



# Structured Approaches to Managing Change

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*Change management is crucial in today's fast-moving world. Three perspectives may be of value in thinking about change management: internally driven vs. externally driven change; change directed at products and services vs. those directed at design and production; and incremental vs. revolutionary change. A number of structured approaches have been developed for thinking about the implications of change. This paper summarizes three of those approaches: Geoffrey Moore's "crossing the chasm," Robert Fichman and Chris Kemerer's "assimilation gap," and Abdelkader Daghfous and George White's "innovation analysis model."*

## Introduction

In today's world of rapid technological change, managing changes in both technologies and processes are among the foremost challenges for high-tech organizations. The emphasis in models such as the Capability Maturity Model for Software (CMM®) [1] and standards such as ISO 9001 on both process stability and continual improvement are difficult to balance.

Three perspectives may be of value in thinking about change management:

- internally driven change (push) vs. externally driven change (pull)
- change directed at products and services vs. those directed at design and production processes
- incremental vs. revolutionary change

Internally driven change comes about when an organization develops a new process or technology, in a research and development unit, for example, which is then "pushed" into use. Externally driven change occurs when an organization adopts a new technology or process that was developed elsewhere, i.e., "pulled" into use by demand. Note the focus on push or pull of technology in distinguishing between internal and external change. An alternative interpretation could be change-driven by the chief executive officer (internal driver) vs. that forced by the customer (external driver).

Product-oriented change is designed to be directly embedded in the products and services offered by the organization. An example is building software products with a graphical user interface (GUI) to broaden the market appeal of a product. Process-oriented change affects the way a product is designed or a service is provided. An example would be a usability engineering laboratory, where the effectiveness of various GUI designs are explored.

Incremental change and revolutionary change shade into one another, but the distinction can be dramatic between a *kaizen*-style<sup>1</sup> approach to gradual, cumulative improvement and business process engineering that starts over with a clean slate.

Combinations of these three perspectives are fairly common, e.g., internally driven innovation embedded in the organization's products that is intended to revolutionize the market,

such as Visicalc, or the adoption of an external technology to be incorporated into the production process as an incremental improvement, such as the Unified Modeling Language.

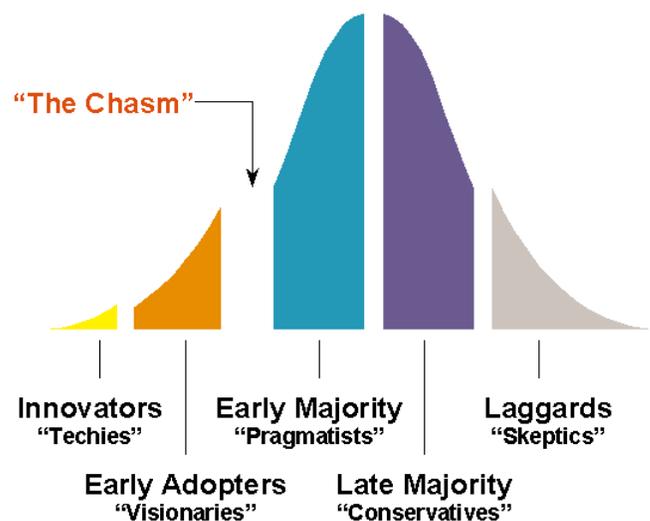
One of the challenges for a CMM writer is to determine which of these perspectives should be incorporated into the model as a determinant of organizational capability. For the Software CMM, we chose to focus on process-oriented change, regardless of source or magnitude. An executive, however, must address all of these aspects since organizational success — and survival — can be limited by failure from any of these perspectives.

It is somewhat surprising to note, therefore, that few high-tech organizations place significant emphasis on models and tools for structuring their thinking about innovation and change. An exception to this generalization is the emphasis in high-tech organizations on marketing their products to appropriate market niches. The work of Geoffrey Moore, for example, is both well-known and influential in high-tech companies.

## Moore's Crossing the Chasm

A common model for characterizing the classes of people involved with technology adoption is that they can be listed as innovators (techies), early adopters (visionaries), early majority (pragmatists), late majority (conservatives), and laggards (skeptics) (see Figure 1). Moore extends this by identifying a "chasm"

Figure 1. *Crossing the chasm between visionaries and pragmatists.*



*The Capability Maturity Model and CMM are registered in the U.S. Patent and Trademark office to Carnegie Mellon University.*

that separates early adopters and the early majority; a gap between two fundamentally separate phases in the development of a high-tech market [2]. The early phase builds from a few, highly visible, visionary customers, but transitioning to the mainstream phase, where the buying decisions fall predominantly to pragmatists, is a major challenge. The key to Moore's insight is characterizing the differences between these communities and how to proactively deal with them.

To address the chasm via organizational learning (i.e. process management) implies that the organization recognizes the existence of the chasm and the importance of addressing the needs of the early majority differently than from those of innovators and early adopters.

### Fichman and Kemerer's Assimilation Gap

Fichman and Kemerer take a slightly different perspective by examining the assimilation gap between a new technology acquired by an organization, the traditional mechanism for measuring adoption, and its actual deployment and use [3,4]. Many researchers treat the acquisition of a technology as the adoption event, yet the failure to address the actual deployment makes a critical assumption about the last stages of the standard technology adoption curve illustrated in Figure 2.

Fichman and Kemerer point out that widespread acquisition of a technology is not necessarily followed by widespread deployment and use, as shown by the assimilation gap in Figure 3. Traditionally, innovation attributes such as relative advantage, complexity, and compatibility are viewed as the determinants of the rate and level of diffusion. Fichman and Kemerer propose that acquisition and deployment have different drivers, even though they are related processes. Acquisition is driven by the expectation of future benefits owing to increasing returns, but knowledge barriers impede deployment.

To address the assimilation gap via organizational learning (or process management) implies that the organization recognizes the difference between acquiring and deploying a technology and is proactive in tracking and addressing deployment issues. This means understanding the factors influencing returns to adoption (such as network externalities, learning-by-doing,

Figure 2. The standard technology adoption S-curve.

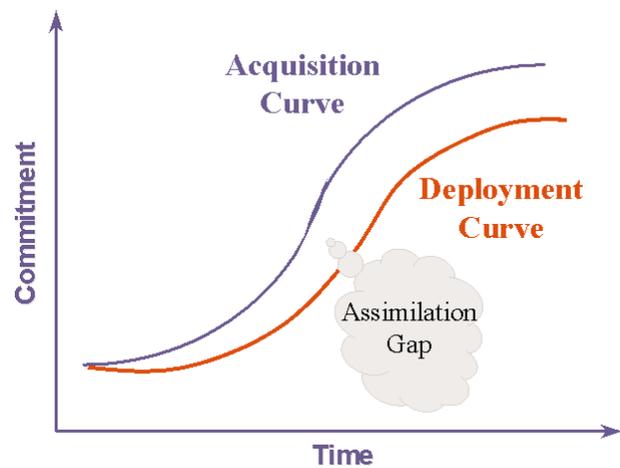
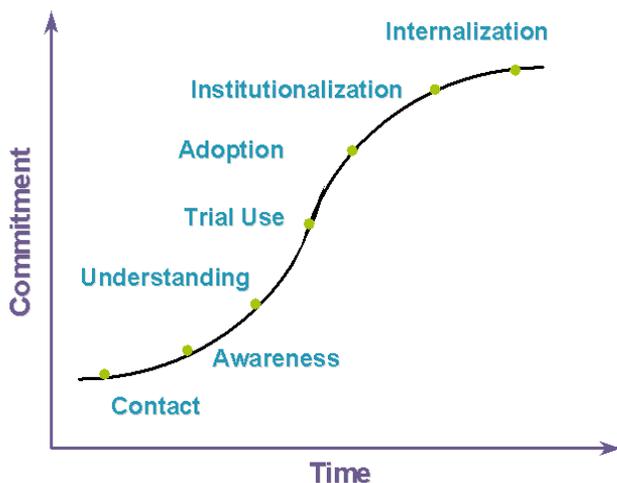


Figure 3. Fichman and Kemerer's Assimilation Gap.

and technological interrelatedness) and knowledge barriers (such as complexity and scaling).

### The Daghfous and White Innovation Analysis Model

Daghfous and White have integrated a number of time-based approaches to characterizing the process of innovation that consider product and process evolution and marketing. They add an information axis and a focus on how information interacts with the demand and supply axes. The Daghfous and White model is primarily used by companies concerned with innovation management. The Daghfous and White innovation analysis model has three dimensions — product/process, application linkage, and information [5], illustrated as an "unfolded" three-dimensional graphic in Figure 4.

The product/process axis, also known as the supply axis, is the axis along which events proceed technically, from initial invention to successful innovation. This sequence of events can be characterized as:

- **INVENTIVE ACTIVITY** — new scientific principles or new combinations of existing principles provide substantial value-added power or flexibility over previous means.
- **EMBODIMENT ACTIVITY** — combination of new invention with existing complementary technology to deliver added value towards specified product performance.
- **OPERATIONAL ACTIVITY** — functions of finance, manufacturing, distribution, and maintenance adapting their processes to the new technology as necessary or advantageous; operationally delivering and sustaining the new product in customer use.
- **MARKET EVOLUTION** — the continuing processes of customers and suppliers jointly extending the usage of the innovation as far as possible, maximizing value-added and profit, under precise knowledge of the product/processes and applications linkages involved.

The applications linkage axis, also known as the demand axis, is the axis along which those events that define markets proceed, from initial definition of concept value to successful application

TRANSILIENCE — APPLICATION LINKAGE VS. PRODUCT/PROCESS

Concept Definition			
Utility Integration			
Product Penetration			
Market Evolution	Operational Activity	Embodiment Activity	Inventive Activity



SUPPLY — INFORMATION VS. PRODUCT/PROCESS

Precise Knowledge	Operational Activity	Embodiment Activity	Inventive Activity
Likely Optimization			
Plausible Plan			
Conceivable Scheme			

DEMAND — INFORMATION VS. APPLICATION LINKAGE

Precise Knowledge	Product Penetration	Utility Integration	Concept Definition
Likely Optimization			
Plausible Plan			
Conceivable Scheme			

Figure 4. *The Daghfous and White Innovation Analysis Model.*

of the innovative product. The customer’s question is, “Why would anyone want to do that?” This sequence can be characterized as:

- **CONCEPT DEFINITION** — the concept of a prospective innovation must define value in the context of customer applications.
- **UTILITY INTEGRATION** — to incorporate the value concept of an innovation, the user has to adapt the business activities into which it is integrated to maximize its utility.
- **PRODUCT PENETRATION** — the major growth of application usage requires validation of the utility as integrated into customer use, communication to firm and trade of values obtained, escalation of use in existing applications, and extension of use to new applications.
- **MARKET EVOLUTION** — see above. This phase is common to supply and demand.

The information axis deals with the transformation of uncertainty and ignorance into precise knowledge. Uncertainty means that the information does not exist to remove variance of expectations — the opposite of uncertainty is precision. Uncertainty can only be resolved by experience, by trial-and-error. Ignorance means the information is known or accessible elsewhere, but the innovator is oblivious and thus at a competitive disadvantage. The opposite of ignorance is knowledge. Ignorance is most efficiently addressed by study and analysis prior to operations.

The information available during successive phases of an innovation can be characterized as:

- **CONCEIVABLE SCHEME** — information and analysis on a potential innovation are sufficient to show that the innovation could succeed but are insufficient to show that it should succeed.
- **PLAUSIBLE PLAN** — prospects for innovation success are qualitatively positive.
- **LIKELY OPTIMIZATION** — all accessible information and complete analysis provide positive probability for success and for maximum values added.
- **PRECISE KNOWLEDGE** — comprehensive cumulative innovation provides precise knowledge of how innovation has succeeded to date and how its evolution should continue.

Managerial decisions regarding innovation are dominated by the lack of information. Lack of information is a major inhibitor to innovation, and addressing this lack is a direct consequence of innovation — although resolving uncertainty and ignorance require different approaches. Information gathering along the product/process axis usually results in removing ignorance. Information gathering along the application linkage axis usually results in removing uncertainty. It can be assumed that once information is learned, it will not be forgotten.

The ultimate objective, or bulls-eye, for an innovation is continuing market evolution under precise knowledge, with optimum products from optimum processes satisfying optimum demand. The sequence, if not the timing, of events is predictable using the Daghfous and White model.

To manage innovations that may be adopted externally via organizational learning or process management implies that the organization recognizes the importance of the information axis and how it impacts the other axes. This means analyzing where a technology or product is on the process/product and application linkage axes.

### Conclusions

The Software CMM focuses on process-centered change, whether the change is incremental or revolutionary, internal or external. Product-oriented change is not considered within the scope of process management, although it is a fairly simple extension of the ideas in the CMM to incorporate product change management.

Considering the perspectives suggested by these and other innovation management models can lead to significant changes in models such as the CMM, which are widely influential in driving process improvement. They can also influence strategic decision-making by broadening and structuring the thinking of executives.

An objective view of the challenges that must be overcome in adopting a new technology or process can be materially aided by structuring the analysis around models such as the three summarized in this paper. Simply piloting a new technology and determining that it is likely to be beneficial is insufficient, as these models so aptly point out. ♦

## About the Author



**Mark C. Paulk** is a senior member of the technical staff at the Software Engineering Institute (SEI)<sup>2</sup>. He has been with the SEI since 1987 and initially worked on the Software Capability Evaluation project. He has worked with the Capability Maturity Model project since its inception and was the project leader during the development of version 1.1 of the CMM. He is

a contributor to the International Organization for Standardization's Software Process Improvement and Capability Determination (SPICE) project, which is developing a suite of international standards for software process assessment. Prior to his work with the SEI, Paulk was a senior systems analyst for System Development Corporation (later Unisys Defense Systems) at the Ballistic Missile Defense Advanced Research Center in Huntsville, Ala. He is a senior member of the Institute of Electrical and Electronic Engineers and a senior member of the American Society for Quality Control. Paulk has a master's degree in computer science from Vanderbilt University and a bachelor's degree in mathematics and computer science from the University of Alabama in Huntsville.

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## Notes

1. Kaizen is the Japanese word for an incremental change philosophy.
2. The SEI is a federally funded research and development center sponsored by the Department of Defense.

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