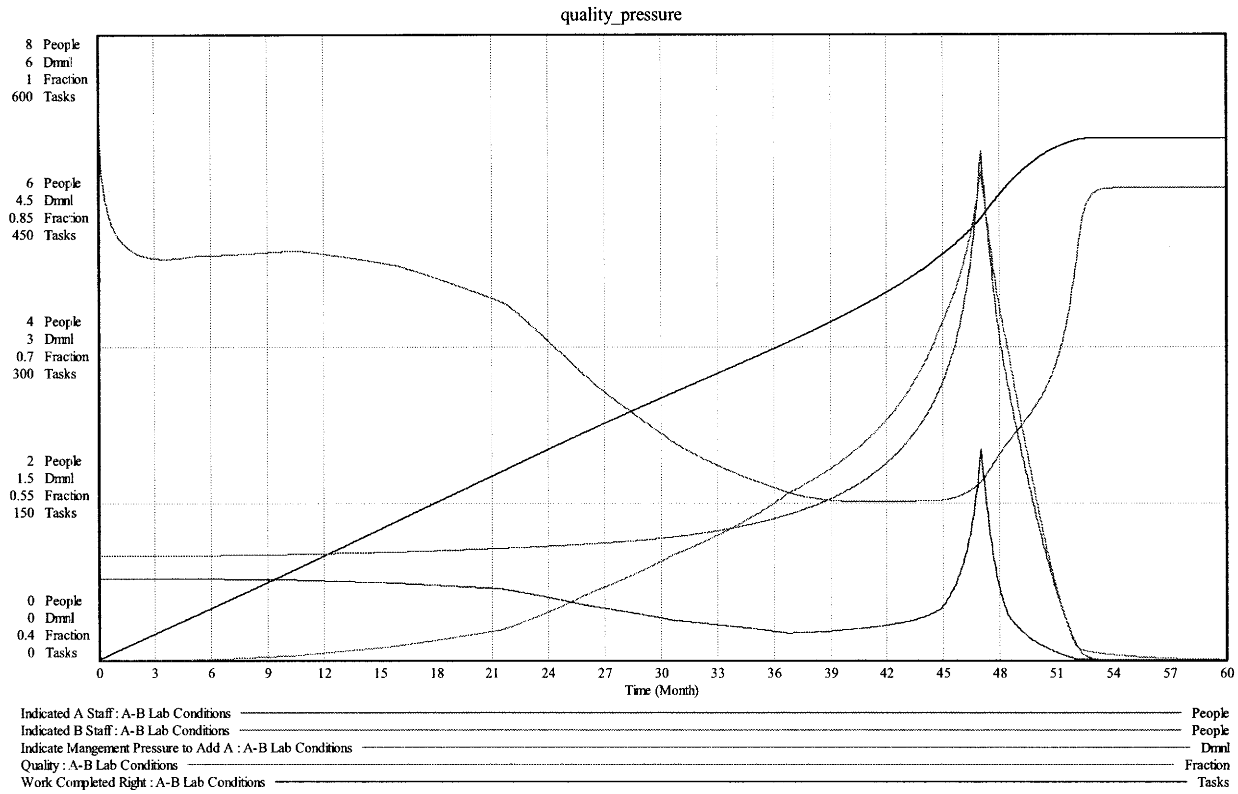
© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu




We did not complete the schedule on time (~1 month schedule slip). "Indicated Completion Rate" is very slow to respond. Unlike the successful case, "Indicated Completion Rate" lags behind the work fractions. The main driver of this lag is the increased "Fraction Perceived to be Complete". In looking at the "Fraction Really Complete" (FRC) and "Fraction Perceived to be Complete" (FPC) we see only large deviation. Therefore staffing decisions based on the PFC is starting to adversely affect the team.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu



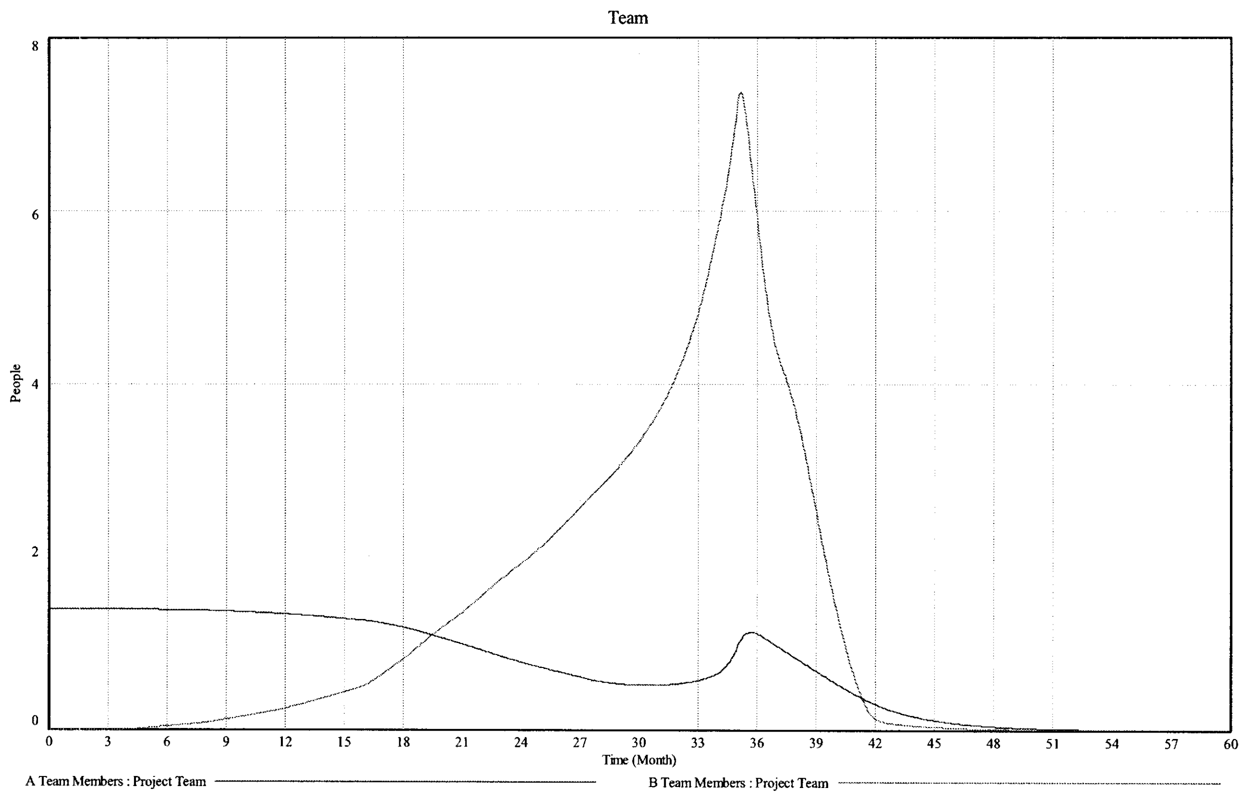

Here we begin to see quality effects on pressure on the “Indicated Fraction of A”. The project got off to a strong start and transitioned smoothly, albeit slowly, and the B team finished off the effort with some last minute firefighting. During the transition period, quality does indeed dip, yet does not trigger a pressure effect to increase the size of the A Team Members. The B team adjustments initially lag behinds the “Indicated Management Pressure to Add A” (IMP), then B team adjustments quickly accelerate. As the B team staffing rises, we see an increase in IMP when fully staffed. The project is in jeopardy. In response to this pressure, the analysis reveals a firefighting scenario, causing an increase in the A staff to try to bring the project back on schedule. The “A” players are able to deliver on schedule.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

## Section 12.4 Researched Project Team Analysis

The model builds off of test case two but is programmed with the research data collected reflecting the current DoD program environment which sparked this study. Research also indicated that the software team serving as the basis for this study was composed of B team members[102]. Here the project team faced a tighter deadline the prior case. The following parameters are used: "Scheduled Completion Date" is set to 36 months. The following charts show the impact of leveraging the all A team.



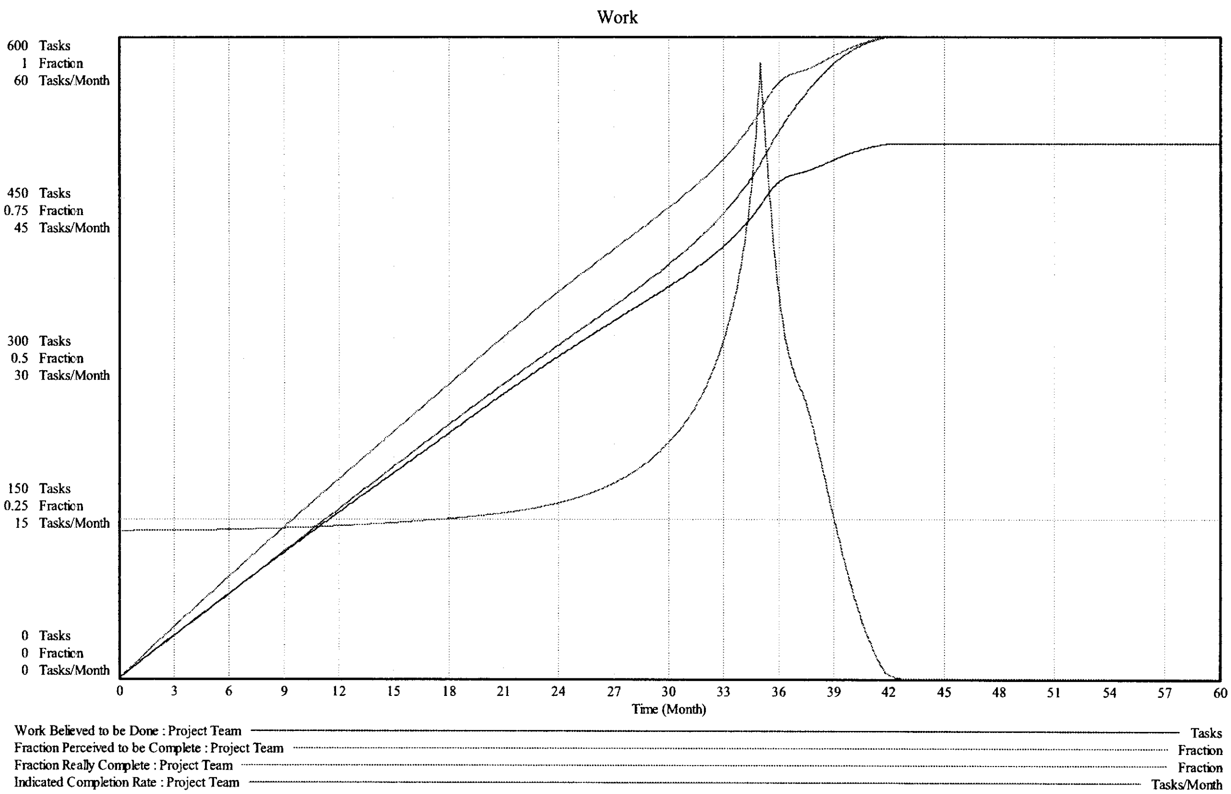

Again, we see the trade mark X in transition between the A and B member mix. Unlike the successful 'A' player only case, here we run into trouble. The response from the 'B' team growth is delayed followed by a very sharp increase towards the end (month 36) of the project. Additionally, we see a small spike in 'A' team personnel. The response indicates that we are in firefighting mode. In other words, we brought back additional 'A' team members. We missed schedule by six months.

102 The notion of the B team delivering the project was supported by all research data. Additionally, contractor interviews (not recorded) also supported this theme.



© Jeffrey Manning- All Rights Reserved
jwm@sloan.mit.edu

What is interesting is that this team mix mirrors the real world observations. The project finished a year late, with an increase in team mix near the initial completion date. A year later, the program completed within increase mix of senior corporate expertise.

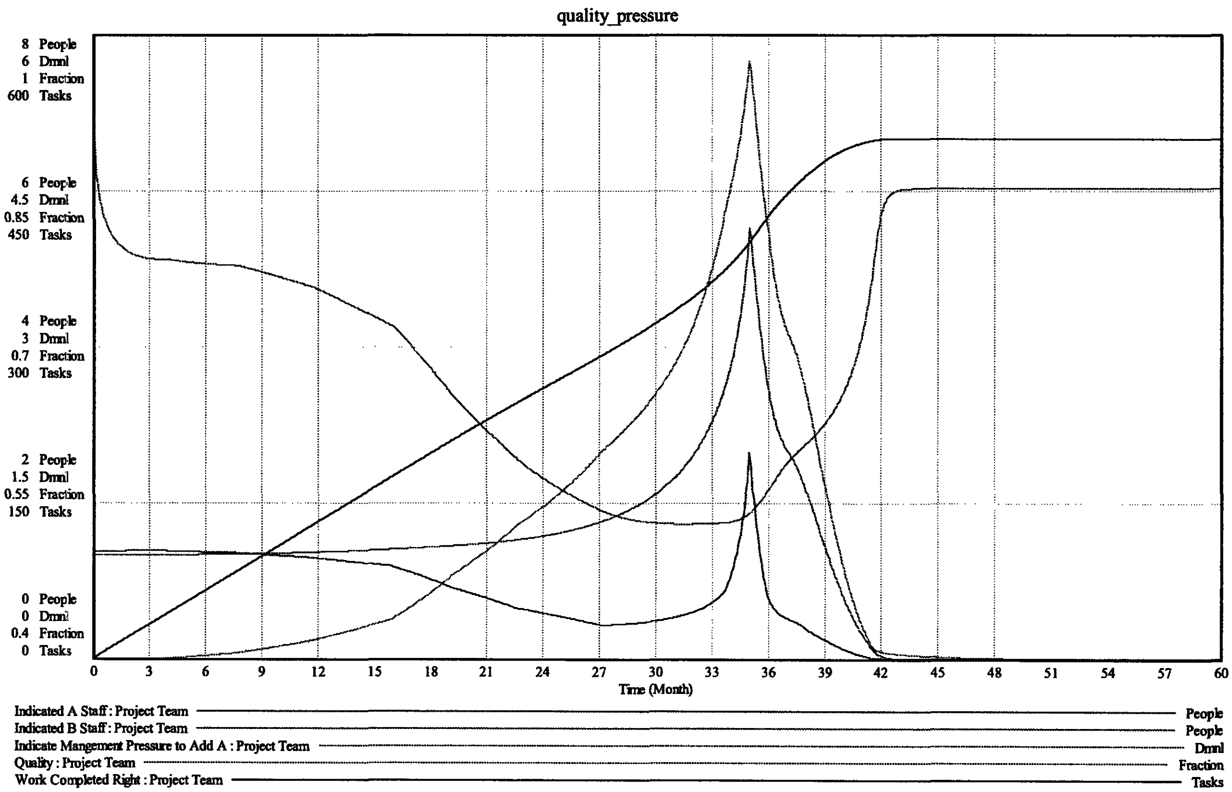



We did not complete the schedule on time (6 month schedule slip). "Indicated Completion Rate" is very slow to respond. Unlike the successful case, "Indicated Completion Rate" lags behind the work fractions. The main driver of this lag is the very high "Fraction Perceived to be Complete". This graph suggests that not only is the project paying the price for the relatively low quality of the B player, but there is a significant delay in its detection. This suggests a compound effect. The B player has to "work off" the great initial quality of the 'A' team and then erode based on his own quality. In looking at the "Fraction Really Complete" (FRC) and "Fraction Perceived to be Complete" (FPC) we see a large deviation. Therefore staffing decisions based on the PFC is starting to adversely affect the team. The study labels this "work off" factor or the additional delay in detecting poor performance as "Residual Goodwill". In



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

other words, there is some “grace” time based on past performance. It is not until the project is in obvious trouble that behavior drastically changes.



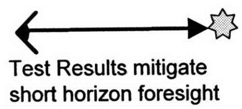

The above assumptions of “working off” the developed ‘A’ team positive effects (from “Fraction Perceived to be Complete) are realized. Quite clearly quality dives with the addition of the B team members. The B team adjustments initially lag behinds the “Indicated Management Pressure to Add A” (IMP), then B team adjustments quickly accelerate. As the B team staffing rises, we see an increase in IMP when fully staffed. The project is in jeopardy. In response to this pressure, the analysis reveals a firefighting scenario, causing an increase in the A staff to try to bring the project back on schedule. We see the improvement in “Work Completed Right” with the increase in slope starting in month 36.

## Section 12.5 Role of Test Results

There is hope! Lack of vision can be mitigated. Research indicated that a ‘B’ player’s lack of vision can be offset with the incorporation of frequent testing. By preventing long “black-out” periods with no real, measurable test results, can greatly improve ‘B’ player’s success.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu




Increasing Trust

Test Results/Test Points
- Analysis: mathematical model
- Simulation: application simulation
  - Matlab
  - Executable XML
  - High Bandwidth Communication
- Actual Code: real product results

**Figure V-4 Test Results**

There is an engineering heuristic "test early; test often". By testing early and often, we have measurable results. This lessons the impact of the 'B' player's poor metronome and "internal" test generator. There is less dependence because they are placed real test results.

The net effect of "test early; test often" is best summarized by "running a marathon broken up into 400 meter sprints."[103] By breaking up the marathon into smaller sprints, results are collected and definitive progress (or lack of progress) is calculated. Corrections can be made. This incremental and iterative process is shown against the "big bang" approach.

---

[103] Kuschel, Steven Dr. ZMET interview



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

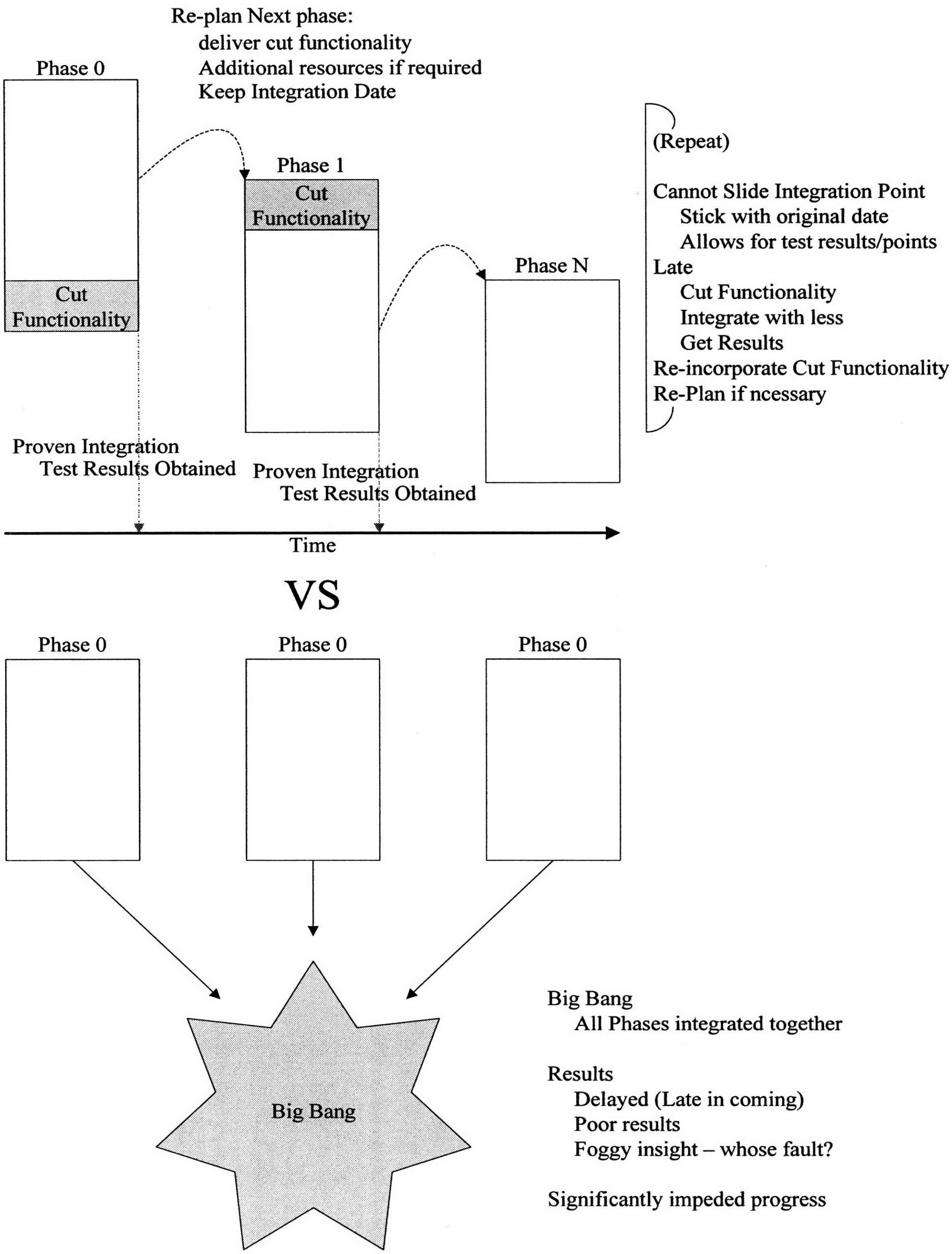



**Figure V-5 Incremental vs. Big Bang**

The effect of this testing is to try to mitigate the B player's lack of vision but forcing the "Fraction Perceived to be Complete" to mirror the "Fraction Really Complete". To test early is



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

controlled by the lookup table "Table for Effect of Work Progress" and the "Max Time to Discovery Rework".

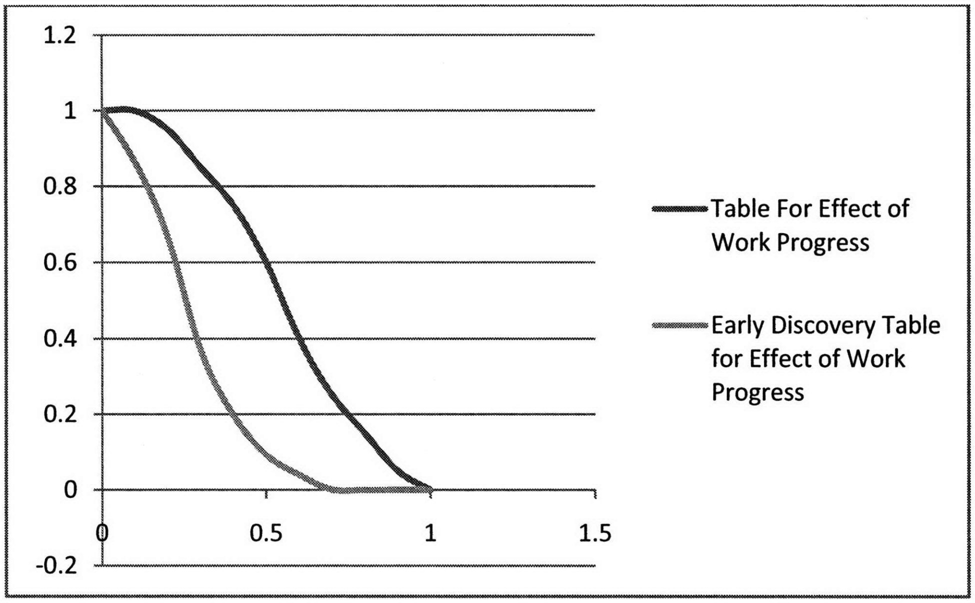
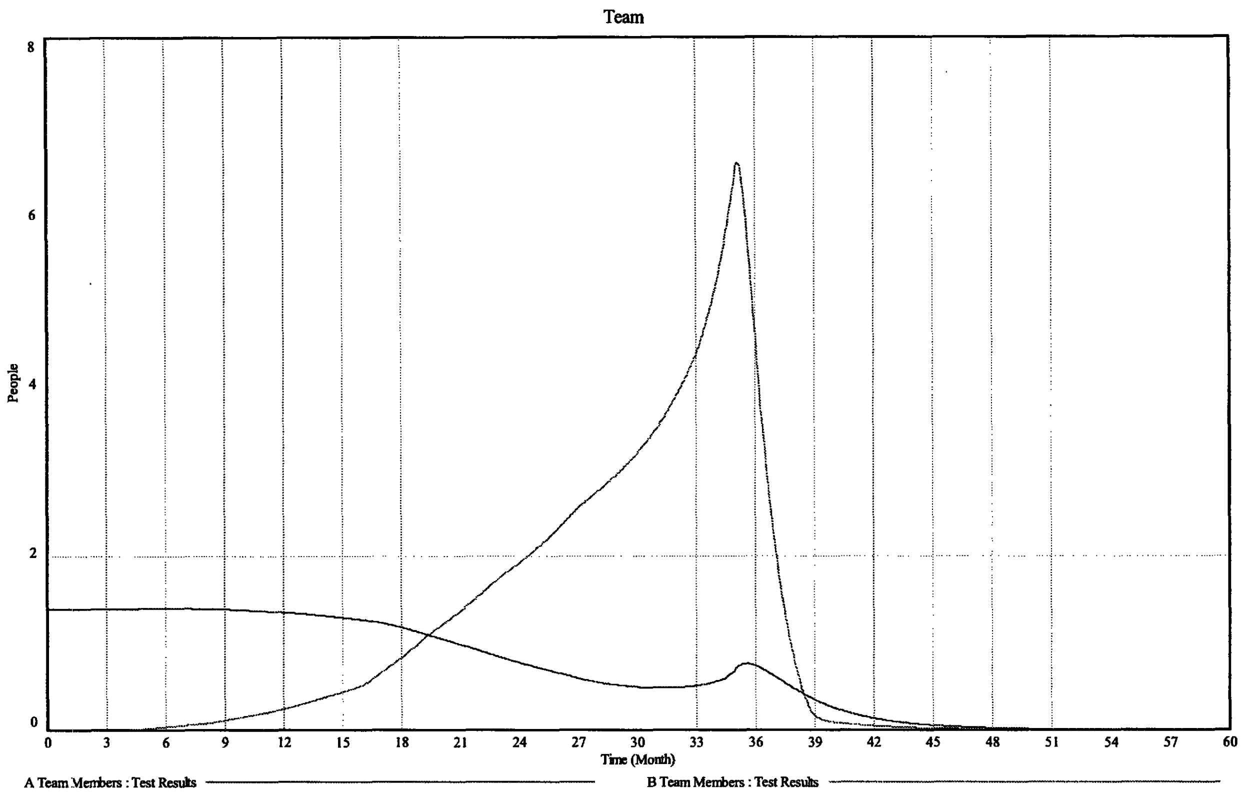


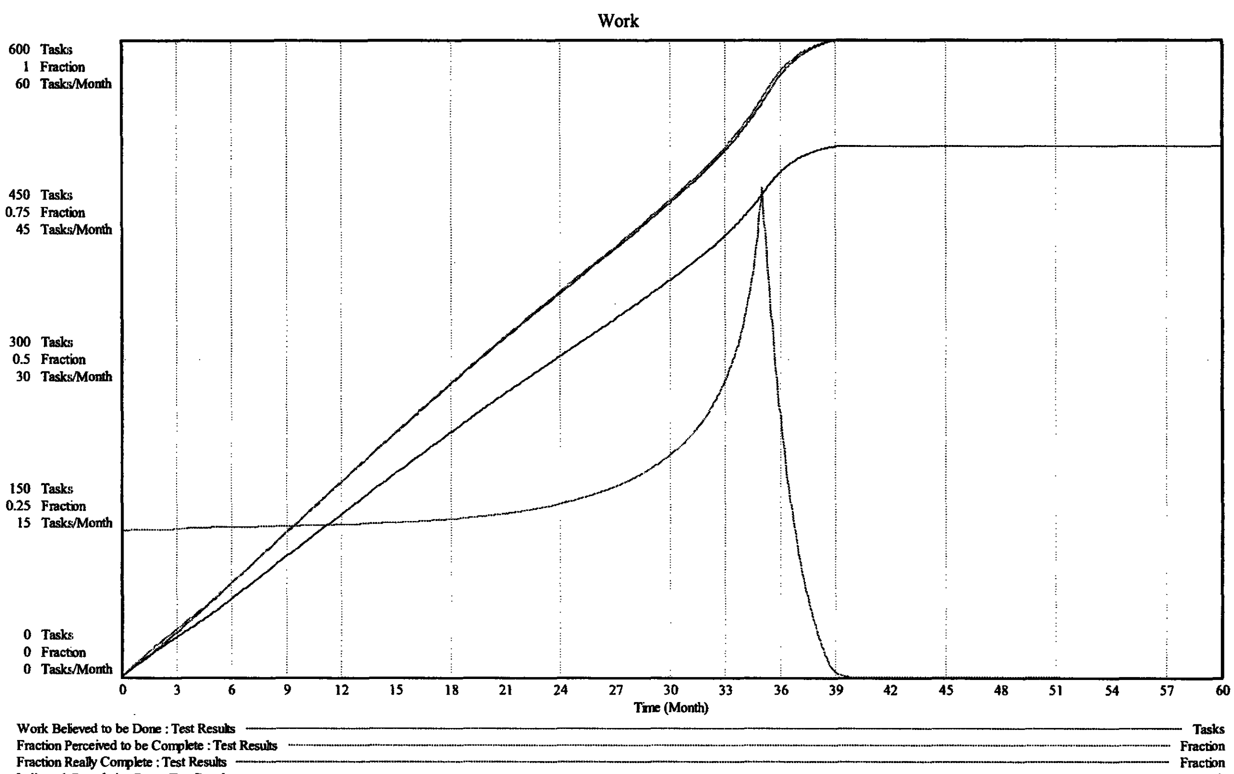

**Figure V-6 Table for Effect of Work Progress**

As shown, this test case analysis switches from the blue (normal case for all prior scenarios) to the olive line of the earlier discovery capability. Additionally, we alter the "Max Time to Discover Rework" to a value of 3 months.



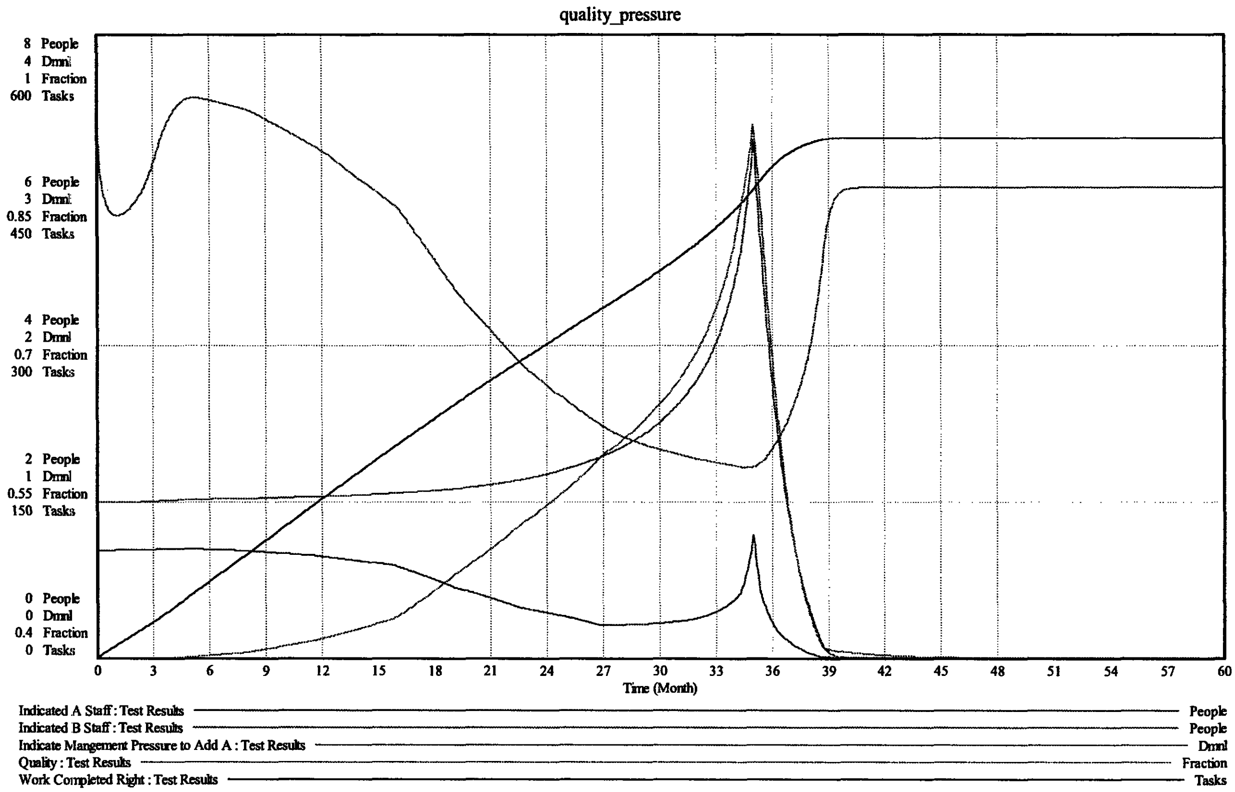
© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu






© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu




Analysis of the graph produces very positive results. By testing early and often, in fact the two work fractions are essential identical (work graph). As such, even with the transition effects on quality, the project team was able to deliver the project essentially on time (~37 months). The major driver of performance recovery is the almost identical measures of FRC and the PFC. Test results reduce the gap between the two variables. We are making staffing decisions with accurate information.

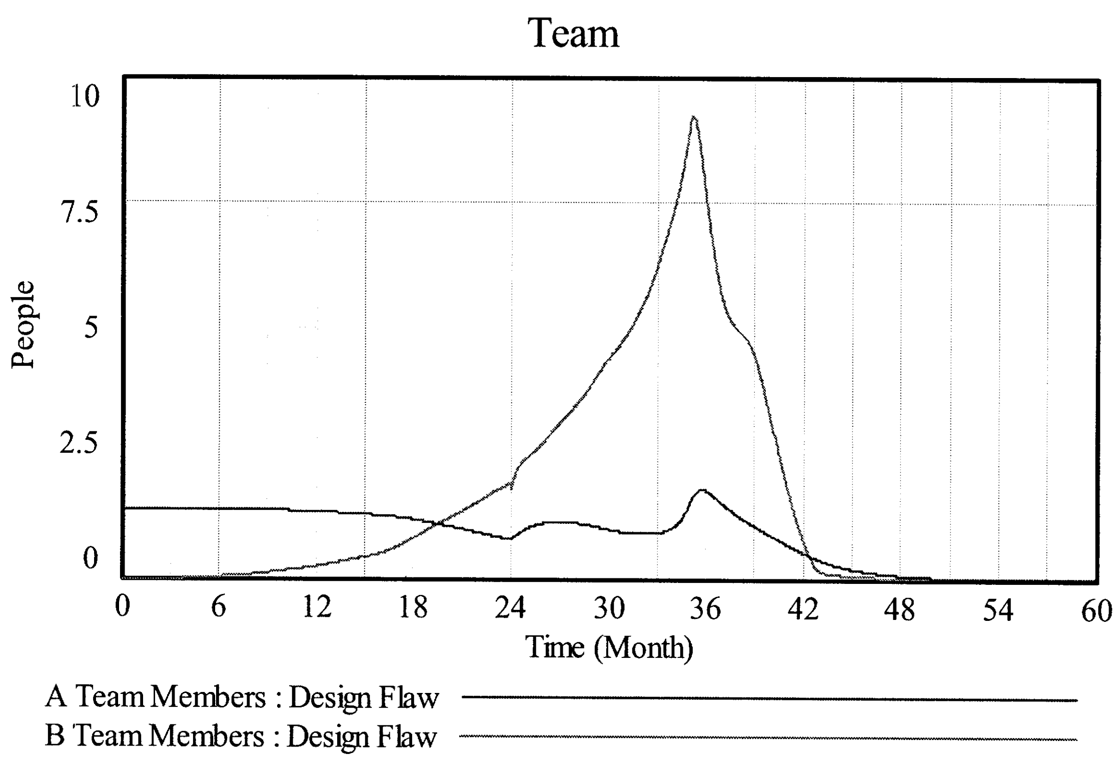
## Section 12.6 Design Flaw Discovered

Design flaws do happen; in fact more often than any one will admit. Design flaws are expensive in terms of both impact and cost to schedule and place additional unexpected pressure on projects. This test case mirrors the conditions of an unexpected design flaw discovery. This is modeled by injecting at a pre-specified month an unexpected increase in tasks to complete. The case assumptions revert back to Researched Project Team Analysis. The shock is controlled by the following parameters:



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

- "Shock Time" – The time (in months) when the "Shock Impact" is inserted into the "Work To Do" stock. Set to 24 months
- "Shock Impact" – The amount of tasks injected into the "Work To Do" stock. Set to 100 tasks.

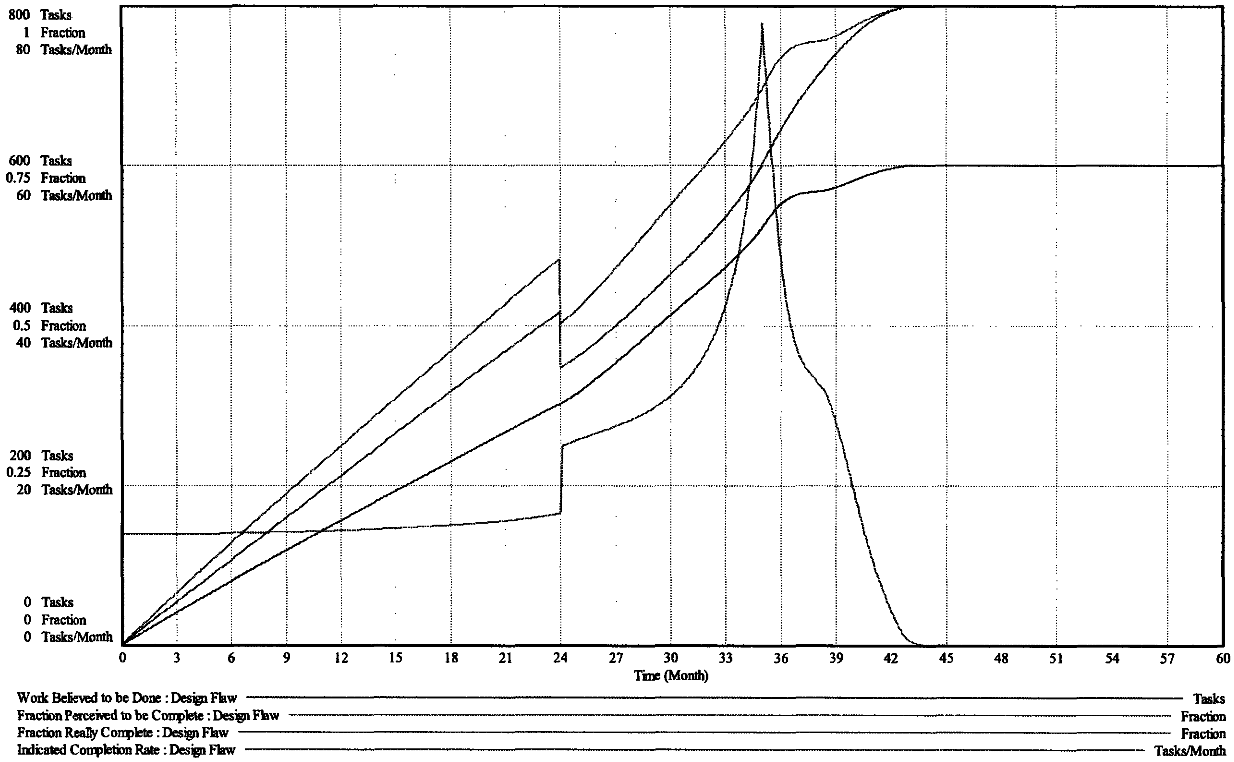




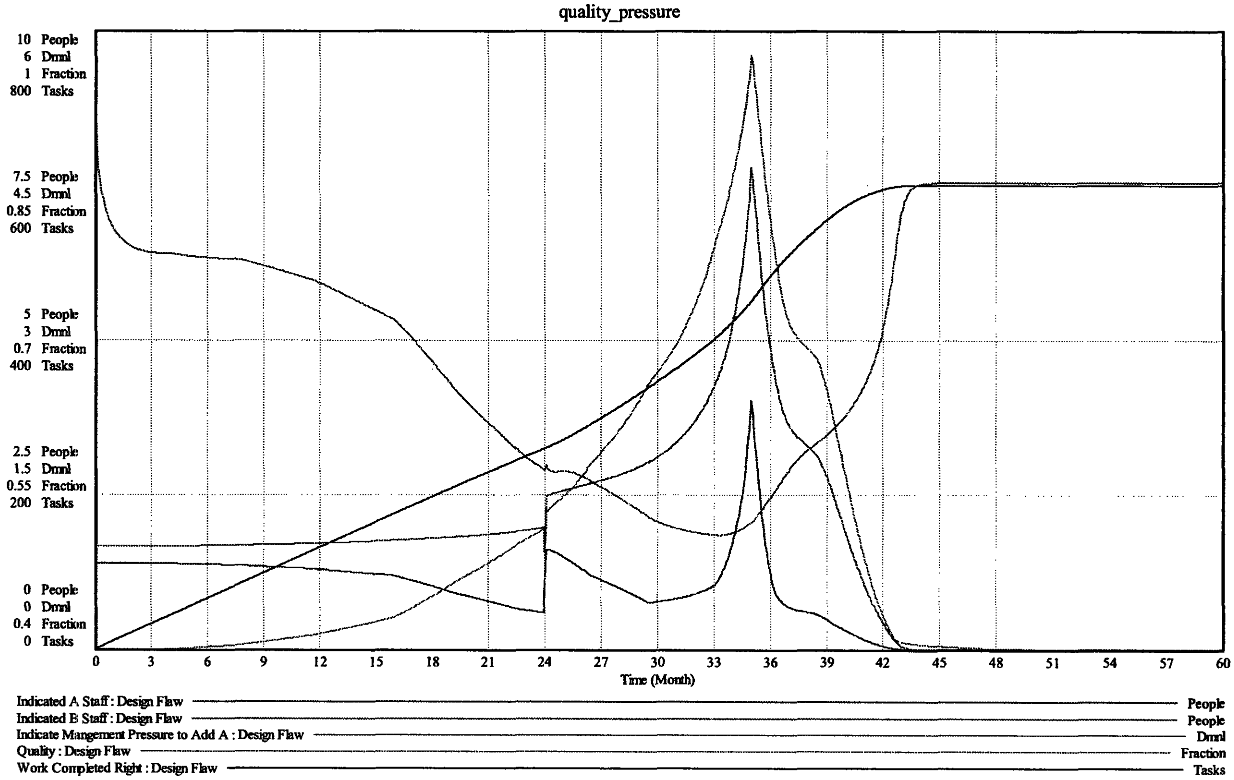

© Jeffrey Manning- All Rights Reserved

jwm@sloan.mit.edu

Work




quality_pressure






© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

Again, the addition of unexpected rework has caused another slip in the schedule. We can see the obvious impact at the 24th month and injects 100 additional tasks. The A/B teaming immediately responds to the design flaw solves the issues. The B team once again takes over, by makes very little progress requiring another late firefighting episode. Even with two distinct firefighting efforts, the project team missed the schedule. This test scenario shows the largest gap between RFC and PFC.

## Section 12.7 Summary

The A/B teaming strategy can work. In fact, if everything goes as expected this strategy does well in the sense we have freed up or expensive "A" resources for new business development and that we are able to make higher profit margins using cheaper, less skilled engineers (B team). If the B team does run into trouble, we can quickly bring back the "A" and still make schedule.

But, we do see the staffing effects of the removal of the 'A' team members. What is interesting is the "lost year" occurs early in the program between months 12-24. The "B" requires some time to erode the "good will" developed by the "A" team. Here we are relatively flat, working under false pretenses. The B team is basking in the early progress of the 'A' team good will. It is not until the quality setup by the 'A' team erodes that a response is seen. It is a quick and sudden collapse. The response is a swift growth of not only B team members, but we also see a spike in the 'A' team. Firefighting is occurring.

Yet, most managers have some reason to expect the unexpected. This is where the A/B teaming strategy struggles. The strategy fails to deliver on time with increasing schedule pressure (test case 3) or increasing performance pressure through a design flaw (test case 5). There is some hope. Research indicates with the advent of more rigorous and disciplines test strategy, the impact of the B team can be mitigated. This is a direct result of objective, repeatable, systematic test results which drastically narrows the "Fraction Perceived to be Complete" and "Fraction Really Complete"



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

## Section 12.8 Handoff Analysis

Leaving the skill and work rate analysis alone, it is time to shift gears to determine the effects of altering the product life cycle pressures. One possible risk mitigation strategy is to alter the transition period to keep the 'A' players on the project longer. Although there is strong incentive to return the 'A' player back to new business development, a pattern of failed projects temper an aggressive approach.

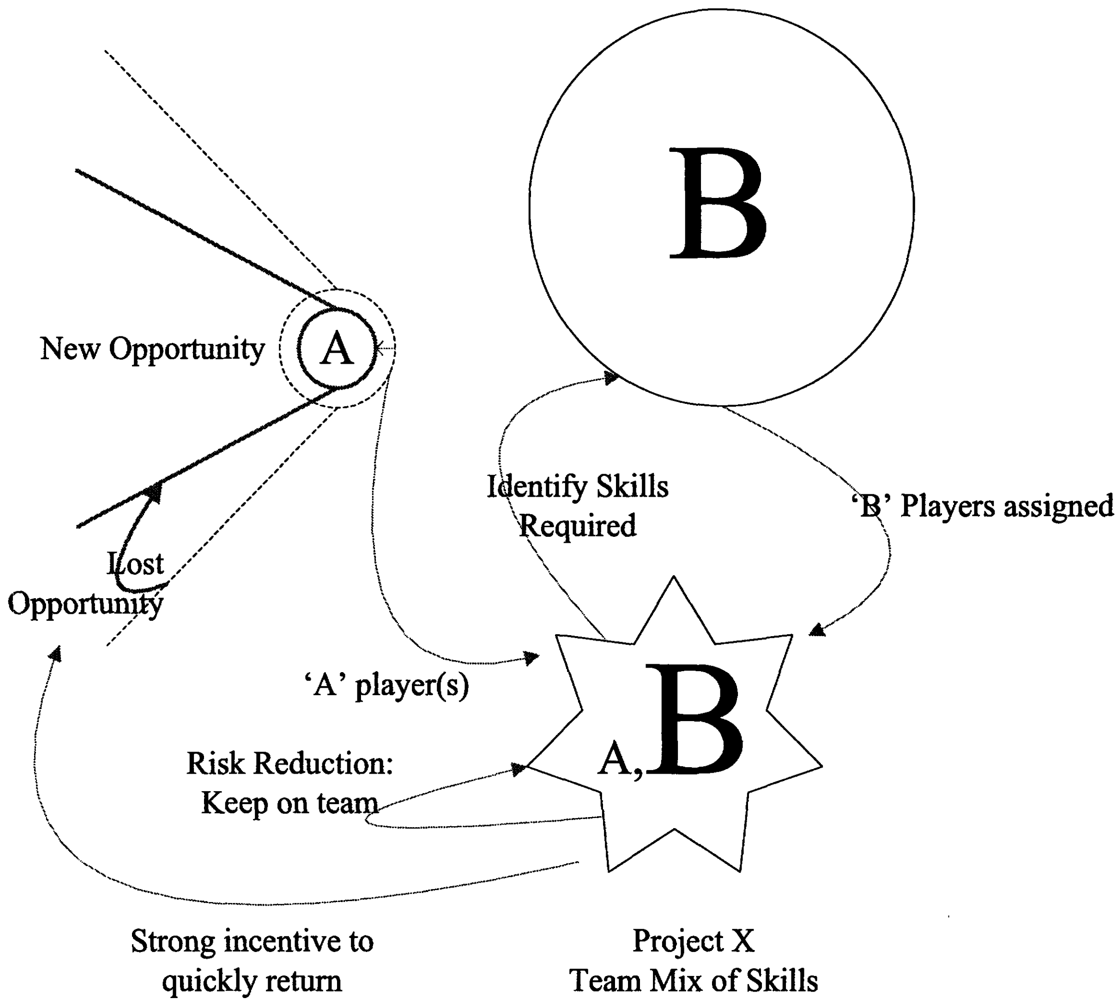



**Figure V-7 Handoff Analysis**

Currently, the analysis is centered on the above approach for the "Base Fraction of A Given Full Quality" (BFAGFQ).



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

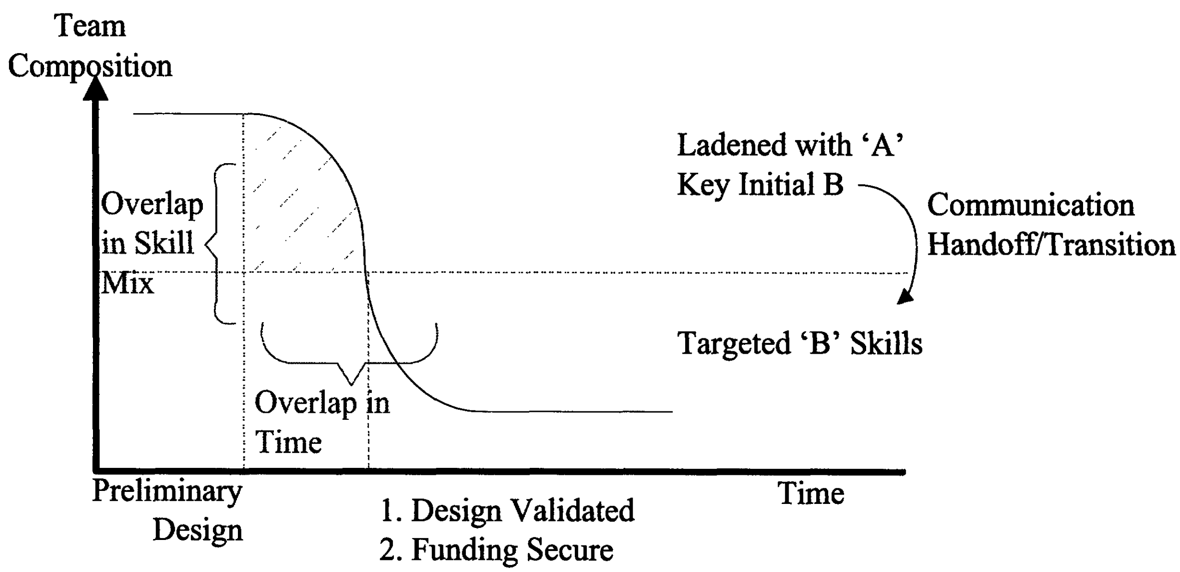



**Figure V-8 Transition Parameters**

There is an attempt to "hand-off" from the A team members to the B team members shaded in green. As shown, there are two parameters affecting the transition period: overlap in skill mix (team composition axis) as well as an overlap in time (time axis). As visualized, we will analyze the impact of modifying the transition period to retain our 'A' team members in two distinct cases:

- **Delayed Removal**: In the delayed removal, we are simulating a unified A/B team. Simulation increases our overlap in skill mix by defining the Design Complete indication earlier in time. This has the effect of bringing on additional B staff earlier in the product life cycle to improve learning. In addition, we delay the design validation which increases the overlap in time between the "A" player and the "B" player. The "A" players will remain on the team for a longer period of time to handle any "tricky" issues that might pop up (unknown unknowns).
- **Quick Removal**: For completeness, we test the early overlap and sharp removal of the "A" team. This is equivalent to the "throw it over the fence" operation mode. Once the design is validated, just toss it over the fence with little interaction with the downstream implementation team.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

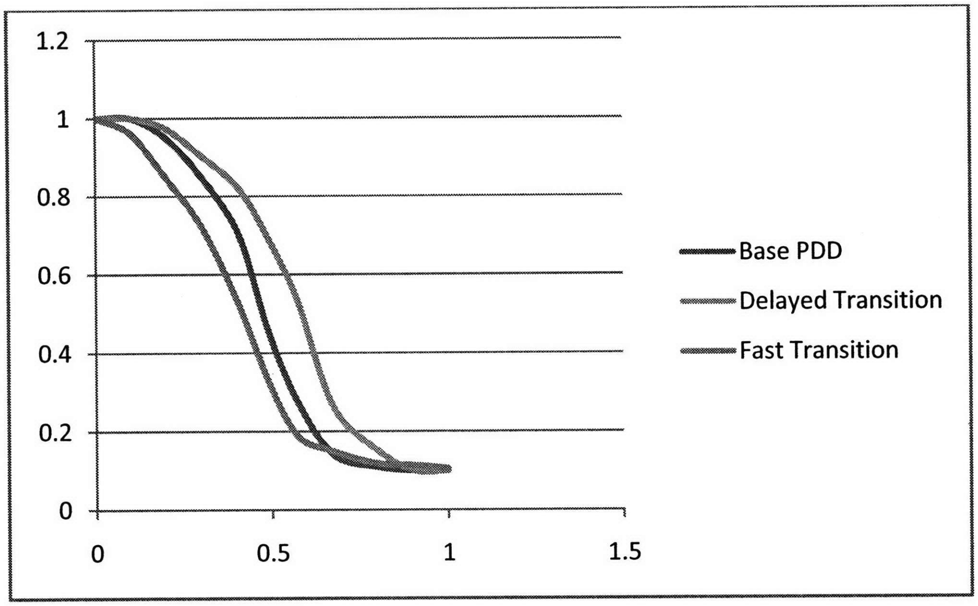



**Figure V-9 Base Fraction of A Given Full Quality**

The above figure compares the two approaches with the base case.

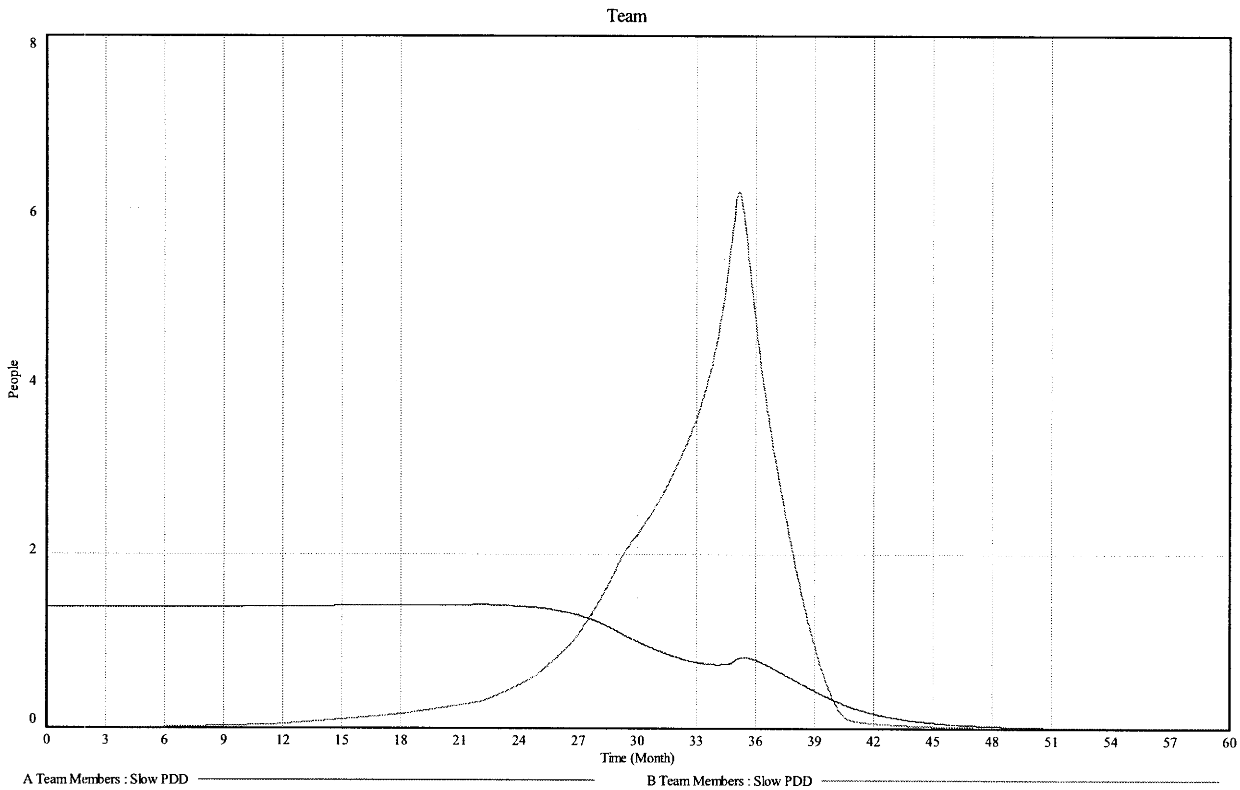
## Section 12.8.1 Delayed Removal – The Unified Team Approach

In the delayed removal, we are simulating a unified A/B team: not quite the optimal team (as in test case one) but better than the project team (as in test case 3). Simulation increases our overlap in skill mix by defining the Design Complete indication earlier. In addition, we delay the design validation which increases the overlap in time between the "A" player and the "B" player. The "A" players will remain on the team for a longer period of time to handle any "tricky" issues that might pop up (unknown unknowns).

Necessary to analyze the effects of the transition, we need to modify the BFAGFQ (see above figure). If we define the transition periods earlier (design complete) and transition the team more slowly (design validation), deeper into implementation can we help the schedule erosion? The following graphs represent the modified BFAGFQ.

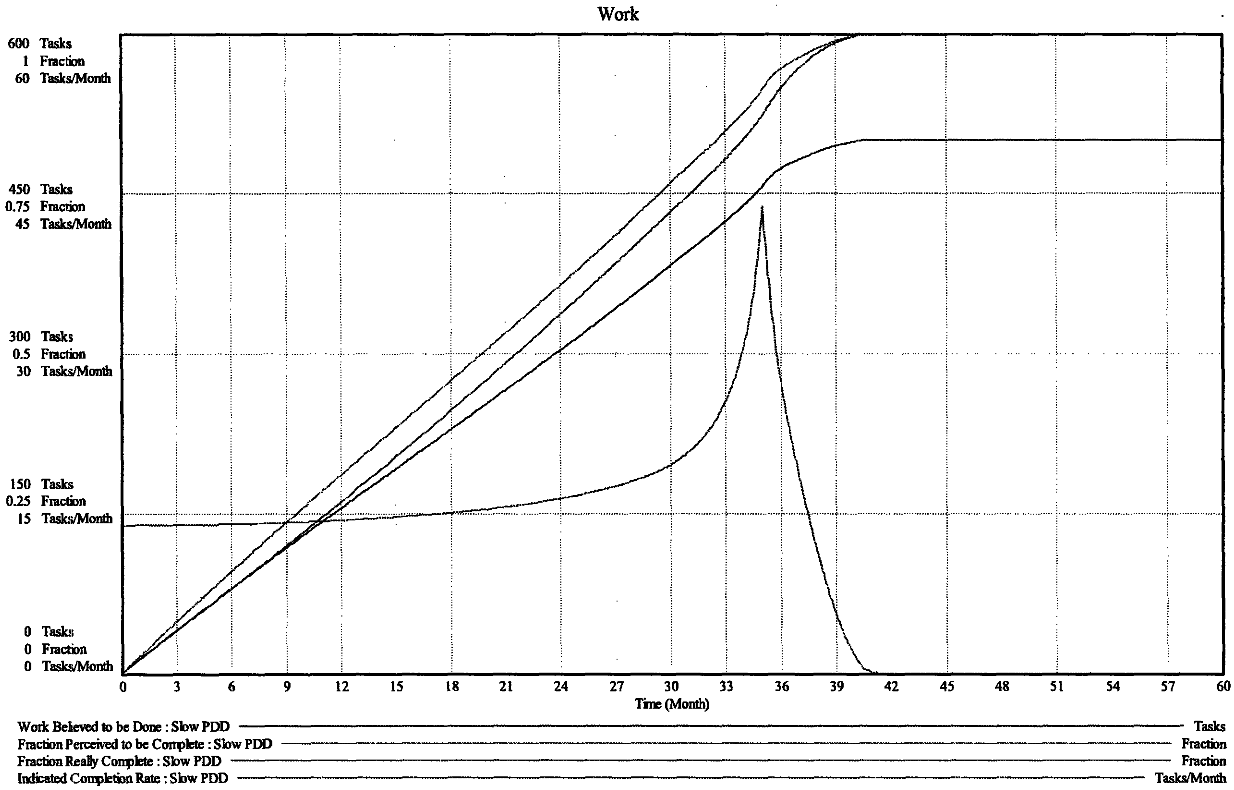


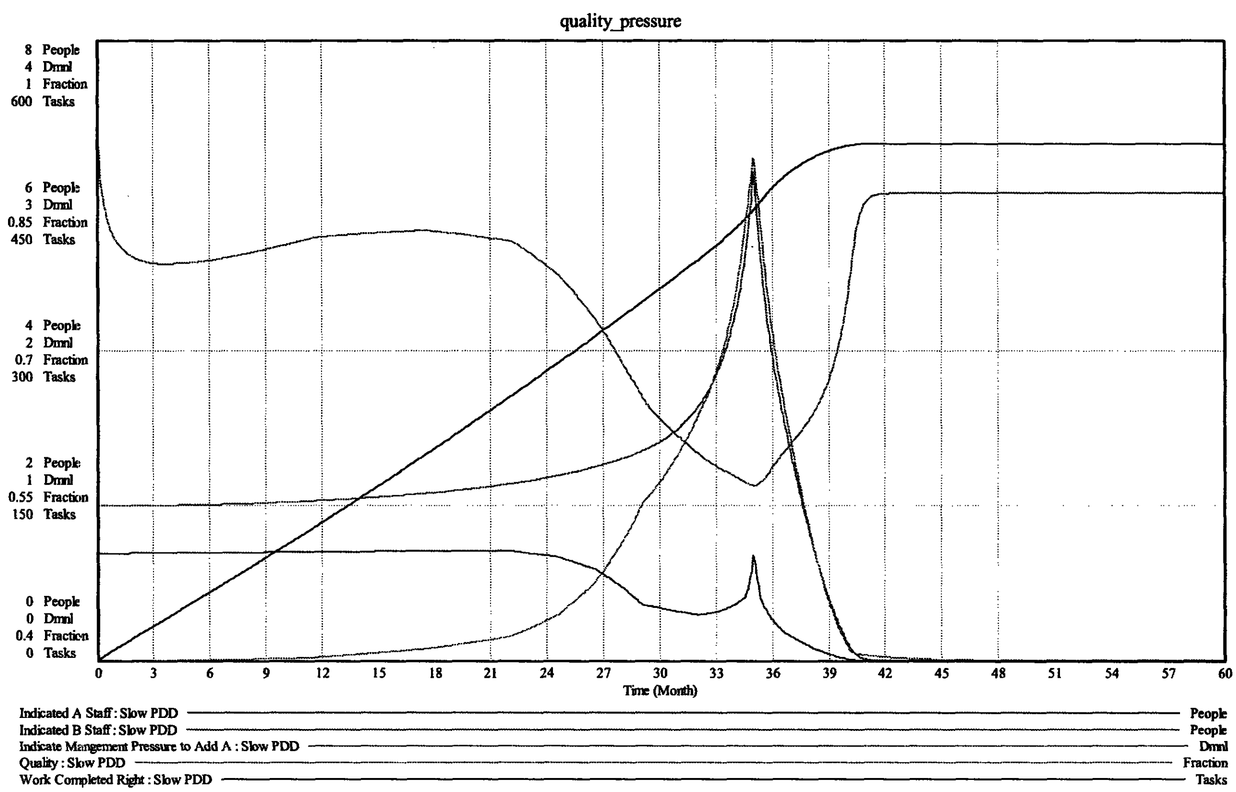
© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu






© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu



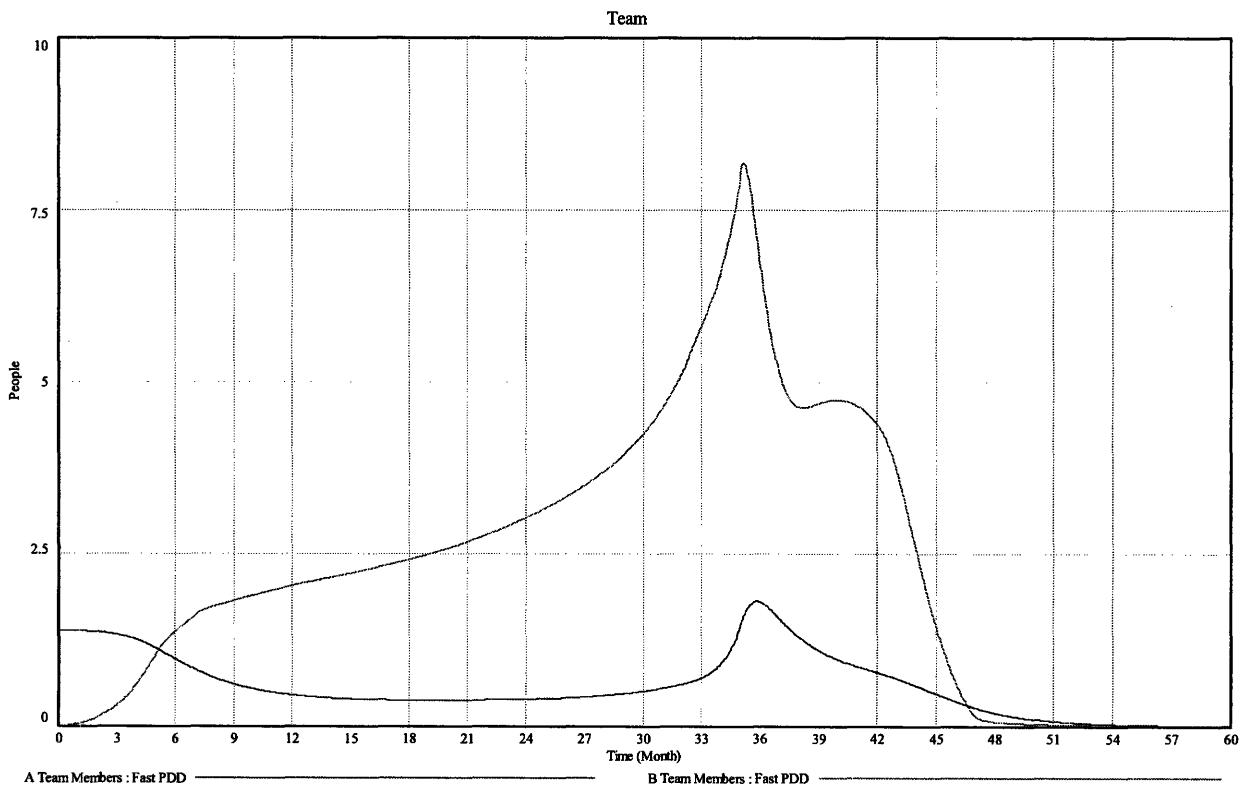



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

As the graphs indicate, there is some change from the prior failed project team (test case three). The project completes a three months later, seeing better performance. This is large part is because the team composition in beginning to look more like the optimal team strategy (test case one).

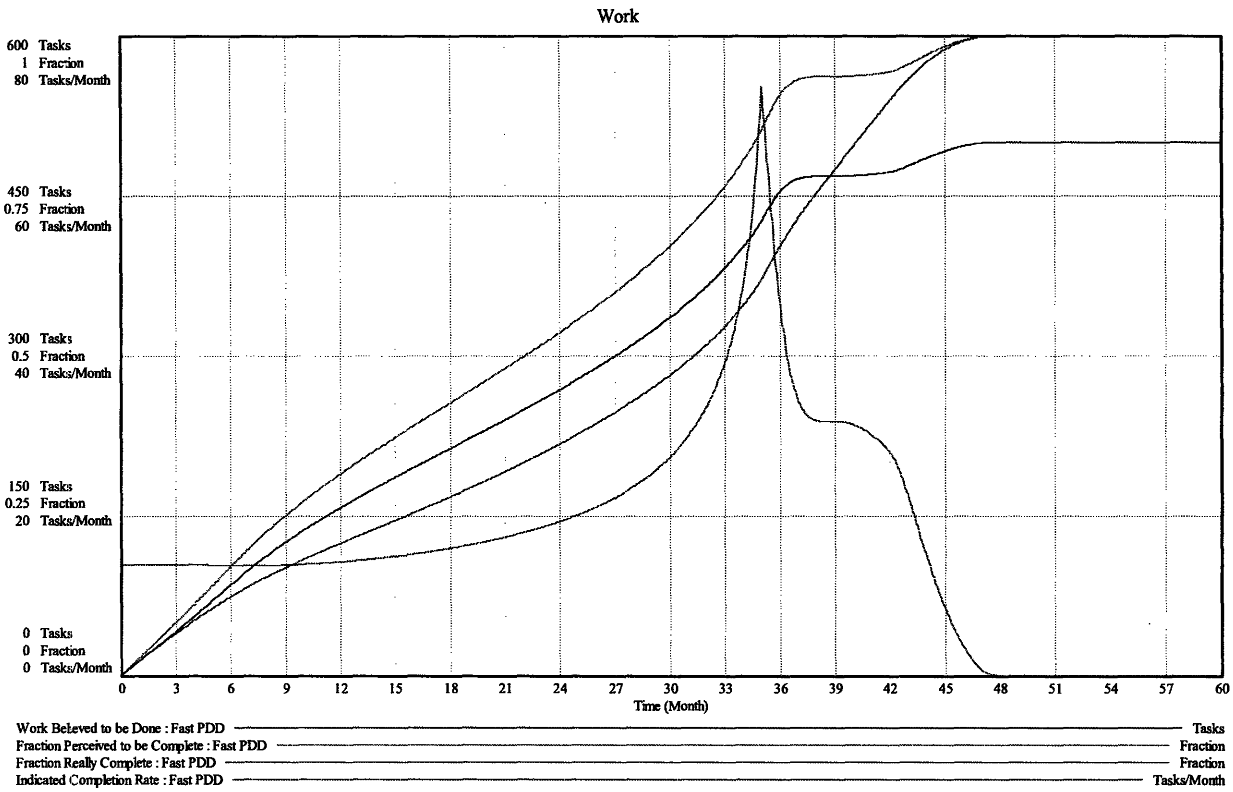
## Section 12.8.2 Quick Removal – "Throw It Over The Fence"

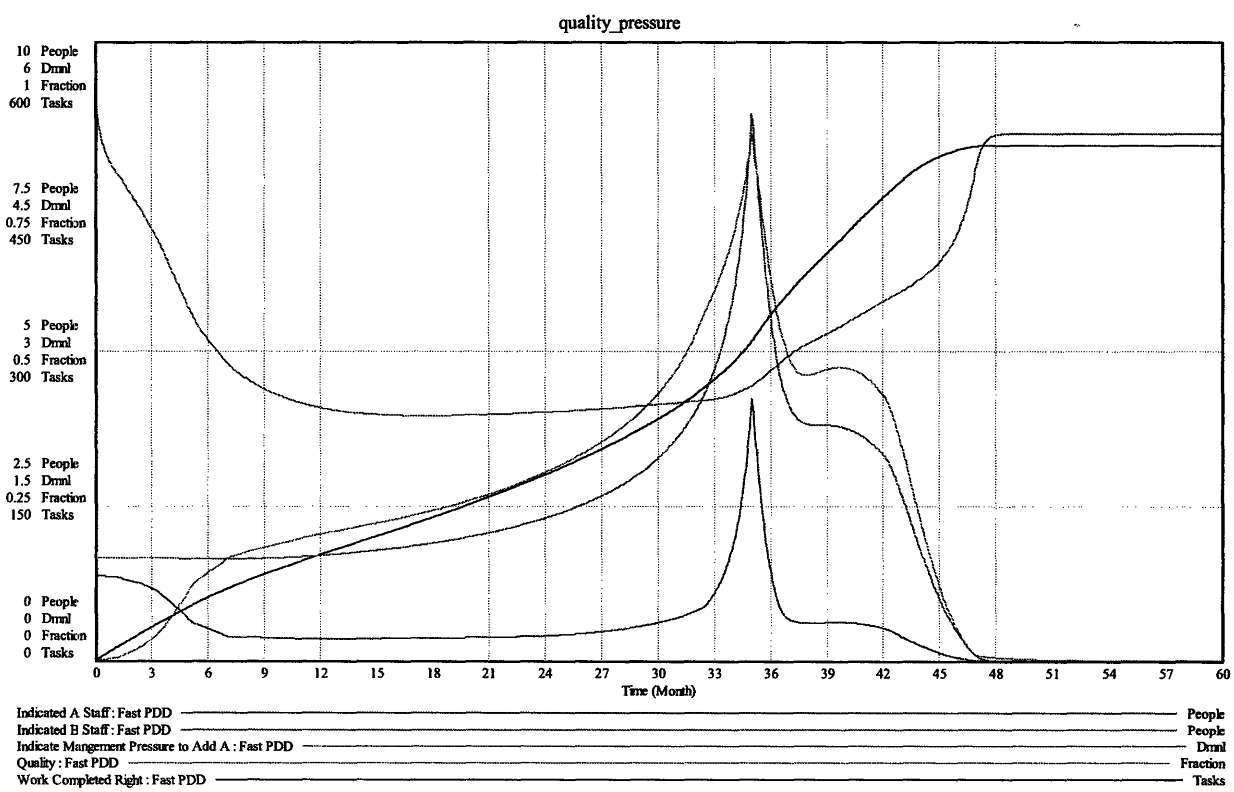
For completeness, we test the early overlap and sharp removal of the "A" team. This is equivalent to the "throw it over the fence" operation mode. Once the design is validated, just toss it over the fence with little interaction with the downstream implementation team. The following graphs are the results.






© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu






© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

In this case, the project team performs very poorly, delaying the project for an entire year. The team transition "X" is very quick and there exists a large between FRC and PFC. This behavior should be avoided at all costs.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

## PART VI Conclusion

We have modeled and studied an organizational plan, A/B Teaming Strategy, of slowly reducing strong leadership and technical ability off of existing, pipeline projects leaving the "B" team to bring home the victory! In other words, we reference the sport's analogy, the first stringers are up by forty points in the third, put in the second stringers, there in no way we can lose. Besides if it gets close at the end, we will just bring back the first stringers. Through our analysis, given pristine lab conditions, modeled "B" teams were able to execute to plan and deliver the project on schedule (see second simulation). In other words, the A/B teaming strategy to deal with conflicting corporate goals of new business development and squeezing projects for margin works as expected – assuming there are no unknown, unknowns lurking just over the horizon. Unfortunately, bad things happen, especially in high risk, high technology ventures. When these bad things happen even despite this inherently sound plan, the team's all failed to meet the schedule deadline. Even bringing in the vaunted "A" players to save the day failed to meet schedule (see third/fifth simulations).

Simulation and experimentation revealed two key drivers of "bad tidings": the role of testing and the potential for a fundamental design flaw. For the purposes of our research, a discovered design flaw is defined as a shock to the work to do and possibly revisiting work correctly completed. First the role of testing when properly executed does in fact reduce the chance of missed schedule. However, analysis reveals integration intervals in the order of four to six months are needed in order to mitigate the "B" player's lack of leadership, technical ability and foresight (see the fourth test case). Anything short than a disciplined approach built into the very fabric of processes and leadership easily results in a missed schedule.

Secondly, design validation is inherently subjective measure based on the opinions of discipline experts. Decisions based on objective, measurable data is few and far between. This is not to say design validation lacks rigor or discipline nor are the experts really experts. Rather, the information is subjective – or in our modeling terms perceived. As our analysis clearly shows, especially in the successful project team and the test results scenarios, perceived closely mirroring real fractions of complete yields successful outcomes. Without hard data to discover



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

the unknown, unknowns, schedules are at risk. Perceived data is dangerous data. Analysis of this shock of new work (or work generated from a design flaw) significantly drive a wide gap between what was perceived to be complete and what was really complete. Decision in the model reflected the real world were the perceived value is taken as gospel. As we have seen not only in simulation but in our DoD program, decisions on perceived values if done long enough without object measure will eventually lead to failure.

The following six heuristics are a result of the synthesis and simulation of both the literature review and analysis sections of this study. These six heuristics are considered equal and are presented in no particular order.

1) **Innovation Triangle is real and does exist.** Corporate strategy cannot starve portfolio projects from the critical "A" team members. Their ability to scan the horizon, see 2nd, 3rd and fourth order effects is critical. Especially attention should be given to the start of the integration period (in staged gate life cycle). Strategic Policy should consider bringing back the initial "A" team members during the initial stages. It is during this stage where most problems "magically" surface.

2) **Test Early; Test Often.** In an ideal world, if all managers had a crystal ball, they would be able to peer into the project and actually see and measure the Fraction Really Complete. Unfortunately, all managers operate on Fraction Perceived to be Complete. By reworking schedules to allow for smaller development cycles with definitive integrations and test periods, projects greatly reduce the impact of diverging Fraction Really Complete and Fraction Perceived to be Complete. Decisions are then based on accurate information and produce the intended effect. The longer testing lags, the larger the divergence, resulting in less accurate information. Decisions made on poor data seldom result in the intended effect.

3) **Quality is King!** Quality not only determines the Work Completed Right but also generated Undiscovered Rework. Undiscovered Rework are errors injected into the project because of poor quality workmanship. Errors cause rework and rework causes iteration on the same work believed to be completed. Today's managers heavily rely on Gant and Pert project



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

management tools. Unfortunately the math behind the tools do not allow for iteration – or loops. Iteration is bad. As such, by and large, the undiscovered rework is seldom recognized, let alone managed.

4) **Transitions are painful.** Analysis indicates that even transitions between similar skill level team members causes a worse before better condition. Experimentation reveals worse before better hits quality hard, causing a sharp drop of 15-20% in quality before eventually recovering. Worse, with a dramatic shift in personnel skill mix, a shift from architecture to implementation, drastic quality hits can be seen in the worse before better mechanics. Here drops of 30-40% in quality were seen during the transition time (settling time).

5) **Retain Skeleton "A" staff.** Projects should retain "skeleton "A" staff" even if only a small percentage of their work week. This will prevent knowledge erosion. Additionally, the "A" staff can impact performance with their foresight. Their internal clocks can sniff out lack or progress long before detected by collecting project metrics. In addition, the "A" staff can have a capabilities benefit. As previously discussed, the "A" player acts like a corporate gatekeeper. This can benefit the program by keeping up with the latest developments not only within the corporation but external as well.

6) **"Lost Year"!** The lost year (in our examples 6 months) is a result of early project dynamics. Good initial project success is a double edged sword. Looks great, but cuts very deep. Analysis revealed a delay caused by trying to erode this "initial success" or goodwill. This caused an added delay in the detection of the poor performance. The delay allowed the Fraction Perceived to be Complete and the Fraction Really Complete to diverge.

In conclusion, this research study challenges the A/B Teaming strategy as sound practice in mitigating poorly aligned corporate objectives. The study also provides a set of heuristics that can be used by program managers, development managers or even team leaders. Further study is required on how to best implement these concepts and to what extent each should be implemented. Finally, this effort demonstrates the power and flexibility of the System Dynamics



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

methodology. The tool was invaluable in providing insight into the rise and collapse of the complex, multimillion dollar program.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

# Appendix A: Model Equations

Product Life Cycle Adjustment=
Base Fraction of A Given Full Quality(Fraction Perceived to be Complete)
~ Dmnl
~ Manages the team transitions. Using the Base Fraction of A Given Full \
Quality (defines our key product life cycle stage gates) indexed by our \
perceived completion, make important staffing decisions.
|

Slowed Transition Base Fraction of A Given Full Quality(
[(0,0)-(1,1)],(0,1),(0.1,1),(0.293578,0.973684),(0.443425,0.903509),(0.556575,0.820175\

),(0.620795,0.692982),(0.672783,0.535088),(0.740061,0.263158),(0.819572,0.153509),(\
0.9,0.1),(1,0.1))
~ Fraction
~ Life cycle that manages team transitions
|

Fast Transition Base Fraction of A Given Full Quality(
[(0,0)-(1,1)],(0,1),(0.0336391,0.960526),(0.0672783,0.846491),(0.0917431,0.723684),(\

0.119266,0.52193),(0.146789,0.328947),(0.201835,0.188596),(0.30581,0.149123),(0.525
994\
,0.118421),(0.685015,0.114035),(0.804281,0.105263),(0.9,0.1),(1,0.1))
~ Fraction
~ |

Effect of Work Progress=
IF THEN ELSE( Use Early Table, Early Discovery Table for Effect of Work
Progress(MIN\
(1,Max(0,Fraction Really Complete))) , Table for Effect of Work
Progress(MIN(1,Max(\
0,Fraction Really Complete))) )
~ Dmnl
~ Drives the time to discover rework from its maximum value to the minimum \
value as fraction really complete increases from 0 to 1.
|

Use Early Table=
0
~ Dmnl
~ Use as a toggle to reference the needed table.
|



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

Early Discovery Table for Effect of Work Progress(
[(0,0)-
(1,1)],(0,1),(0.0183486,0.868421),(0.0397554,0.666667),(0.058104,0.416667),(0.0764526\

,0.232456),(0.107034,0.0964912),(0.204893,0.0263158),(0.431193,0),(0.611621,0),(0.76
1468\
,0),(0.883792,0),(1,0))
~ Dmnl
~ Lookup table translating work really complete into a rework discovery time
|

Pulse Shock Rate=
(Shock Impact/TIME STEP)*PULSE(Shock Time,TIME STEP)*Enable Shock
~ Tasks/Month
~ |

Enable Shock=
1
~ Dmnl
~ |

Total Work To Do=
STEP(Shock Impact, Shock Time)*Enable Shock+Initial Work To Do
~ Tasks
~ |

Fraction Perceived to be Complete=
Work Believed to be Done/Total Work To Do
~ Fraction
~ The fraction of work management believes is done correctly. This fraction \
includes undiscovered rework as well as work actually done correctly.
|

Planned Average Completion Rate=
Total Work To Do/Schedule Completion Date
~ Tasks/Month
~ What out plan originally calls for.
|

Fraction Really Complete=
Work Completed Right/Total Work To Do
~ Fraction
~ The fraction of work that is really complete in contrast to the fraction \
believed to be complete. The fraction really complete only includes work \



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

done, and not undiscovered rework.
|

Shock Impact=
100
~ Tasks
~ |

Shock Time=
24
~ Month
~ |

Work To Do= INTEG (
+Pulse Shock Rate+Rework Discovery Rate-Rework Generation Rate-Work Accomplished Rate\
,
Initial Work To Do)
~ Tasks
~ Work to do on the project includes the initial scope, plus tasks which \
include errors as these errors are discovered.
|

Feasible Work Rate=
MIN(Max Work Rate,Team Work Rate)
~ Tasks/Month
~ Potential Work Rate
|

Quality=
Normal Quality*Team Skill Level*Effect of Prior Work Quality on Quality
~ Fraction
~ The fraction of work done correctly, and therefore becomes work done.
|

A Assignment Rate=
(Indicated A Staff-A Team Members)/Time To Adjust A Staff
~ People/Month
~ Flow (+/-) based on the indicated B staff and the current team numbers. \
This is smoothed out over the time constant.
|

A Staff Average Skill=
0.95



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

~ Fraction
~ The fraction of work done correctly if all other endogenous factors are \
1.0. Normal quality reflects the fraction of work done correctly given \
the factors that are not included explicitly in the model.
|

A Staff Work Rate=
10
~ Tasks/(Month*Person)
~ Tasks completed per Month
|

A Sub Team Work Rate=
A Staff Work Rate*A Team Members
~ Tasks/Month
~ A's portion of the tasks per month.
|

A Team Members= INTEG (
A Assignment Rate,
Initial Work To Do/Schedule Completion Date/A Staff Work Rate)
~ People
~ Number of A players.
|

B Assignment Rate=
(Indicated B Staff-B Team Members)/Time To Adjust B Staff
~ People/Month
~ Flow (+/-) based on the indicated B staff and the current team numbers. \
This is smoothed out over the time constant.
|

B Staff Average Skill=
0.55
~ Fraction
~ The fraction of work done correctly if all other endogenous factors are \
1.0. Normal quality reflects the fraction of work done correctly given \
the factors that are not included explicitly in the model.
|

B Staff Work Rate=
5
~ Tasks/(Month*Person)
~ Tasks B Staff are able to complete per month



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

|

B Sub Team Work Rate=
B Team Members*B Staff Work Rate
~ Tasks/Month
~ What the B sub team members can complete with there skill level
|

B Team Members= INTEG (
B Assignment Rate,
Initial B Team Members)
~ People
~ Number of B members on the aggregate team
|

Base Fraction of A Given Full Quality(
[(0,0)-(1,1)],(0,1),(0.1,1),(0.2,0.95),(0.3,0.85),(0.406728,0.701754),(0.489297,0.45614\

),(0.571865,0.276316),(0.672783,0.140351),(0.795107,0.109649),(0.9,0.1),(1,0.1))
~ Fraction
~ Life cycle that manages team transitions
|

Current Productivity=
(Rework Generation Rate+Work Accomplished Rate)/Team Size
~ Tasks/(Month*Person)
~ Current productivity
|

Effect of Pressure(
[(0,0)-(10,4),(0,0.745614),(0.232416,0.77193),(0.422018,0.780702),(0.562691,0.807018\

),(0.727829,0.842105),(0.880734,0.921053),(1,1),(1.1315,1.2193),(1.31193,1.45614),(\

1.67584,1.72807),(1.97554,1.7807),(2.94495,1.81579)],(0,1),(0.5,1),(1.5,1),(2.59939\

,1.24561),(3.21101,1.78947),(4.12844,2.52632),(5.01529,3.10526),(6.14679,3.59649),(\
7.5841,3.77193),(8.62385,3.82456),(9.87768,3.80702))
~ Fraction
~ |

Indicated B Staff=
Indicated Total Staff-Indicated A Staff
~ People



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

~ Indicated B staff based on productivity changes (increased staff) and \
quality issues (usually reducing there numbers). The reduction means that \
the A players have taken over some of the task already being worked on or \
will be worked on.

|

Minimum Time to Finish Work=

1

~ Month

~ For planning staffing, the minimum time over which management desires to \
complete the remaining tasks. Note that this is larger than the minimum \
time required to finish any one task.

|

Indicate Mangement Pressure to Add A=

Indicated Completion Rate/Planned Average Completion Rate

~ Dmnl

~ Based on what we planned, and our current needs, we might need to make a \
staffing decision to bring on additional A resources.

|

Indicated A Staff=

Indicated Fraction of A*Indicated Total Staff

~ People

~ Indicated A staff based quality issues (increase in numbers) and product \
life cycle progress (reduction in numbers)

|

Indicated Completion Rate=

Work To Do/Time Remaining

~ Tasks/Month

~ Amount of work to be done to get the project completed

|

Indicated Fraction of A=

Product Life Cycle Adjustment*Pressure to Change Fration of A

~ Fraction

~ Indicated fraction of A based on the current quality factors.

|

Indicated Total Staff=

Indicated Completion Rate/Current Productivity

~ People

~ Total staff need to complete the project on time given the current time, \



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

productivty and initial schedule estimates

|

Initial B Team Members=

0

~ People

~ Initial equilibrium conditions.

|

Initial Work To Do=

500

~ Tasks

~ Initial amount of tasks scheduled for the project

|

Schedule Completion Date=

36

~ Month

~ Time required to initially complete the schedule

|

Pressure to Change Fration of A=

Effect of Pressure(Indicate Mangement Pressure to Add A)

~ Dmnl

~ Based on the current perceived quality, we might need to bring back \
additional A resources.

|

Team Size=

A Team Members+B Team Members

~ People

~ Current Team Size

|

Team Skill Level=

((A Staff Average Skill*A Team Members)+(B Staff Average Skill*B Team Members))/(A Team Members\
+B Team Members)

~ Fraction

~ Team Skill Level... It is a multiplication of fractions - there is a \
diluting factor.

|

Team Work Rate=



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

A Sub Team Work Rate+B Sub Team Work Rate
~ Tasks/Month
~ Total team work rate
|

Time Remaining=
Max(Minimum Time to Finish Work,Schedule Completion Date-Time)
~ Month
~ The months remaining before the project reaches the scheduled completion \
date. Once that date is reached, the model assumes that management tries \
to finish the project in a minimum time.
|

Time To Adjust A Staff=
3
~ Month
~ Time to find and add the critical A resource.
|

Time To Adjust B Staff=
0.25
~ Month
~ Time to find and allocate a resource to the team. Additional time can be \
added to include amount of time to become productive as well
|

Effect of Prior Work Quality on Quality=
Sensitivity for Effect of Quality on Quality*Table for Effect of Prior Work Quality on Quality\
(Average Work Quality)+(1-Sensitivity for Effect of Quality on Quality)
~ Dimensionless
~ This effect represents the fact that undiscovered errors in upstream work \
products tend to cause errors in current work. The effect is specified in \
the table relationship driven by average work quality to date, and can be \
reduced or increased by the sensitivity multiple.
|

Normal Quality=
1
~ Fraction
~ The fraction of work done correctly if all other endogenous factors are \
1.0. Normal quality reflects the fraction of work done correctly given \
the factors that are not included explicitly in the model.
|



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

Sensitivity for Effect of Quality on Quality=
1
~ Dimensionless
~ Increases or decreases the strength of the effect of prior quality on \
current quality specifed in the graphical relationship.
|

Table for Effect of Prior Work Quality on Quality(
[(0,0)-(1,1)],(0,0.05),(0.1,0.1),(0.2,0.2),(0.3,0.3),(0.4,0.4),(0.5,0.5),(0.6,0.6),(\
0.7,0.7),(0.8,0.8),(0.9,0.9),(1,1))
~ Dimensionless
~ |

Rework Discovery Rate=
(Undiscovered Rework/Time To Discover Rework)
~ Tasks/Month
~ The rate of discovering errors in prior work products.
|

Undiscovered Rework= INTEG (
Rework Generation Rate-Rework Discovery Rate,
0)
~ Tasks
~ Work which contains errors and will need to be redone, but the need for \
which has not yet been recognized.
|

Max Work Rate=
Work To Do/Min Time to Finish Task
~ Tasks/Month
~ The maximum rate at which work can be accomplished given available tasks \
to do.
|

Min Time to Finish Task=
0.25
~ Month
~ The average minimum time it takes to execute a task.
|

Average Work Quality=
Max(1e-006,Work Completed Right)/Max(1e-006,Work Believed to be Done)
~ Fraction



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

~ The average quality of all the "upstream" work done to date. This equals \
work done (correctly) divided by total work done (which includes \
undiscovered rework).

|

Max Time to Discover Rework=
12
~ Month
~ The time to discover rework early in the project when strictly design \
tasks are being done.

|

Work Completed Right= INTEG (
Work Accomplished Rate,
0)
~ Tasks
~ Work done correctly.

|

Time To Discover Rework=
Max Time to Discover Rework*Effect of Work Progress+(1-Effect of Work Progress)*Min Time To Discover Rework
~ Month
~ The average time between when an error is created and when it is \
discovered. This average is assumed to start at a maximum value early in \
the project, and then fall to a minimum value as the fraction of the \
project completed increases. Because this model represents the entire \
project, we assume that early activities create the design which is then \
later coded and tested (if software) or built (if hardware). Therefore, \
errors are most readily discovered when the project is in the code/test or \
build phases.

|

Work Believed to be Done=
Work Completed Right+Undiscovered Rework
~ Tasks
~ Work Believed to be done

|

Min Time To Discover Rework=
0.25
~ Month
~ The time to discover rework late in the project when building and testing \
tasks are being done.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

|

Rework Generation Rate=
(1-Quality)*Feasible Work Rate
~ Tasks/Month
~ Work being done incorrectly.
|

Table for Effect of Work Progress(
[(0,0)-(1,1)],(0,1),(0.1,1),(0.2,0.95),(0.3,0.85),(0.4,0.75),(0.5,0.6),(0.6,0.4),(0.7\
,0.25),(0.8,0.15),(0.9,0.05),(1,0))
~ Dmnl
~ Lookup table translating work really complete into a rework discovery time
|

Work Accomplished Rate=
Quality*Feasible Work Rate
~ Tasks/Month
~ Work being done correctly.
|

********************************************************
.Control
********************************************************~
Simulation Control Parameters
|

FINAL TIME = 60
~ Month
~ The final time for the simulation.
|

INITIAL TIME = 0
~ Month
~ The initial time for the simulation.
|

SAVEPER =
TIME STEP
~ Month [0,?]
~ The frequency with which output is stored.
|

TIME STEP = 0.0625



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

~ Month [0,?]
~ The time step for the simulation.
|

```
\\\---/// Sketch information - do not modify anything except names
V300  Do not put anything below this section - it will be ignored
*Team Mix
$192-192-192,0,Times New Roman|12||0-0-0|0-0-0|0-0-255|-1--1--1|-1--1--1|96,96,100,0
\\\---/// Sketch information - do not modify anything except names
V300  Do not put anything below this section - it will be ignored
*Re-Work Cycle
$192-192-192,0,Times New Roman|12||0-0-0|0-0-0|0-0-255|-1--1--1|-1--1--1|96,96,100,0
10,1,Work To Do,551,432,51,23,3,131,0,0,0,0,0,0
10,2,Work Completed Right,967,436,41,28,3,131,0,0,0,0,0,0
10,3,Undiscovered Rework,802,433,54,23,3,131,0,0,0,0,0,0
1,4,6,1,4,0,0,22,0,0,0,-1--1--1,,1|(551,555)|
1,5,6,3,100,0,0,22,0,0,0,-1--1--1,,1|(802,555)|
11,6,1276,667,555,6,8,34,131,0,0,1,0,0,0
10,7,Rework Discovery Rate,667,575,109,12,40,131,0,0,-1,0,0,0
1,8,10,3,4,0,0,22,0,0,0,-1--1--1,,1|(712,430)|
1,9,10,1,100,0,0,22,0,0,0,-1--1--1,,1|(633,430)|
11,10,620,671,430,6,8,34,3,0,0,1,0,0,0
10,11,Rework Generation Rate,671,465,35,27,40,131,0,0,-1,0,0,0
1,12,14,2,4,0,0,22,0,0,0,-1--1--1,,1|(967,260)|
1,13,14,1,100,0,0,22,0,0,0,-1--1--1,,1|(551,260)|
11,14,636,762,260,6,8,34,131,0,0,1,0,0,0
10,15,Work Accomplished Rate,762,286,94,18,40,131,0,0,-1,0,0,0
10,16,Work Believed to be Done,980,736,57,19,8,3,0,0,0,0,0,0
1,17,2,16,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(1028,575)|
1,18,3,16,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(869,611)|
10,19,Fraction Really Complete,880,538,48,19,8,3,0,0,0,0,0,0
1,20,2,19,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(950,500)|
10,21,Average Work Quality,277,708,48,19,8,3,0,0,0,0,0,0
1,22,16,21,1,0,45,0,2,64,0,-1--1--1,|12||0-0-0,1|(614,902)|
10,23,Quality,359,252,24,11,8,3,0,0,0,0,0,0
1,24,23,10,1,0,45,0,2,64,0,-1--1--1,|12||0-0-0,1|(553,343)|
1,25,23,15,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(543,278)|
10,26,Normal Quality,210,226,49,11,8,3,0,0,0,0,0,0
1,27,26,23,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(266,218)|
10,28,Time To Discover Rework,642,633,58,19,8,3,0,0,0,0,0,0
10,29,Max Time to Discover Rework,507,634,53,30,8,131,0,0,0,0,0,0
10,30,Min Time To Discover Rework,767,657,51,28,8,131,0,0,0,0,0,0
1,31,29,28,1,0,0,0,0,64,0,-1--1--1,,1|(558,660)|
1,32,30,28,1,0,0,0,0,64,0,-1--1--1,,1|(709,660)|
```



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

1,33,28,7,1,0,45,0,2,64,0,-1--1--1,|12||0-0-0,1|(631,601)|
1,34,3,6,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(752,528)|
10,35,Work Completed Right,158,661,61,19,8,2,0,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
1,36,35,21,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(212,655)|
10,37,Feasible Work Rate,684,154,63,15,8,131,0,0,0,0,0,0
10,38,Min Time to Finish Task,425,131,40,19,8,3,0,0,0,0,0,0
10,39,Max Work Rate,528,170,52,11,8,3,0,0,0,0,0,0
1,40,37,15,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(707,268)|
1,41,37,11,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(620,278)|
1,42,1,39,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(587,310)|
1,43,38,39,0,0,0,0,0,64,0,-1--1--1,,1|(474,149)|
1,44,39,37,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(614,159)|
10,45,Table for Effect of Work Progress,537,734,58,19,8,3,0,0,0,0,0,0
10,46,Effect of Work Progress,668,796,44,24,8,131,0,0,0,0,0,0
1,47,19,46,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(872,618)|
1,48,45,46,1,0,0,0,0,64,0,-1--1--1,,1|(604,784)|
1,49,46,28,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(681,703)|
10,50,Rework Generation Rate,1438,1001,41,29,8,130,1,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
10,51,Work Accomplished Rate,1213,996,49,24,8,130,1,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
1,52,21,67,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(198,459)|
10,53,Work Completed Right,1215,467,61,19,8,2,1,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
10,54,Work Accomplished Rate,426,810,50,19,8,2,1,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
10,55,Work Accomplished Rate,434,858,50,19,8,2,1,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
10,56,Work Completed Right,543,308,61,19,8,2,1,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
10,57,Work Accomplished Rate,425,814,50,19,8,2,1,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
10,58,Work Completed Right,401,818,61,19,8,2,1,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
10,59,Work Accomplished Rate,396,844,51,26,8,130,1,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
10,60,Rework Discovery Rate,1031,883,38,25,8,130,1,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
10,61,Fraction Perceived to be Complete,1157,591,69,19,8,3,0,0,0,0,0,0
1,62,16,61,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(1098,681)|
10,63,Work Accomplished Rate,1194,675,67,19,8,2,1,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

10,64,Rework Discovery Rate,1387,655,54,19,8,2,1,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
10,65,Rework Generation Rate,403,320,57,19,8,2,1,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
12,66,0,396,692,48,48,4,132,0,3,-1,0,0,0,255-0-0,0-0-0,|12||255-0-0
R: Errors Build On Errors
10,67,Effect of Prior Work Quality on Quality,204,402,66,19,8,3,0,0,0,0,0,0
10,68,Sensitivity for Effect of Quality on Quality,105,471,72,19,8,3,0,0,0,0,0,0
1,69,68,67,1,0,45,0,2,64,0,-1--1--1,|12||0-0-0,1|(145,435)|
10,70,Table for Effect of Prior Work Quality on Quality,113,300,79,19,8,3,0,0,0,0,0,0
1,71,70,67,1,0,0,0,0,64,0,-1--1--1,,1|(153,342)|
10,72,Indicated Completion Rate,1327,371,54,19,8,3,0,0,0,0,0,0
10,73,Indicated Total Staff,1119,204,48,19,8,131,0,0,0,0,0,0
1,74,72,73,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(1224,294)|
10,75,Indicated Fraction of A,1388,51,43,19,8,3,0,0,0,0,0,0
10,76,Pressure to Change Fration of A,1511,177,62,19,8,3,0,0,0,0,0,0
10,77,Effect of Pressure,1617,96,56,11,8,3,0,0,0,0,0,0
1,78,77,76,1,0,0,0,0,64,0,-1--1--1,,1|(1566,126)|
10,79,Time Remaining,1474,517,50,11,8,3,0,0,0,0,0,0
10,80,Schedule Completion Date,1625,492,55,19,8,3,0,0,0,0,0,0
1,81,80,79,1,0,0,0,0,64,0,-1--1--1,,1|(1543,537)|
10,82,Minimum Time to Finish Work,1613,648,56,19,8,3,0,0,0,0,0,0
1,83,82,79,1,0,0,0,0,64,0,-1--1--1,,1|(1515,577)|
1,84,79,72,1,0,45,0,2,64,0,-1--1--1,|12||0-0-0,1|(1379,480)|
10,85,Indicated A Staff,1266,0,54,11,8,3,0,0,0,0,0,0
10,86,Indicated B Staff,1088,-2,53,11,8,3,0,0,0,0,0,0
1,87,73,85,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(1225,95)|
1,88,85,86,1,0,45,0,2,64,0,-1--1--1,|12||0-0-0,1|(1146,-65)|
1,89,73,86,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(1084,48)|
10,90,Base Fraction of A Given Full Quality,1078,328,61,19,8,3,0,0,0,0,0,0
10,91,Product Life Cycle Adjustment,1203,442,60,19,8,3,0,0,0,0,0,0
10,92,Current Productivity,870,181,39,19,8,3,0,0,0,0,0,0
1,93,75,85,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(1346,24)|
10,94,Indicate Mangement Pressure to Add A,1434,291,65,19,8,3,0,0,0,0,0,0
10,95,Planned Average Completion Rate,1620,390,55,19,8,3,0,0,0,0,0,0
1,96,95,94,1,0,0,0,0,64,0,-1--1--1,,1|(1566,330)|
1,97,94,76,0,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(1468,239)|
1,98,92,73,1,0,45,0,2,64,0,-1--1--1,|12||0-0-0,1|(1015,203)|
12,99,0,1097,470,45,45,5,132,0,3,-1,0,0,0,255-0-0,0-0-0,|12||255-0-0
B: Team Transition
12,100,0,1384,191,45,45,4,132,0,3,-1,0,0,0,255-0-0,0-0-0,|12||255-0-0
B: Sisyphus
12,101,0,980,113,52,52,5,132,0,3,-1,0,0,0,255-0-0,0-0-0,|12||255-0-0
B: Improve Pdy



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

1,102,91,75,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(1271,206)|
1,103,72,94,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(1395,330)|
1,104,80,95,1,0,0,0,0,64,0,-1--1--1,,1|(1625,431)|
1,105,76,75,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(1464,96)|
1,106,61,91,1,0,45,0,2,64,0,-1--1--1,|12||0-0-0,1|(1187,520)|
1,107,11,92,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(818,318)|
1,108,15,92,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(777,210)|
10,109,Work To Do,1081,521,51,11,8,2,1,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
10,110,Work To Do,1318,530,51,11,8,2,0,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
1,111,110,72,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(1300,462)|
10,112,Time,1456,614,26,11,8,2,0,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
1,113,112,79,1,0,45,0,2,64,0,-1--1--1,|12||0-0-0,1|(1450,568)|
10,114,A Team Members,720,-246,40,20,3,3,0,0,0,0,0,0
10,115,B Team Members,737,-87,40,20,3,3,0,0,0,0,0,0
1,116,117,115,4,0,0,22,0,0,0,-1--1--1,,1|(835,-79)|
11,117,956,899,-79,6,8,34,131,0,0,1,0,0,0
10,118,B Assignment Rate,899,-54,58,17,40,131,0,0,-1,0,0,0
1,119,120,114,4,0,0,22,0,0,0,-1--1--1,,1|(826,-248)|
11,120,924,898,-248,6,8,34,3,0,0,1,0,0,0
10,121,A Assignment Rate,898,-221,45,19,40,131,0,0,-1,0,0,0
10,122,B Staff Average Skill,210,-265,52,19,8,3,0,0,0,0,0,0
10,123,A Staff Average Skill,131,-160,52,19,8,3,0,0,0,0,0,0
10,124,B Sub Team Work Rate,508,-46,41,19,8,3,0,0,0,0,0,0
10,125,A Sub Team Work Rate,506,-214,41,19,8,131,0,0,0,0,0,0
10,126,A Staff Work Rate,448,-290,60,11,8,3,0,0,0,0,0,0
10,127,B Staff Work Rate,530,17,59,11,8,3,0,0,0,0,0,0
1,128,127,124,1,0,0,0,0,64,0,-1--1--1,,1|(530,-8)|
1,129,115,124,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(571,-21)|
1,130,114,125,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(626,-275)|
1,131,126,125,1,0,0,0,0,64,0,-1--1--1,,1|(491,-242)|
10,132,Team Work Rate,386,-152,55,11,8,3,0,0,0,0,0,0
10,133,Team Skill Level,235,-107,53,11,8,3,0,0,0,0,0,0
1,134,124,132,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(432,-90)|
1,135,125,132,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(426,-205)|
10,136,Team Size,627,-159,34,11,8,3,0,0,0,0,0,0
1,137,115,136,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(645,-118)|
1,138,114,136,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(659,-184)|
10,139,Time To Adjust B Staff,890,-158,58,19,8,3,0,0,0,0,0,0
1,140,139,118,1,0,0,0,0,64,0,-1--1--1,,1|(884,-103)|
10,141,Time To Adjust A Staff,932,-300,50,19,8,131,0,0,0,0,0,0
10,142,Team Size,178,-13,43,11,8,2,1,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
10,143,Initial B Team Members,783,-17,45,19,8,3,0,0,0,0,0,0
1,144,115,133,1,0,45,0,2,64,0,-1--1--1,|12||0-0-0,1|(382,72)|
1,145,114,133,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(411,-354)|



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

1,146,122,133,0,0,0,0,0,64,0,-1--1--1,,1|(221,-188)|
1,147,123,133,0,0,0,0,0,64,0,-1--1--1,,1|(184,-132)|
1,148,141,121,1,0,0,0,0,64,0,-1--1--1,,1|(930,-276)|
10,149,B Staff Average Skill,1151,147,56,19,8,2,1,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
1,150,115,118,1,0,0,0,2,64,0,-1--1--1,|12||0-0-0,1|(816,-117)|
1,151,114,121,1,0,0,0,0,64,0,-1--1--1,,1|(789,-309)|
12,152,48,1006,-75,10,8,0,3,0,0,-1,0,0,0
1,153,117,152,100,0,0,22,0,0,0,-1--1--1,,1|(950,-79)|
12,154,48,1044,-244,10,8,0,3,0,0,-1,0,0,0
1,155,120,154,100,0,0,22,0,0,0,-1--1--1,,1|(969,-248)|
1,156,143,115,0,0,0,0,0,64,1,-1--1--1,,1|(764,-45)|
1,157,132,37,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(425,36)|
1,158,133,23,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(245,24)|
1,159,136,92,1,0,45,0,2,64,0,-1--1--1,|12||0-0-0,1|(689,34)|
10,160,Initial Work To Do,438,545,49,19,8,3,0,0,0,0,0,0
10,161,Initial Work To Do,960,621,54,19,8,2,1,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
10,162,Initial Work To Do,1317,668,54,19,8,2,1,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
10,163,Initial Work To Do,1688,284,54,19,8,2,1,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
1,164,86,118,0,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(1009,-23)|
1,165,85,121,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(1173,-126)|
1,166,126,114,0,0,0,0,0,64,1,-1--1--1,,1|(587,-267)|
1,167,160,114,0,0,0,0,0,64,1,-1--1--1,,1|(575,156)|
1,168,80,114,0,0,0,0,0,64,1,-1--1--1,,1|(1178,127)|
1,169,67,23,1,0,43,0,2,64,0,-1--1--1,|12||0-0-0,1|(259,303)|
10,170,Initial Work To Do,1161,926,54,19,8,130,0,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
12,171,48,344,438,10,8,0,3,0,0,-1,0,0,0
1,172,173,171,100,0,0,22,0,0,0,-1--1--1,,1|(373,437)|
11,173,48,399,437,6,8,34,3,0,0,1,0,0,0
10,174,Pulse Shock Rate,399,456,56,11,40,131,0,0,-1,0,0,0
10,175,Shock Time,387,358,39,11,8,3,0,0,0,0,0,0
10,176,Shock Impact,469,384,45,11,8,3,0,0,0,0,0,0
1,177,176,174,0,0,0,0,0,64,0,-1--1--1,,1|(438,415)|
1,178,175,174,0,0,0,0,0,64,0,-1--1--1,,1|(391,400)|
10,179,TIME STEP,302,374,50,11,8,2,0,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
1,180,179,174,0,0,0,0,0,64,0,-1--1--1,,1|(344,410)|
10,181,Enable Shock,301,517,44,11,8,3,0,0,0,0,0,0
1,182,181,174,0,0,0,0,0,64,0,-1--1--1,,1|(343,490)|
10,183,Total Work To Do,987,969,60,11,8,3,0,0,0,0,0,0
10,184,Shock Time,1083,865,48,11,8,2,0,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
10,185,Shock Impact,865,885,54,11,8,2,0,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
1,186,185,183,0,0,0,0,0,64,0,-1--1--1,,1|(919,923)|
1,187,184,183,0,0,0,0,0,64,0,-1--1--1,,1|(1039,911)|



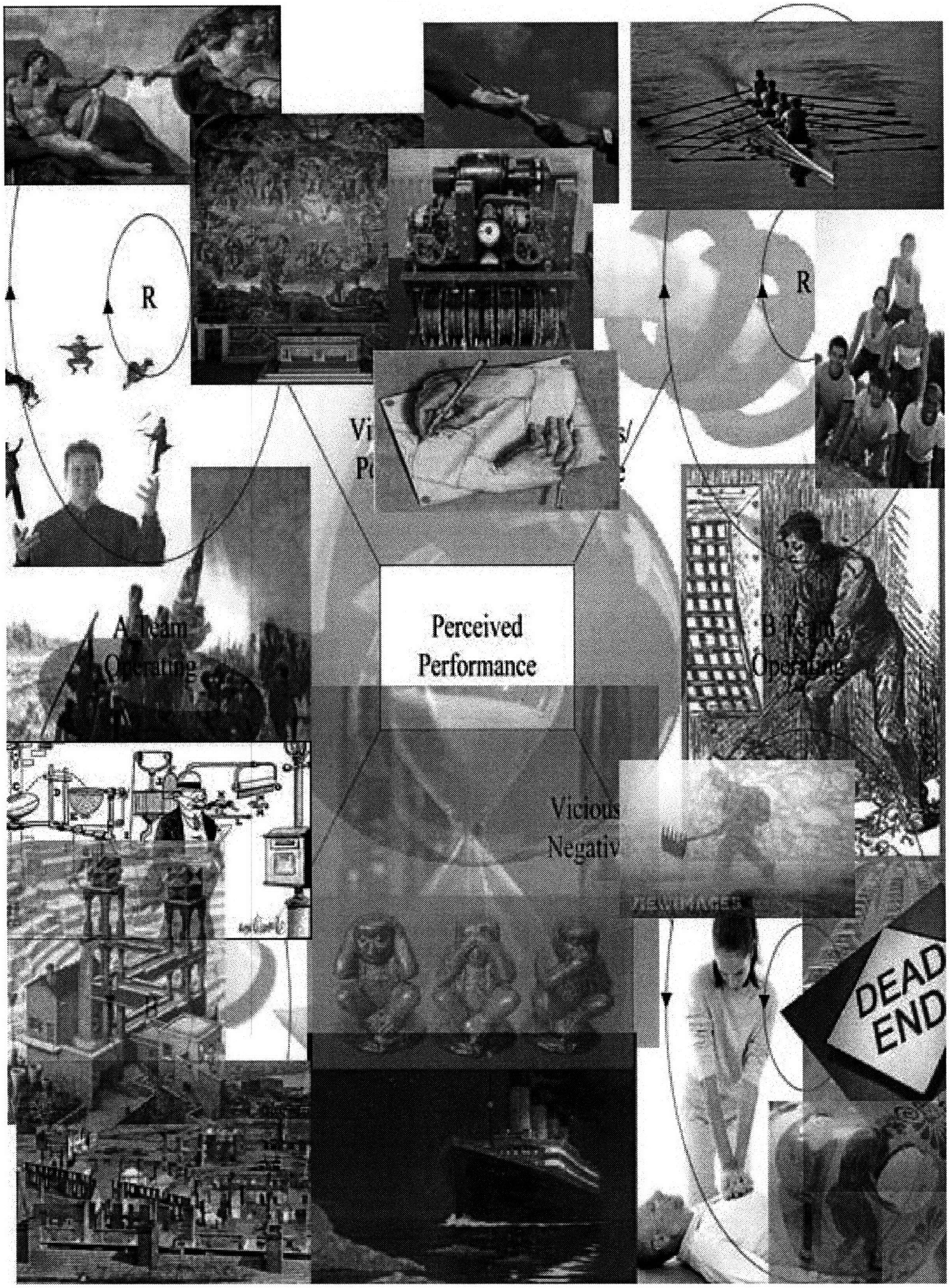
© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

10,188,Enable Shock,981,850,53,11,8,2,0,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
1,189,188,183,0,0,0,0,0,64,0,-1--1--1,,1|(983,902)|
1,190,170,183,0,0,0,0,0,64,0,-1--1--1,,1|(1075,946)|
1,191,173,1,4,0,0,22,0,0,0,-1--1--1,,1|(452,437)|
1,192,160,1,0,0,0,0,0,64,1,-1--1--1,,1|(487,495)|
10,193,Total Work To Do,966,619,54,19,8,2,0,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
1,194,193,19,1,0,0,0,0,64,0,-1--1--1,,1|(917,592)|
1,195,193,61,1,0,0,0,0,64,0,-1--1--1,,1|(1053,618)|
10,196,Total Work To Do,1862,172,54,19,8,2,0,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
10,197,Total Work To Do,1604,272,54,19,8,2,0,3,-1,0,0,0,128-128-128,0-0-0,|12||128-128-128
1,198,197,95,0,0,0,0,0,64,0,-1--1--1,,1|(1610,324)|
10,199,Early Discovery Table for Effect of Work Progress,511,821,78,32,8,131,0,0,0,0,0,0
1,200,199,46,1,0,0,0,0,64,0,-1--1--1,,1|(593,822)|
10,201,Use Early Table,685,874,51,11,8,3,0,0,0,0,0,0
1,202,201,46,1,0,0,0,0,64,0,-1--1--1,,1|(693,840)|
10,203,Fast Transition Base Fraction of A Given Full Quality,1298,668,77,28,8,3,0,0,0,0,0,0
10,204,Slowed Transition Base Fraction of A Given Full Quality,1302,757,77,28,8,3,0,0,0,0,0,0
1,205,90,91,0,0,0,0,0,64,0,-1--1--1,,1|(1134,380)|



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

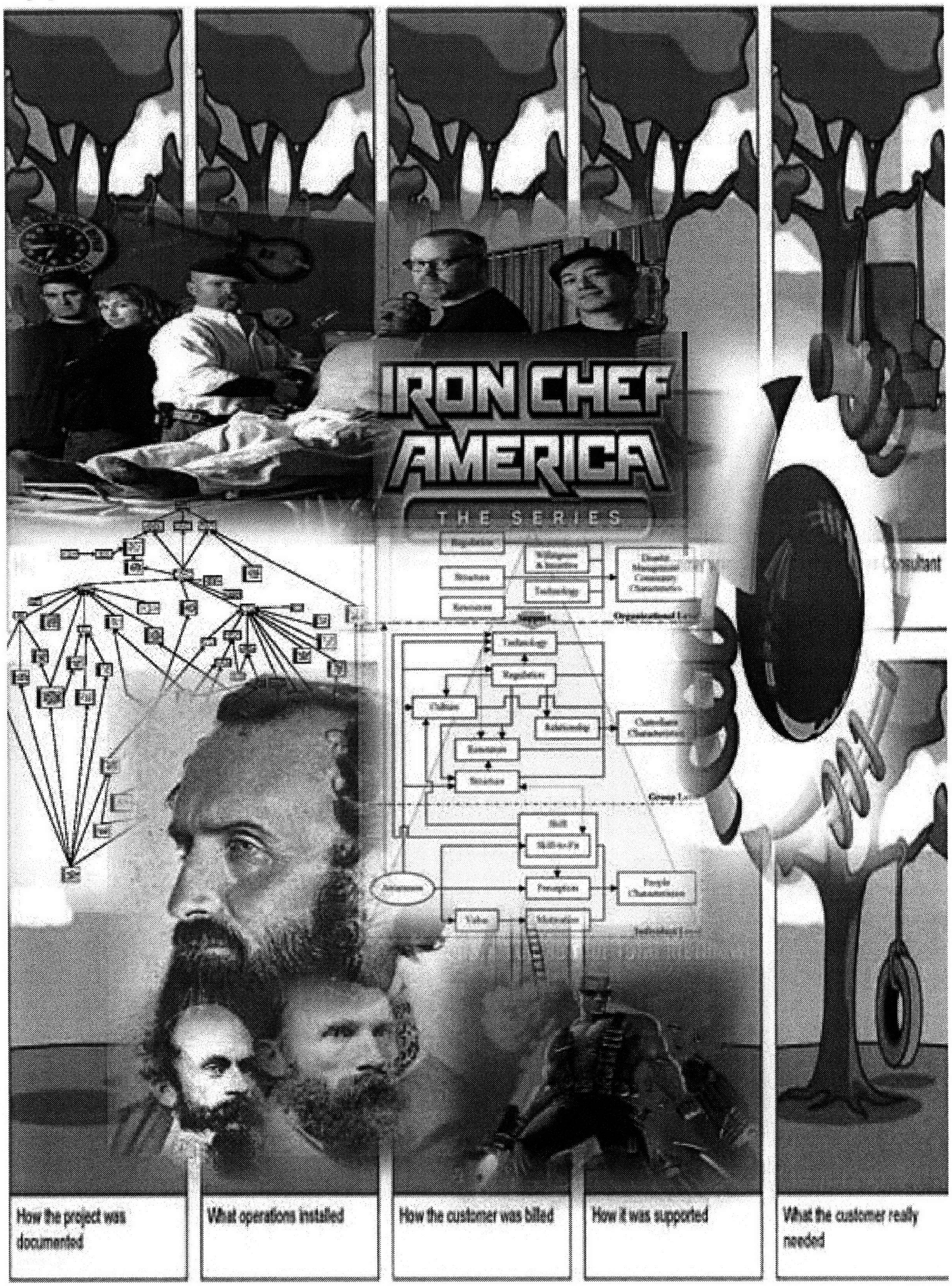
## Appendix B: Global Collage






© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

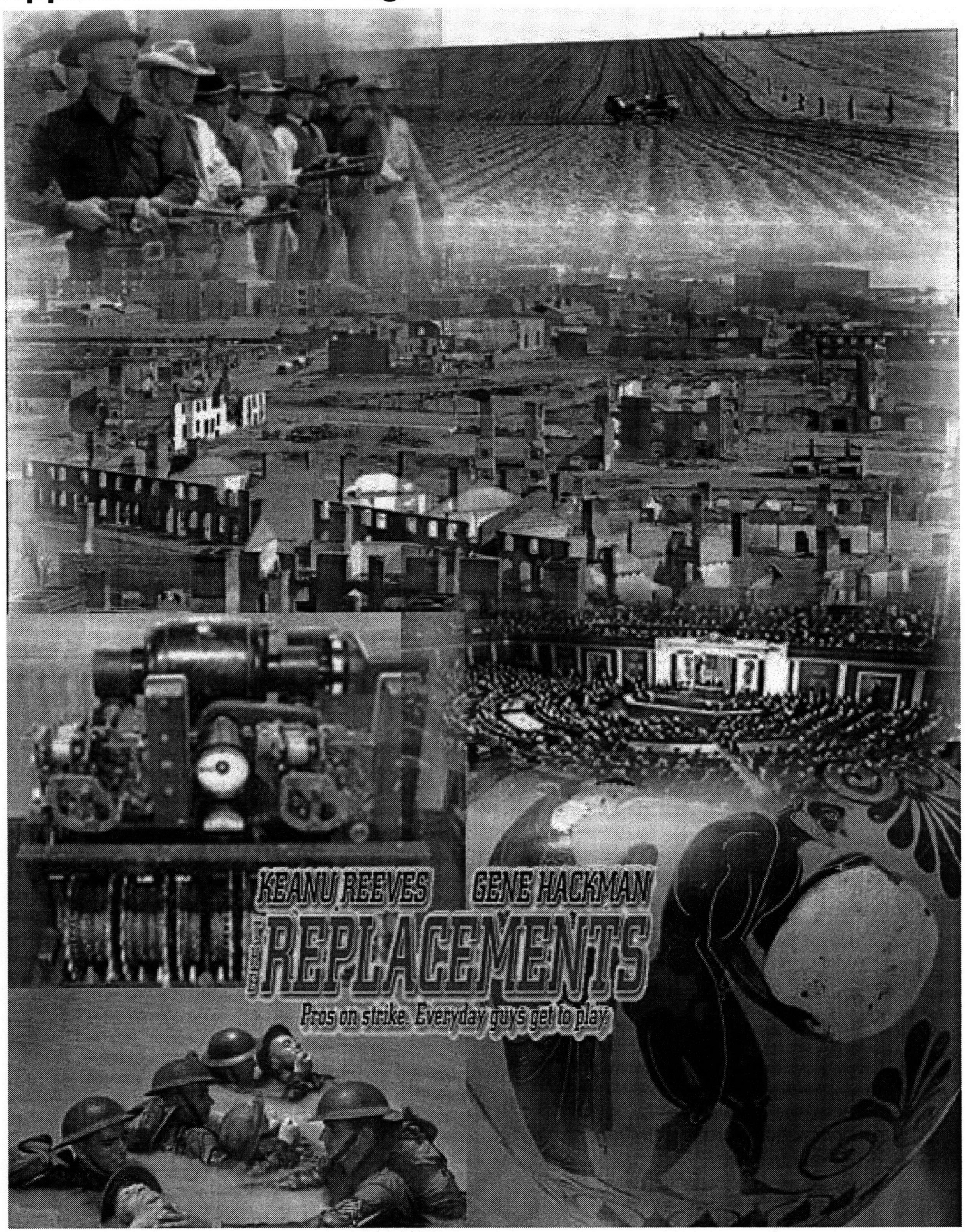
## Appendix C: Alpha Collage






© Jeffrey Manning- All Rights Reserved
jwm@sloan.mit.edu

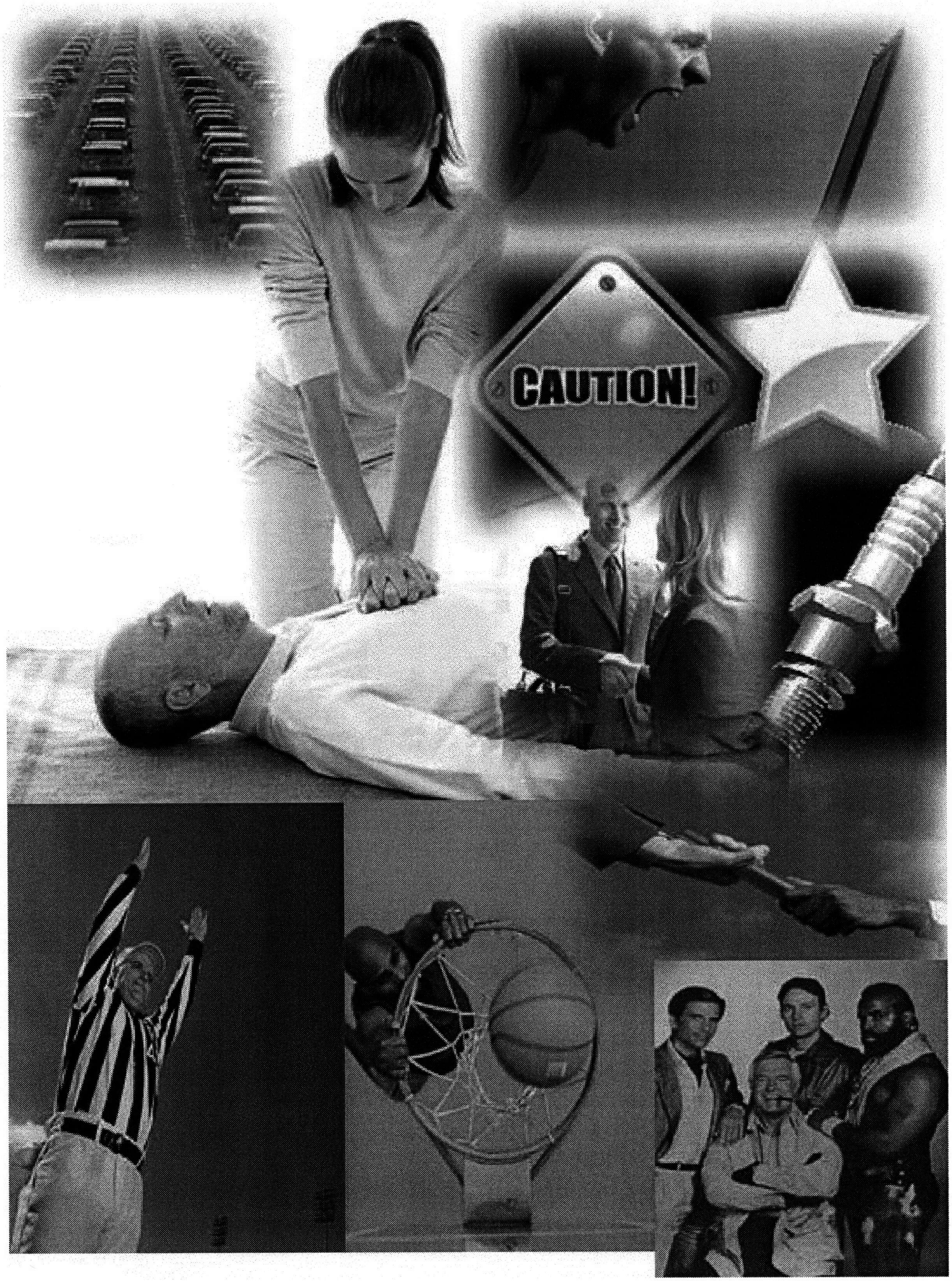
## Appendix D: Beta Collage






© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

## Appendix E: Gamma Collage






© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

# PART VII Bibliography

Abelson, L., R. Adams and S. Eslinger. "Acquisition Modeling: The Key to Managing Complex Acquisition Complexity." 3rd OSD Conference on the Acquisition of Software Intensive Systems, January 2006.

Allen, T. Managing the Flow of Information. MIT Press Cambridge Ma, 1977.

Andrew, James P. et al. "Innovation 2007: BCG Senior Management Survey." The Boston Consulting Group, August 2007.

ANSI/EIA-748-1998, Earned Value Management Systems

Barthol, R. P and R. G. Bridge. (1976), "The Echo Multi-Response Methods for Surveying Value and Influence Patterns in Groups," Psychological Reports, 22, 1345-1354.

Business Week Online. December 19, 2007. "The State of Innovation."
Business Week Online. April 24, 2006. The Worlds Most Innovative Companies.

Chandler, A. D. Strategy and Structure: Chapters in the history of American Industrial Enterprise. Cambridge, MA: MIT Press 1962.

Christensen, G and J. Olsen. (2002) "Mapping Consumers' Mental Models with ZMET", Psychology & Marketing, Vol 19(6)477-503 (June 2002)

Cooper, K.G. The Rework Cycle (a series of 3 articles): Why Projects Are Mismanaged; How It Really Works ... And Reworks and Benchmarks for the Project Manager. PMNETwork Magazine, February 1993

Cooper, K.G. and T. W. Mullen. "Swords and Plowshares: The Rework Cycles of Defense and Commercial Software Development Projects," American Programmer, May,1993.

Denzin, N. K. The Research Act: A theoretical Introduction to Sociological Methods. 3rd ed., Prentice Hall, Englewood Cliffs NJ, 1989

Devine, D. J., & Philips, J. L. (2001). Do smarter teams do better: A meta-analysis of cognitive ability and team performance." *Small Group Research, 32*, 503-528.

Eisenhardt, K. "Building Theories from Case Study Research", Academy of Management Review, 1989, Vol 14, No. 4, 532-550

Ellis, A. P. J et. al (2003). "Team Learning: Collectively connecting the dots." *Journal of Applied Psychology, 88*, 821-835.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

Faraj, S., & Sproull, L. (2000). "Coordinating expertise in software development teams." *Management Science, 46*, 1554-1568.

Farok J. Contractor and Peter Lorange eds., Cooperative Strategies in International Business. Lexington, Mass.: Lexington Books, 1984.

Freeman, J. Organizational life cycles and natural selection process. In B Staw & L. L. Cummings (Eds), Research in Organizational Behavior (Vol 4). Greenwich, CT: JAI Press, Inc. 1982

Forrester (1961) Industrial Dynamics. Cambridge Mass, The M.I.T. Press.

From the foreword to The Pogo Papers, Copyright 1952-53.

Gersick, C. "Time and transition in work teams: Toward a new model of group development." Academy of Management Journal, 1988 31, 9-41

Griffin, A. and J. Hauser. "Voice of the Customer." Marketing Science, Vol. 12, No. 1 (Winter, 1993) 1-27.

Glauser, G. G and A. L. Strauss. 1967. The discovery of grounded theory: Strategies for qualitative research. Chicago: Aldine.

Gutman, Jonathan (1982), "A means-End Chain Model Based on Consumer Categorization Processes", Journal of Marketing, 46 (Spring), 60-72

Hackman, J. Richard (2007). "What does it take to figure out what is going on?", Tech Report No. 4, Harvard University.

Heifetz, Ronald and Laurie, Donald. "The Work of Leadership", Harvard Business Review; Dec2001, Vol. 79 Issue 11, p131-141

Heifetz, R. (1994). Leadership Without Easy Answers. Belknap/Harvard, 1994

Hinings, Royston and Greenword. The Dynamics of Strategic Change. Basil Blackwell Ltd. Oxford, UK

"How Companies approach innovation: A McKinsey Global Survey"." McKinsey Quarterly. Oct. 2007

Janis, I.J. (1982). Groupthink: Psychological studies of policy decisions and fiascoes (Second ed.). Boston: Houghton Mifflin Company



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

Jaruzeleski, Barry and Kevin Dehoff. "The Customer Connection: The Global Innovation 1000." Strategy + Business, Booz, Allen, Hamilton. 12/10/07

Kidder, T. Soul of a Machine. New York: Avon

Killing, Peter J. "How to make a global joint venture work." Harvard Business review, May-June 1982, p 120-7

Krawczyk, Peter. ZMET images from the qualitative 1:1 in-depth interview

Lee, M et al. "Using ZMET to explore barriers to the adoption of 3G mobile banking services". International Journal of Retail & Distribution Management; 2003; 31 6/7, p 340-8

LePine, J. A. (2005). "Adaptation of teams in response to unforeseen change: Effects of goal difficulty and team composition in terms of cognitive ability and goal orientation." *Journal of Applied Psychology, 90*, 1153-1167.

Lyneis, James M., Cooper, Kenneth G., and Els, Sharon A., "Strategic Management of Complex Projects: A Case Study Using System Dynamics." System Dynamics Review 17(3), 237–260.

Manning, Jeff. Summary collage of qualitative research.

Merton, R. K. Social theory and social structure. New York; The Free Press, 1968.

Miles, M. and A. Huberman. Qualitative Data Analysis. Newbury Park, Ca. Sage.

Miller, D. and P Friesen. Organizations: A Quantum View. New York: Prentice Hall. 1984

Miller D. "Towards a new contingency approach: the search for organization gesalts." Journal of Mangement Studies, 18: 1-26.

Morgan, Anthony I. (1984) "Point of View: Magic Town Revisited (A Personal Perspective)," Journal of Advertising Research, 24, 4 (August/September), 49-51

Neuman, G. A., Wagner, S. H., & Christiansen, N. D. (1999). "The relationship between work team personality composition and the job performance of teams." *Group & Organization Management, 24*, 28-45.

Perlow, L., G. Okhuysen and N. Repenning. "The Speed Trap: Exploring the Relationship Between Decision Making and Temporal Conext", Academy of Management Journal, 2002, Vol 45, No. 5, 931-955

Pettyjohn, Eric. From qualitative interview.



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu

Pinfield, L. Organizations and organization theory. 1982, Marshfield, Ma.: Pitman

Ransom, S. et al. "The Structure of organizational structures." Administrative Science Quarterly, 25: 1-17. 1980

Repenning, N. et al. "Past the Tipping Point: The Persistence of Firefighting in Product Development", web.mit.edu/nelsonr/www/.

Schumpeter, J. A. The Theory of Economic Development, Cambridge, MA: Harvard University Press, 1934

Spiggle, S. "Analysis and interpretation of qualitative data in consumer research", Journal of Consumer Research, VOL 21, December 1994, pp 491-503

Spradley, James P. Ethnographic Interview. Wadsworth Publishing. 1979

Sterman, J. D. Business dynamics: Systems thinking and modeling for a complex world. Boston: Irwin/McGraw-Hill 2000

Tushman, M. and E. Romanelli (1985) "Organizational Evolution: A metamorphosis model of convergence and reorientation", in L.L. Cummings and Barry Straw (Eds), Research in Organizational Behavior, 7: 171-222. Greenwich, CT: JAI Press.

Ulrich, K. and S. Eppinger. Prodcut Design and Development. 3rd Edition. McGraw-Hill, New York, 2004

Weber, M. The protestant ethic and the spirit of capitalism. New York: Scribner, 1952

West, Dr. Harry. Guest Lecturer, MIT, Product Design and Development ESD.40, September, 2006

Yin, S. (2001) "The Power of Images", American Demographics, November 2001 p.32-3

Zaltman G. and R. Coulter. "Seeing the voice of the customer: metaphor based advertising research", Journal of Advertising Research, Vol. 35, No. 4, July/August, pp 25-51

Zaltman G. "Rethinking market research: putting people back in", Journal of Marketing Research, November, pp 424-35



© Jeffrey Manning- All Rights Reserved jwm@sloan.mit.edu