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# A Theory of Enterprise Transformation

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**ABSTRACT**

The information technology revolution has driven the pace of competition and rapid globalization. Consequently, enterprises increasingly need to consider and pursue fundamental change—transformation—to maintain or gain competitive advantage. This need raises important research issues concerning how transformation is best understood and pursued. This paper outlines a theory of enterprise transformation to guide research on these issues. The theory focuses on why and how transformation happens, as well as ways in which transformation is addressed and pursued in terms of work processes and the architecture of these processes. A variety of industry and corporate vignettes is used to illustrate the theory. A portfolio of research initiatives are discussed in terms of how they can advance the proposed theory, while also enhancing practices of enterprise transformation. © 2005 Wiley Periodicals, Inc. Syst Eng 8: 279–295, 2005

Key words: enterprise systems; enterprise transformation; strategic management; system of systems; architecture; decision making; social networks

## 1. INTRODUCTION

Enterprise transformation concerns change, not just routine change but fundamental change that substantially alters an organization's relationships with one or more key constituencies, e.g., customers, employees, suppliers, and investors. Transformation can involve new value propositions in terms of products and services, how these offerings are delivered and supported, and/or how the enterprise is organized to provide these offerings. Transformation can also involve old value propositions provided in fundamentally new ways.

Transformation can be contrasted with business process improvement. Adoption of the principles of Total Quality Management [Deming, 1986] has resulted in many enterprises focusing on their business processes and devising means to continually improve these processes. The adoption of TQM may be transformative for an enterprise. However, as judged by the definition of transformation provided here, the ongoing use of TQM subsequent to implementation is not transformative. The whole point of TQM is to make continual change a routine undertaking.

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Business Process Reengineering [Hammer and Champy, 1993] can be much more transformative. Adoption of BPR has led to much fundamental redesign of business processes. This rethinking followed the guidance "don't automate; obliterate." In this way, both the adoption and implementation of BPR tends to be transformative, although success is, by no means, guaranteed. One can then apply the principles of TQM to continually improve the reengineered business processes.

Rather than routine, transformation tends to be discontinuous, perhaps even abrupt. Change does not occur continually, yielding slow and steady improvements. Instead, substantial changes occur intermittently, hopefully yielding significantly increased returns to the enterprise. Transformation and routine change converge when, as with BPR and TQM, the transformation involves fundamental new ways of pursuing routine change.

This paper outlines a theory of enterprise transformation. The theory focuses on why and how transformation happens, as well as ways in which transformation is addressed and pursued in terms of work processes and the architecture of these processes. As later discussion elaborates, the theory argues for the following definition:

> Enterprise transformation is driven by experienced and/or anticipated value deficiencies that result in significantly redesigned and/or new work processes as determined by management's decision making abilities, limitations, and inclinations, all in the context of the social networks of management in particular and the enterprise in general.

A variety of industry and corporate vignettes are used to illustrate the elements of this theory and definition. A portfolio of research initiatives are discussed in terms of how they can advance the proposed theory, while also enhancing practices of enterprise transformation.

## 2. ROLE OF THEORY

The study and pursuit of enterprise transformation is very much a transdisciplinary endeavor. The types of initiatives discussed later in this paper involve disciplines ranging from artists and architects, to engineers of all types and economists, as well as management, public policy, and so on. The efforts of research teams pursuing these initiatives often begin with intense discussions of the fundamental basis for these pursuits.

In essence, these discussions involve two questions. First, what is the theoretical basis for our research initiatives? Second, how do the emerging results of these efforts contribute to and advance theory? Given the range of disciplines just noted, it is important to understand what is meant by "theory" in the context of our investigations of enterprise transformation.

Are we like Newton or Einstein postulating an axiomatic basis for the universe and working to derive "laws" such as $F = MA$ or $E = MC^2$? Or are we more like Darwin, combing the South Seas for evidence of our origins? For the former, we would formulate mathematical models from which we could deduce system behaviors and then compare those behaviors with observations. Eventually, we would devise theorems and proofs regarding behavioral phenomena such as response, stability, observability, and controllability in our "model worlds" [Rouse, 2003b].

For the latter, we would rely on statistical inference to gain an understanding of what affects what, and under what conditions. This choice reflects the complex nature of the world of interest, with a wide range of players, forces, and factors interacting dynamically to slowly yield long-term changes. This complexity precludes creating a model world of sufficient validity to enable reaching defensible conclusions about the real world. Thus, we must experiment in the real world.

The distinction just elaborated contrasts the role of theory in axiomatic and empirical traditions in science and engineering. However, the research initiatives of interest also include participants from art, literature, music, politics, law, and so on. This suggests that we might need to consider the role of theory in the arts and humanities vs. science and engineering [Snow, 1962; Rouse, 2003a], as well as the role of theory in legal, political, and social systems [Diesing, 1962].

These elaborations might be overwhelming were it not for the fact that the theory we need is to drive our research rather than explain or motivate change, perhaps of artistic or social nature, for instance. The theory should drive our hypotheses, determine the variables of interest, and specify potentially relevant environmental factors. Research results should confirm or reject our hypotheses, support or refute the effects of variables, and assess the relevance of environmental factors. The rules of statistical inference will govern these evaluations.

Therefore, we are very much like Darwin combing the enterprise seas to gain understanding of the origins and processes of transformation. The theory presented in this paper is intended to help us determine where to look and what to look for. Specifically, the theory helps us to recognize enterprises of potential interest and the variables of importance to identifying enterprises that have attempted transformation, how they have pursued it, and the consequences of these pursuits. Thus, our

theory fits into the empirical tradition. The possibility of an axiomatic theory depends on the relationships and patterns that our empirical studies will unearth.

## 3. CONTEXT OF TRANSFORMATION

Enterprise transformation occurs in—and is at least partially driven by—the external context of the economy and markets. As shown in Figure 1, the economy affects markets that, in turn, affect enterprises. Of course, it is not quite as crisply hierarchical as indicated in that the economy can directly affect enterprises, e.g., via regulation and taxation. The key point is that the nature and extent of transformation are context-dependent.

For public sector enterprises, the term "constituency" can replace the term "market." The financially oriented metrics shown in Figure 1 also have to be changed to reflect battles won, diseases cured, etc. This paper will occasionally draw parallels between private and public sector enterprises; however, full treatment of these parallels is beyond the scope of this paper.

There is also an internal context of transformation—the "intraprise" in Figure 1. Work assignments are pursued via work processes and yield work products, incurring costs. Values and culture [Davenport, 1999], reward and recognition systems [Flannery, Hofrichter, and Platten, 1996; Weiss and Hartle, 1997], individual and team competencies [Katzenbach and Smith, 1993], and leadership [Kouzes and Posner, 1987; George, 2003] are woven throughout the intraprise. These factors usually have strong impacts on an enterprise's inclinations and abilities to pursue transformation.

## 4. MODELING THE ENTERPRISE

Enterprise transformation occurs in the external context of Figure 1. The enterprise, with its internal strengths and weaknesses, and external opportunities and threats, operates within this broader external context. Possibilities for transformation are defined by the relationships between the enterprise and this context. The model of the enterprise as a system shown in Figure 2 provides a basis for understanding these possibilities.

Relationships among the elements of the enterprise system are as follows. Inputs affect both work processes and enterprise state. For example, input resources (e.g., people, technology, and investment) affect both how work is done and how well it is done. As another example, input market conditions (e.g., demand and competition) affect quality and pricing of products and services.

The concept of "state" is central to the theory of enterprise transformation. The state of a system is the set of variables and their values that enable assessing where the system is and projecting where it is going. We tend to think that financial statements define the state of an enterprise as a system. However, financial variables are usually insufficient to project the future of an enterprise and a deeper characterization of state is needed [Rouse, 2001]. The Balanced Scorecard [Kaplan and Norton, 1996] or, deeper yet, an enterprise-oriented version of the House of Quality [Hauser and Clausing, 1988] are two possibilities.

Output is derived from the evolving state of the enterprise. For example, revenues can be determined from the numbers of units of products or services sold and the prices of these offerings. Determining profits

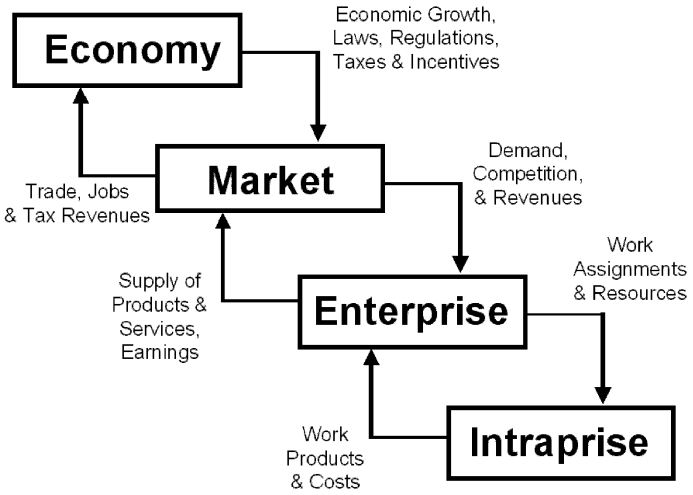


**Figure 1.** Context of enterprise transformation.

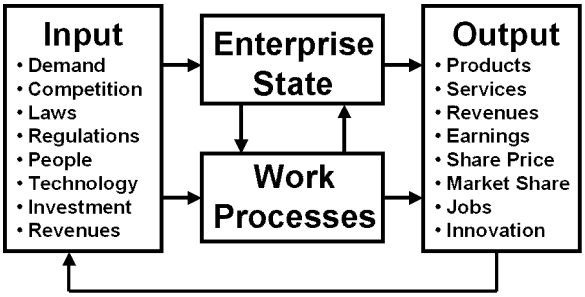


**Figure 2.** Elements of enterprise system.

requires also knowing the costs of providing offerings. Units sold relate, at least in part, to customer satisfaction as determined by product and service functionality, quality, and price, all relative to competing offerings.

The construct of "value" is central to the arguments that follow. The value of the enterprise is traditionally viewed as its market capitalization, i.e., share price times number of outstanding shares. Share price is traditionally conceptualized as the net present value of future enterprise free cash flows, i.e., revenues minus costs. This view of value is often characterized as shareholder value.

From this perspective, state variables such as revenues, costs, quality and price determine value. These variables are themselves determined by both work processes and architectural relationships among processes. Inputs such as investments of resources affect work processes. Coming full circle, the value of projected outputs influences how input resources are attracted and allocated.

Table I summarizes several examples of enterprise domains, processes, states, work, and value. It is important to note that value, for example in terms of unit prices, will depend on the competing offerings from other enterprises. Similarly, the importance of any set of military objectives secured depends on the objectives secured by adversaries. Thus, as noted earlier, knowledge of context is essential to understanding enterprises as systems.

The examples in Table I serve to illustrate the multifaceted nature of value. It could be argued that all of the facets shown in the right column are simply intermediate surrogates for shareholder value; hence, shareholder value is the central construct. On the other hand, it is very difficult to argue that shareholder value, as traditionally defined, is the sole driver of enterprise transformation. For many types of enterprises, shareholder value is the ultimate measure of success, but other forces such as markets, technologies, and the economy often drive change. Examples discussed later illustrate these forces.

Many fundamental changes address value from the perspective of customers and, to a much lesser extent, suppliers and employees. According to Peter Drucker [2001], "The purpose of a business is to create a customer." Thus, for example, while loss of market share and subsequent decreasing stock market valuation can be viewed as end effects in themselves, they also may be seen as symptoms of declining value of products and services as perceived by customers. Clearly, a broader view of value is needed [Slywotsky, 1996; Slywotsky and Morrison, 1997].

## 5. A THEORY OF ENTERPRISE TRANSFORMATION

Succinctly, experienced or expected value deficiencies drive enterprise transformation initiatives. Deficiencies are defined relative to both current enterprise states and expected states. Expectations may be based on extrapolation of past enterprise states. They may also be based on perceived opportunities to pursue expanded markets, new constituencies, technologies, etc. Thus, deficiencies may be perceived for both reactive and proactive reasons.

Transformation initiatives involve addressing what work is undertaken by the enterprise and how this work

**Table I. Example Domains, Processes, States, Work, and Value**

| Domain | Process | State | Work | Value |
|---|---|---|---|---|
| Manufacturing | Production | Work in Process | Products | Unit Price Minus Cost |
| Service | Delivery | People in Queues | Transactions | Customer Satisfaction |
| R&D | Research | Studies in Progress | Technology Options | Potential of Options |
| Military | Operations | Positions of Forces | Objectives Secured | Importance of Objectives |

is accomplished. The work of the enterprise ultimately affects the state of the enterprise, which is reflected, in part, in the enterprise's financial statements, Balanced Scorecard assessment, or the equivalent. Other important elements of the enterprise state might include market advantage, brand image, employee and customer satisfaction, and so on. In general, the state of the enterprise does not include variables internal to work processes.

This is due to the fact that we only need state estimates sufficient to enable explaining, predicting, and/or controlling future states of the system. To illustrate, the state of an aircraft is usually defined in terms of its location, speed, attitude, etc., but not the current RPM of its fuel pumps, air flow in the cabin, and electron charge of its LED displays. Similarly, the state of an enterprise does not include current locations of all salespeople, ambient temperatures in each of its factories, the water flow in the rest rooms, etc. Were we not able to define state at a higher level of aggregation and abstraction, the complexity of modeling airplanes or enterprises would be intractable.

## 5.1. Value Deficiencies Drive Transformation

More specifically, enterprise transformation is driven by perceived value deficiencies relative to needs and/or expectations due to:

- Experienced or expected downside losses of value, e.g., declining enterprise revenues and/or profits
- Experienced or expected failures to meet projected or promised upside gains of value, e.g., failures to achieve anticipated enterprise growth
- Desires to achieve new levels of value, e.g., via exploitation of market and/or technological opportunities.

In all of these cases, there are often beliefs that change will enable remediation of such value deficiencies. Change can range from business process improvement to more fundamental enterprise transformation.

## 5.2. Work Processes Enable Transformation

In general, there are three broad ways to approach value deficiencies, all of which involve consideration of the work of the enterprise:

- Improve how work is currently performed, e.g., reduce variability.
- Perform current work differently, e.g., web-enable customer service.
- Perform different work, e.g., outsource manufacturing and focus on service.

The first choice is basically business process improvement. As discussed in the Introduction, this choice is less likely to be transformative than the other two choices. The second choice often involves operational changes that can be transformative depending on the scope of changes. The third choice is most likely to result in transforming the enterprise. This depends, however, on how resources are redeployed. Liquidation, in itself, is not necessarily transformative.

The need to focus on work processes is well recognized [e.g., Hammer and Champy, 1993; Womack and Jones, 1996; Kessler, 2002]. Reengineered and lean processes have been goals in many transformative initiatives. Indeed, a focus on processes may, at least initially, require transformation of management's thinking about an enterprise. The extent to which this subsequently transforms the enterprise depends on the extent of changes and success in their implementation.

Transformation can also involve relationships among processes, not just individual work processes in and of themselves. These relationships are often framed in terms of an "architecture." It is common to express architectures in terms of multiple "views." The *operational* view is a description of the activities, operational elements, and information flows required to support enterprise operations. The *technical* view is a set of rules defining the interactions and interdependencies of system elements to assure compatibility and satisfaction of requirements. The *system* view describes the physical connections, locations, key nodes, etc., needed to support enterprise functions [Sage and Lynch, 1998].

Transformation of work processes inherently must affect the operational view of the architecture. Changes of this view are likely to affect the technical and systems views. In contrast, changes of system and/or technical views that do not change operational views do not, by definition, change work processes. Hence, these types of changes may improve processes but do not transform the enterprise.

Bailey and Barley [2004] have argued for a renaissance in the study of work. They chronicle the substantial changes in work—from production workers to knowledge workers—while industrial engineering was abandoning the study of work practices and design. In the context of the theory outlined here, engineering will have to reembrace work studies to play a central role in enterprise systems research [Rouse, 2004].

Rasmussen and his colleagues [1986, 1994] have pioneered the use of work domain analysis to charac-

terize human roles, jobs, and tasks in complex systems. Building on this foundation, we can characterize the work of the enterprise in terms of the hierarchy of purpose, objectives, functions, tasks, and activities. Transformation of work can be pursued at all levels of this hierarchy.

Changing the tasks and activities of the enterprise, by themselves, relates to business process improvement. In contrast, changing the purpose, objectives, and/or functions of the enterprise is more likely to be transformational. Such changes may, of course, cause tasks and activities to then change. Thus, change at any level in the hierarchy is likely to cause changes at lower levels.

It seems reasonable to hypothesize that the higher the level of transformation, the more difficult, costly, time-consuming, and risky the changes will be. For instance, changing the purpose of the enterprise is likely to encounter considerable difficulties, particularly if the extent of the change is substantial. In many cases, e.g., defense conversion, such change has only succeeded when almost all of the employees were replaced [Rouse, 1996].

Ultimately, one could liquidate the enterprise and redeploy its financial and perhaps physical assets in other ventures. However, it is difficult to characterize this as transformation. Thus, there is a point at which the change is sufficiently substantial to conclude that the enterprise has been eliminated rather than transformed.

## 5.3. Allocation of Attention and Resources

Input is also central to the theory of enterprise transformation. As implied by Figure 2, input includes both external variables related to customers, competitors, demand, interest rates, and so on, as well as internal variables such as resources and their allocation among work processes. Transformation involves allocating attention and resources so as to:

- Anticipate and adapt to changes of external variables, i.e., control the enterprise relative to the "road ahead" rather than the road behind.
- Cultivate and allocate resources so as to yield future enterprise states with high projected value with acceptable uncertainties and risks.

Thus, the ability of an enterprise to redeploy its human, financial, and physical resources is central to the nature and possibility of transformation.

## 5.4. Management Decision-Making

Value deficiencies and work processes define the problem of enterprise transformation—one should recognize and/or anticipate deficiencies and then redesign work processes to remediate these deficiencies. To fully understand transformation, however, we need to understand both the problem and the problem solvers. Thus, a characterization of management decision-making is central to our overall theory.

Nadler and Tushman [1989] summarize how managers address change, ranging from tuning, to adaptation, to reorientation, to re-creation. They focus on how management addresses the more complex and difficult changes of reorientation and re-creation in terms of diagnosing the problem, formulating a vision, creating a sense of urgency, linking change to core strategic issues, communicating and leading, and broadening the base of leadership, all in the context of a mixture of planning and opportunism that includes redesign of key processes and nurturing of investments as returns emerge over time.

Hollnagel's [1993] contextual control model of cognition has potential for describing how managers address the problems and decisions outlined by Nadler and Tushman. He outlines how the competence of decisions makers, combined with the characteristics of the situation (i.e., number of goals, available plans, mode of execution, and event horizon) combine to determine the chosen mode of control, ranging from scrambled, to opportunistic, to tactical, to strategic. The overarching premise is that strategic control is preferable to scrambled control.

However, Mintzberg's [1975] classic paper, as well as more recent works [Mintzberg, Ahlstrand, and Lampel, 1998; Mintzberg and Lampel, 1999], serves to shatter the myth of the manager as a coolly analytical strategist, completely focused on optimizing shareholder value using leading-edge methods and tools. Simon [1957, 1969] articulates the concept of "satisficing," whereby managers find solutions that are "good enough" rather than optimal. Another important factor is the organizational environment that can be rife with delusions that undermine strategic thinking [Rouse, 1998].

Thus, Nadler and Tushman describe the work of managers addressing transformation, and Hollnagel's model suggests how managers' respond to this work. Mintzberg and Simon's insights provide realistic views of real humans doing this work, often in an organization beset by one or more of Rouse's organizational delusions.

This somewhat skeptical view of management decision-making ignores several important aspects of hu-

man decision making. Managers' expertise and intuitions [Klein, 2002] and abilities to respond effectively in a blink [Gladwell, 2005] can be key to success, especially in recognizing what is really happening in an enterprise. The effective use of analogical thinking can also be invaluable, although there is the risk of relying on poor analogies [Gavetti and Rivkin, 2005]. This can lead to doing the wrong things very well.

Managers' roles as leaders, rather than problem solvers and decision-makers, are also central to transformation [George, 2003; Kouzes and Posner, 1987]. The leadership styles of managers who are well attuned to business process improvement may prove to be poor matches for situations requiring reorientation and recreation [Rooke and Torbert, 2005]. Thus, the nature of the problem solver can have a substantial impact.

Beyond the individual skills and abilities of managers and management teams, the "social networks" both internal and external to the enterprise can have enormous impacts [Burt, 2000, Granovetter, 2005]. An important distinction is between strongly and weakly connected networks. Strongly connected networks result in rapid and efficient information and knowledge sharing among members of these networks. Weakly connected networks have "holes," in many cases between strongly connected subnetworks.

Several researchers [Granovetter, 2005, Mohrman, Tenkasi, and Mohrman, 2003; Tenkasi and Chesmore, 2003] have found that weakly connected networks are better sources of new information and novel ideas. The resulting "big picture" perspective may better inform the nature of transformations pursued. In contrast, strongly connected networks are better at implementing change, at least once sense has been made of the anticipated changes and new meaning has been attached to these changes.

Summarizing, the problem of transformation (i.e., value deficiencies prompting redesign of processes) combines with the nature of the problem solvers addressing transformation, as well as their organizations, to determine whether transformation is addressed, how it is addressed, and how well desired outcomes are achieved. Several theories of human problem solving and decision-making, as well as theories of social phenomena, are relevant and useful for elaborating these aspects of the theory of enterprise transformation. The key point is that explanations of any particular instance of transformation will depend on the situation faced by the enterprise, the nature of the particular managers leading the enterprise, and the social structure of the enterprise.

## 5.5. Transformation Processes

How does transformation happen? Transformation processes could be external to the model in Figure 2. However, it would seem that higher levels of transformation expertise would involve incorporation of transformation processes into the work processes in Figure 2. This possibility has been characterized in terms of constructs such as double-loop learning and organizational learning [Argyris and Schon, 1978; Senge, 1990].

Thus, transformation might become integral to normal business practices, perhaps even routine. Of course, this raises the question of the extent to which routine fundamental changes should be considered transformative. It is quite possible that such an evolution of an enterprise would not render changes less fundamental, but would enable much easier implementation of changes.

## 5.6. Summary of Theory

Figure 3 summarizes the theory of transformation outlined in this paper. Transformation is driven by value deficiencies and involves examining and changing work processes. This examination involves consideration of how changes are likely to affect future states of the enterprise. Potential impacts on enterprise states are assessed in terms of value consequences. Projected consequences can, and should, influence how investments of attention and resources are allocated. The problem solving and decision-making abilities of management, as well as the social context, influence how and how well all of this happens.

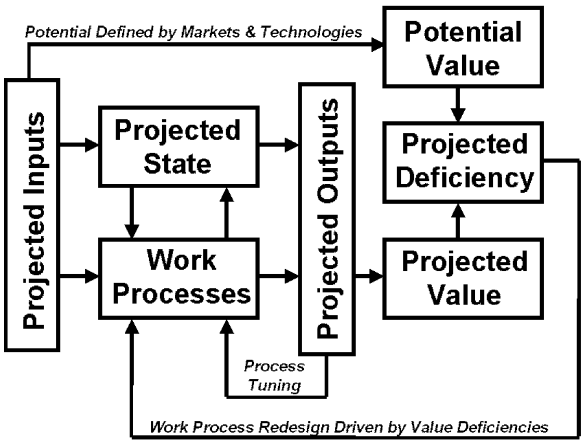


**Figure 3.** Theory of enterprise transformation.

## 6. ENDS, MEANS AND SCOPE OF TRANSFORMATION

As indicated in an earlier paper [Rouse, 2005], there is a wide range of ways to pursue transformation. Figure 4 summarizes conclusions drawn from numerous case studies. The ends of transformation can range from greater cost efficiencies, to enhanced market perceptions, to new product and service offerings, to fundamental changes of markets. The means can range from upgrading people's skills, to redesigning business practices, to significant infusions of technology, to fundamental changes of strategy. The scope of transformation can range from work activities, to business functions, to overall organizations, to the enterprise as a whole.

The framework in Figure 4 has provided a useful categorization of a broad range of case studies of enterprise transformation. Considering transformation of markets, Amazon leveraged IT to redefine book buying, while Wal-Mart leveraged IT to redefine the retail industry. In these two instances at least, it can be argued that Amazon and Wal-Mart just grew; they did not transform. Nevertheless, their markets were transformed. The U.S. Department of Defense's effort to move to capabilities-based acquisition (e.g., buying airlift rather than airplanes) has the potential to transform both DoD and its suppliers.

Illustrations of transformation of offerings include UPS moving from being a package delivery company to a global supply chain management provider, IBM's transition from manufacturing to services, Motorola moving from battery eliminators to radios to cell phones, and CNN redefining news delivery. Examples of transformation of perceptions include Dell repositioning computer buying, Starbucks repositioning coffee purchases, and Victoria's Secret repositioning lingerie buying. The many instances of transforming business operations include Lockheed Martin merging three aircraft companies, Newell Rubbermaid resuscitating numerous home products companies, and Interface adopting green business practices.

The costs and risks of transformation increase as the endeavor moves farther from the center in Figure 4. Initiatives focused on the center (in green) will typically involve well-known and mature methods and tools from industrial engineering and operations management. In contrast, initiatives towards the perimeter (in red) will often require substantial changes of products, services, channels, etc., as well as associated large investments.

It is important to note that successful transformations in the outer band of Figure 4 are likely to require significant investments in the inner bands also. In general, any level of transformation requires consideration of all subordinate levels. Thus, for example, successfully changing the market's perceptions of an enterprise's offerings is likely to also require enhanced operational excellence to underpin the new image being sought. As another illustration, significant changes of strategies often require new processes for decision making, e.g., for R&D investments.

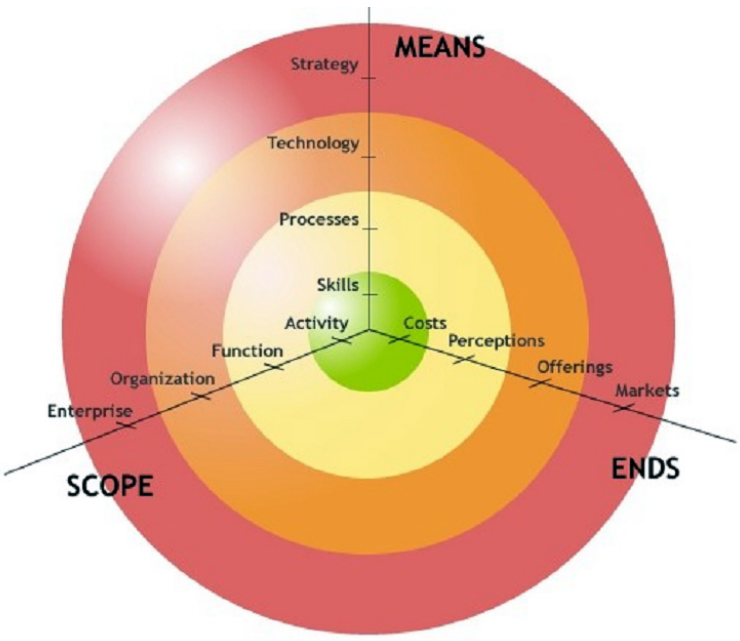


**Figure 4.** Transformation framework. [Color figure can be viewed in the online issue, which is available at www.interscience.wiley.com.]

### 6.1. Value Deficiencies Drive Transformation

Elaborating earlier value-centered arguments, there are basically four alternative perspectives that tend to drive needs for transformation:

- *Value Opportunities:* The lure of greater success via market and/or technology opportunities prompts transformation initiatives.
- *Value Threats:* The danger of anticipated failure due to market and/or technology threats prompts transformation initiatives.
- *Value Competition:* Other players' transformation initiatives prompt recognition that transformation is necessary to continued success.
- *Value Crises:* Steadily declining market performance, cash flow problems, etc., prompt recognition that transformation is necessary to survive.

The perspectives driven by external opportunities and threats often allow pursuing transformation long before it is forced on management, increasing the chances of having resources to invest in these pursuits, leveraging internal strengths and mitigating internal weaknesses. In contrast, the perspectives driven by external competitors' initiatives and internally-caused crises typically lead to the need for transformation being recognized much later and, consequently, often forced on management by corporate parents, equity markets, or other investors. Such reactive perspectives on transformation often lead to failures.

### 6.2. Work Processes Enable Transformation

Transformation initiatives driven by external opportunities and threats tend to adopt strategy-oriented approaches such as:

- Markets Targeted, e.g., pursuing global markets such as emerging markets, or pursuing vertical markets such as aerospace and defense
- Market Channels Employed, e.g., adding Web-based sales of products and services such as automobiles, consumer electronics, and computers
- Value Proposition, e.g., moving from selling unbundled products and services to providing integrated solutions for information technology management
- Offerings Provided, e.g., changing the products and services provided, perhaps by private labeling of outsourced products and focusing on support services.

On the other hand, transformation initiatives driven by competitors' initiatives and internal crises tend to adopt operations-oriented approaches including:

- Supply Chain Restructuring, e.g., simplifying supply chains, negotiating just-in-time relationships, developing collaborative information systems
- Outsourcing & Offshoring, e.g., contracting out manufacturing, information technology support; employing low-wage, high-skill labor from other countries
- Process Standardization, e.g., enterprise-wide standardization of processes for product and process development, R&D, finance, personnel, etc.
- Process Reengineering, e.g., identification, design, and deployment of value-driven processes; identification and elimination of non-value-creating activities
- Web-Enabled Processes, e.g., online, self-support systems for customer relationship management, inventory management, etc.

It is essential to note, however, that no significant transformation initiative can rely solely on either of these sets of approaches. Strategy-oriented initiatives must eventually pay serious attention to operations. Similarly, operations-oriented initiatives must at least validate existing strategies or run the risk of becoming very good at something they should not be doing at all.

The above approaches drive reconsideration of work processes. Processes are replaced or redesigned to align with strategy choices. Operational approaches enhance the effectiveness and efficiency of processes. Of course, the possibilities of changing work processes depend greatly on the internal context of transformation. Leadership is the key, but rewards and recognition, competencies, and so on also have strong impacts on success. Social networks enormously affect implementation of change.

Work processes can be enhanced (by acceleration, task improvement, and output improvement); streamlined (by elimination of tasks); eliminated (by outsourcing); and invented (by creation of new processes). An example of acceleration is the use of workflow technology to automate information flow between process steps or tasks. An illustration of task improvement is the use of decision aiding technology to improve human performance on a given process task (e.g., enabling consideration of more options). Output improvement might involve, for example, decreasing process variability. Streamlining could involve transferring tasks to others (e.g., transferring customer service queries to other customers who have addressed similar questions).

Elimination involves curtailing processes; e.g., Amazon created online bookstores, thus eliminating the need for bookstore-related processes in their business. Invention involves creating new processes; e.g., Dell created innovative build-to-order processes.

## 7. ILLUSTRATIONS OF TRANSFORMATION

Enterprise transformation is, by no means, a new phenomenon. The longbow transformed war—as weapon technology often has—when the English decimated the French at Agincourt in 1415. The printing press in 1453 led to the "pamphlet wars" and Martin Luther's complaints in 1517 that seeded the transformation known as the Protestant Reformation. History is laced with many stories like this.

This section briefly reviews transformative developments and events in the transportation and computer industries, drawing on a longer work on these industries [Rouse, 1996]. Attention then shifts to a range of contemporary stories of change in the telecommunications, retail, entertainment, information, and computing industries. These stories illustrate the range of ongoing transformation throughout the global economy.

### 7.1. Transportation

Before the early 1800s, the dominant forms of transportation—horse, stagecoach, sailing ship, and so on—had not changed substantially in centuries. Then, within roughly 100 years, we had steamboats, railroads, automobiles, and aircraft. In the process of moving from stagecoaches and canal boats to jet planes, humankind changed the speed at which it traveled by a factor of 100. Trips that once took days, now take minutes.

Robert Fulton is traditionally credited with the invention of the steamboat. He was fortunate, however, to be able to build on a variety of earlier efforts. For example, several steamboats were demonstrated following James Watt's improvements of the steam engine in 1769. Nevertheless, with Fulton's demonstration in 1807, the steamboat industry blossomed. By 1819, a steamboat had sailed from Savannah, Georgia to Russia. The first all-steam crossing, without the use of supporting sails, occurred in 1827. By the mid 1800s, transatlantic steamboat lines were competing.

The first reported self-propelled steam land vehicle was in the late 1600s and, by the late 1700s, a French-built steam car had been demonstrated in Paris. Soon after, an English built car was demonstrated. John Blenkinsop built the first practical and successful locomotive in Britain in 1812. The beginning of the railway industry is usually reported as starting with George Stephenson who created the Stockton and Darlington Railway in Britain that opened in September 1825. Soon after, it is argued, the railway era really began with the opening of Liverpool and Manchester Railway in Britain in September 1830. By the 1850s, the railroad's effects on the American economy were pervasive. Uniform methods of construction, grading, and bridging emerged. Much of the design of rails, locomotives, coaches, and freight cars was close to what we have today, at least in terms of appearance.

Frenchman Nicolas-Joseph Cugnot designed the first true automobile in 1769. This automobile was a steam-powered tricycle and was capable of 2.25 mph for 20 minutes. Germans Carl Benz and Gottlieb Daimler are credited with the first gasoline-engine automobile in 1885. In the U.S., George Selden filed a patent for the automobile in 1879. Charles and Frank Duryea created an American gas-powered automobile in 1892–1893. By 1898, there were 50 automobile companies. Between 1904 and 1908, 241 automobile companies went into business. Interestingly, steam propulsion retained a dominant position for quite some time—at the turn of the century, 40% of U.S. automobiles were powered by steam, 38% by electricity, and 22% by gasoline.

Serious speculation about flight occupied such thinkers as Roger Bacon in the 13th century and Leonardo da Vinci in the 15th century. After a wealth of attempts over several centuries, Orville Wright, in 1903, flew for 12 seconds and landed without damage. In 1914 the Census Bureau listed 16 firms as aircraft manufacturers with combined total output for the year of 49 planes. By 1918, the American aircraft industry was delivering 14,000 aircraft with 175,000 employees. However, after the signing of the World War I armistice, production dropped to 263 in 1922.

Commercial aviation eventually diminished the dominance of military customers in the aircraft market. Until the late 1950s, over half of the commercial aircraft in the world were built by Douglas Aircraft, having continually built upon the success of the DC-3. However, Boeing quickly moved into jet aircraft, mostly due to military contracts. Using the military KC-135 as a starting point, Boeing introduced the 707 commercial transport in 1958. Douglas was much slower to shift paradigms. Boeing's "bet" on jet aircraft provided the basis for its strong position in commercial aviation today.

The patterns of transformation just outlined for steamboats, trains, automobiles, and airplanes are closely linked to propulsion—steam, internal combustion, and jet engines. Combined with inventions in mechanical systems, aeronautics, and manufacturing—including many, many inventions that never gained broad acceptance—these patterns moved us faster and

higher, both literally and economically. In the process, many enterprises were formed, and a few transformed successfully to created the companies we know today.

## 7.2. Computing

The evolution of computer technology and the computer industry took hundreds of years. Frenchman Blaise Pascal built the first mechanical adding machine more than 300 years ago. German Gottfried Wilhelm Liebniz, after seeing Pascal's machine, created the Stepped Reckoner in 1673. Charles Babbage conceived the first digital computer in the 1830s. He envisioned this computer—the Analytical Engine—as powered by steam that, as noted in the last section, was "high tech" in the 1830s.

Babbage got his idea for a digital computer from Frenchman Joseph-Marie Jacquard's punch-card programmed looms, developed in the early 1800s. Jacquard's punched card method for controlling looms also influenced American Herman Hollerith, who invented a card-based system for tabulating the results of the 1890 census. Hollerith's venture led to what would later become IBM.

During the latter half of the 19th century and first half of the 20th century, IBM, NCR, Burroughs, Remington Rand, and other companies became dominant in the business equipment industry with tabulators (IBM), cash registers (NCR), calculators (Burroughs), and typewriters (Remington). The dominance of these companies in their respective domains set the stage for their becoming primary players in the computer market.

The emergence of digital computing and the process of maturation of the computer industry started with John V. Atansoff of Iowa State who built a prototype of an electromechanical digital computer in 1939. By 1946, John W. Mauchly and J. Presper Eckert at the University of Pennsylvania had completed the Electronic Numerical Integrator and Calculator, ENIAC, which was the first all-purpose, all-electronic digital computer and led to Remington-Rand's UNIVAC. In the same period, John von Neumann's concepts of stored-program computing served as the model for many digital computers.

Remington-Rand had some early success, including selling UNIVAC machines to the Census Bureau, which displaced IBM tabulators. However, IBM eventually beat out Remington-Rand because IBM recognized the tremendous potential of computers and how they had to be marketed. IBM recognized what was likely to happen in the business machines industry and responded by developing a customer-oriented strategy that helped their customers to deal successfully with trends that were affecting them.

In the late 1950s and early 1960s, a whole new segment of the computer market emerged—interactive rather than centralized computing. IBM dismissed and then ignored this segment. They apparently could not imagine that customers would want to do their own computing rather than have IBM support and possibly staff a centralized computing function. Later IBM tried to catch up, but did so poorly. By the late 1960s, Digital Equipment Corporation (DEC) dominated interactive computing with their minicomputers.

By the late 1970s, Apple was putting the finishing touches on the first microcomputer that would spark a new industry. DEC, in a classic business oversight, failed to take interactive computing to the next logical step of personal computing. Apple, exploiting pioneering inventions at Xerox, created the Macintosh in the mid 1980s. The Mac became the industry standard, at least in the sense that its features and benefits were adopted throughout the personal computer industry. Microsoft and Intel were the primary beneficiaries of this innovation.

Microsoft prospered when IBM chose them to create the operating system software—DOS—for IBM's personal computer. DOS soon became the industry standard, except for Apple enthusiasts. Microsoft Windows replaced DOS as the standard. With the introduction of Windows, Microsoft was able to create software applications for word processing, spreadsheets, presentations, and databases and now controls these markets.

More recently, of course, the Internet has dominated attention. Microsoft continues to battle with a range of competitors, hoping to transform a variety of inventions into dominant market innovations. The rules of the game have changed substantially as this industry has moved from mainframe to mini to micro and now Internet. Most inventions will not become innovations, but certainly a few will.

The patterns of transformation in computing revolve around power and speed. More and more computing operations, faster and faster, differentiate the mainframe, mini, and micro eras. Increasing user control has also been an element of these patterns, although this has resulted with increasing numbers of layers between users and computation. Further, it has been argued that pervasive networking is only possible with increased centralized management of standards, protocols, etc. Thus, the latest pattern of transformation may inherently borrow from old patterns.

## 7.3. Contemporary Illustrations

We have just skimmed through two centuries of innovations in transportation and computing—and the formation (and demise) of thousands of enterprises as

these industries transformed. Now, let us consider what has happened in the opening few years of this century. A summary of these vignettes is provided in Table II.

The telecommunications industry has recently provided several compelling stories of transformation, particularly failures to transform. Perhaps the biggest story is AT&T. The company underestimated the opportunities in wireless and then overpaid for McCaw Cellular to catch up and later spun the cellular business off. They attempted to get into computers via NCR and then spun it off. They overpaid for TCI and MediaOne and then spun them off. They also spun off Lucent. They came late to the Internet data market. All of this created a debt crisis. With reduced market cap, AT&T was acquired by SBC, a former Baby Bell [Economist, 2005a].

Lucent, AT&T's progeny, has not fared much better. Adopting a "high tech" image when spun off in 2000, Lucent abandoned the traditional Baby Bell customers for Internet startups who bought on credit. Lucent overdid mergers and overpaid. They delayed developments of optical systems. Of greatest impact, they inflated sales to meet market expectations. When the Internet

**Table II. Contemporary Illustrations of Transformation**

| Company | Transformation | Outcome |
|---|---|---|
| AT&T | Came late to wireless, computers, and cellular, paying too much to enter. | Facing a debt crisis and reduced market cap, AT&T was acquired by SBC. |
| Clear Channel | Clear Channel executed a long series of acquisitions, accelerated by the 1996 deregulation. | Cost leadership, combined with bundled selling resulted in their revenues growing over 50%. |
| IBM | Transformed from mainframe maker to robust provider of integrated hardware, networking, and software solutions. | Earnings and share price rebounded as services business flourished. |
| Kellogg | Remained committed to its brand strategy but focused on channel needs for consumers' changing concept of breakfast. | Acquired Keebler, resulting in revenue growth of almost 50 % and operating income nearly doubling in 5 year period. |
| Lucent | Adopting "high tech" image, abandoned Baby Bells, overdid mergers, delayed developments of optical systems, and inflated sales. | When Internet bubble burst and customers could not repay loans, $250 billion market cap in 1999 shrunk to $17 billion by 2005. |
| Newell Rubbermaid | With a track record of successfully acquiring over 60 companies, acquisition of Rubbermaid seemed like a natural match. | Acquisition dragged Newell down, losing 50% of the value of the investment. Brand strategy of Rubbermaid did not match Newell. |
| Nokia | New cell phone designs introduced to combat loss of market share. | Market share rebound, but likely temporary due to aggressive competitors. |
| Proctor & Gamble | Acquisition of Gillette, Clairol and Wella while selling off numerous brands. | Outcome uncertain as the "consumer goods industry is caught between slowing sales, rising costs, and waning pricing power." |
| Siemens | Focused on cost reduction, innovation, growth, and culture change, in part by convincing people that there was a crisis. | Revenue almost doubled, net income more than tripled, and revenue per employee almost doubled over 12 years. |
| Thomson | Transformed itself from a traditional conglomerate into a focused provider of integrated electronic information to specialty markets. | They sold more than 60 companies and 130 newspapers, and then acquired 200 businesses becoming a leader in electronic databases. |

bubble burst and customers could not repay loans, Lucent's $250 billion market cap in 1999 quickly shrunk by more than 90% [Lowenstein, 2005].

While AT&T and Lucent were stumbling, Nokia was a star of the telecommunications industry. However, by 2003, Nokia was losing market share (35% to 29%) due to stodgy designs of cellphones, unwillingness to adapt to cellular providers, and internal preoccupation with reorganization. They reacted with new phone designs (e.g., cameras, games, and a velvet cell phone!) and market share rebounded. Nevertheless, the company is being pushed down market to maintain growth in an increasingly competitive market. One expert projects they will end up with something like a 22% market share, with Asian competitors the main beneficiaries [Economist, 2005c].

The retail industry has been highly competitive for several decades. Proctor & Gamble has been one of the stalwarts of this industry. They have maintained their competitive position by boosting innovation, ditching losing brands, buying winning ones, and stripping away bureaucracy. However, the consumer goods industry has found itself caught between slowing sales, rising costs, and waning pricing power. The big box retailers now have the pricing power, both via private labels and "trade spending," i.e., requiring suppliers to pay for store promotions, displays, and shelf space. The acquisition of Gillette for $50B followed P&G's acquisition of Clairol for $5B and Wella for $7B. At the same time, P&G sold off numerous brands. China is a rapidly growing P&G market. Nevertheless, whether these changes can sustain P&G's growth remains to be seen [Economist, 2005b].

Despite fierce competition in the breakfast foods business—including a redefinition of breakfast by time-pressured consumers—Kellogg remained committed to its broad strategy that involved excelling at new product development, broad distribution, and a culture skilled at executing business plans. To sustain this strategy, Kellogg needed a distribution channel for delivering fresh snacklike breakfast foods. They acquired Keebler that also had a brand strategy. Revenue rose by 43% between 1999 and 2003 and operating income nearly doubled [Harding and Rovit, 2004].

Newell had a 30-year track record of successful acquiring over 60 companies in the household products industry. Their success was recognized by the industry's adoption of the concept of "Newellizing" acquisitions. Rubbermaid seemed like a natural match—household products through the same sales channels. However, the acquisition dragged Newell down—losing 50% of the value of the investment. Newell's focus on efficiency and low prices did not match Rubbermaid's brand focus and premium prices [Harding and Rovit, 2004].

Clear Channel and Thomson can illustrate transformation in the entertainment and information sectors, respectively. Clear Channel Communications executed a long series of acquisitions of radio stations, accelerated by the 1996 deregulation, rising to lead the industry with 1200 stations. Focusing on cost leadership involving packaged playlists, central distribution of formats, and shared personnel. They sold bundled advertising and promoted live concerts. Between 1995 and 2003, their revenues grew 55% annually and shareholder return averaged 28% annually [Harding and Rovit, 2004].

From 1997 to 2002, Thomson transformed itself from a traditional conglomerate that included newspapers, travel services, and professional publications into a focused provider of integrated electronic information to specialty markets. They sold more than 60 companies and 130 newspapers. With the proceeds of $6B, they acquired 200 businesses becoming a leader in electronic databases and improving operating margins significantly [Harding and Rovit, 2004].

Large high-technology companies also have to address the challenges of transformation. Following the reunification of Germany, prices in Siemens' markets dropped dramatically, by as much as 50% in 3 years in some businesses. Siemens reacted by focusing on cost reduction, innovation as reflected by patents, growth, and culture change, prompted by the CEO convincing people that there was a crisis. They adopted many of General Electric's ideas, i.e., only staying in businesses where they could be No. 1 or No. 2, GE's people development ideas, and GE's benchmarking practices. Siemens focused on financial markets, alliances, and the internal political and persuasion process. From 1992 to 2004, revenue almost doubled, net income more than tripled, and revenue per employee almost doubled [Stewart and O'Brien, 2005].

By 2002, under the leadership of Louis Gerstner, IBM had been pulled back from the brink, transforming from a mainframe maker into a robust provider of integrated hardware, networking, and software solutions. The new CEO, Samuel Palmisano, continued the company's transformation via a bottom-up reinvention of IBM's venerable values. The transformed values are: (1) dedication to every client's success, (2) innovation that matters—for our company and for the world—and (3) trust and personal responsibility for all relationships. Processes and practices are now being aligned—or realigned—with these values [Hemp and Stewart, 2004].

Summarizing these ten vignettes in terms of the theory of enterprise transformation, we can reasonably assert that:

- Increasing shareholder value by mergers and acquisitions sometimes succeeds (Clear Channel, Kellogg, and Thompson), sometimes fails (AT&T, Lucent, and Newell), and takes time to evaluate (Proctor & Gamble).
- Transformation of the enterprise's value proposition to customers via new product and service offerings is illustrated by the success of IBM, Kellogg, and Thompson and, to a lesser extent, by Nokia.
- Improving productivity via extensive process improvements, as illustrated by IBM and Siemens, can transform an enterprise's value provided to customers, suppliers, and employees and increase shareholder value.

Thus, experienced and/or anticipated value deficiencies drove these transformation initiatives. Process changes were accomplished either organically or via mergers and acquisitions. Success was mixed, as was the case for the many examples from early times.

### 7.5. Conclusions

The need to transform—change in fundamental ways—has long been a central element of the economy and society [Jensen, 2000; Collins, 2001; Collins and Porras, 1994]. Many enterprises are started; some flourish. Those that succeed eventually must face the challenges of change; some succeed in transforming, as illustrated by these vignettes. Most enterprises fail to transform. The study of enterprise transformation focuses on understanding the challenges of change and determining what practices help most to address change and successfully transform.

## 8. IMPLICATIONS OF THEORY

An enterprise can be described in terms of how the enterprise currently creates the value it is achieving—how it translates inputs to states to work to value. Research in enterprise transformation should, therefore, address one or more of these constructs. Elsewhere [Rouse, 2005], I have argued that such research should include six thrust areas:

- Transformation Methods & Tools
- Emerging Enterprise Technologies
- Organizational Simulation
- Investment Valuation
- Organizational Culture & Change
- Best Practices Research

Table III summarizes the relationships among initiatives in these six thrust areas with the state, work, value, and input constructs defined above. This tabulation can enable two important facets of enterprise systems research. First, it can provide a theoretical grounding to research initiatives. Of course, the researchers pursuing these initiatives need to elaborate these theoretical underpinnings much more specifically than presented

**Table III. Relationships of Initiatives to Enterprise Model**

| | Enterprise Input | Work Processes | Enterprise State | Enterprise Output |
|---|---|---|---|---|
| **Transformation Methods & Tools** | How to represent, manipulate, optimize, and portray input, work, state, output, and value for the past, present, and future of the enterprise. | | | |
| **Emerging Enterprise Technologies** | | How emerging enterprise technologies are likely to impact work, state and output, and the strategy/policy implications of these impacts. | | |
| **Organizational Simulation** | | How work processes affect state and the experience of the state of an enterprise. | | |
| **Investment Valuation** | How investments of financial resources | | | Affect value generated, e.g., options created |
| **Organizational Culture & Change** | | How value priorities drive work processes, affect organizational culture and change, and thereby influence state and output. | | |
| **Best Practices Research** | How past and current approaches to and changes of input, work, state, and output have impacted subsequent enterprise value creation, for better or worse. | | | |

here. This need will surely result in elaboration and refinement of the basic theory outlined here.

The second facet concerns the value of the outcomes of these research initiatives. One certainly can expect these outcomes to directly benefit the stakeholders in these initiatives. Beyond these direct benefits, this research should advance fundamental understanding of the nature of enterprises, how they can and should address change, and the factors that affect success and failure. Providing such advances will require paying careful attention to the constructs of state, work, value, and input.

It is unlikely that these constructs will soon be codifiable into an axiomatic set of equations—the phenomena of interest are much too complex. Nevertheless, one can gain deeper understanding of the nature of these constructs, how they can and should be changed, and how best to accomplish such changes. Eventually, this may support formulation of a valid model world with axioms, theorems, proofs, etc. Along the way, the fundamental knowledge gained should help enterprises to recognize needs for fundamental change and address such challenges with success.

## 9. IMPLICATIONS FOR SYSTEMS ENGINEERING AND MANAGEMENT

System engineering and system management are inherently transdisciplinary in the attempt to find integrated solutions to problems that are of large scale and scope [Sage, 2000]. Enterprise transformation involves fundamental change in terms of redesign of the work processes in complex systems. This is clearly transdisciplinary in that success requires involvement of management, computing, and engineering, as well as behavioral and social sciences.

Upon first encountering the topic of enterprise transformation, many people suggest that this must be the province of business schools. However, the functional organization of most business schools mitigates against this possibility. Academic credibility depends on deep expertise in finance, marketing, operations management, organizational behavior, or corporate strategy. Great professional risk can be associated with spreading one's intellectual energy across these areas.

In contrast, systems engineering and management can and must inherently look across functions and view the whole enterprise system. Consider automobile manufacturing as one illustration. The Toyota Production System (TPS) has transformed the automobile industry [Liker, 2004]. Interestingly, development and refinement of the TPS represents business process improvement for Toyota but transformation for all the competitors that had to adopt lean production to compete with Toyota, or compete in other markets, e.g., aircraft production [Kessler, 2003]. In these cases, TPS could not simply be "installed." These practices affected the whole enterprise and success depended on addressing this breadth.

A more recent innovation in the automobile industry is build-to-order [Holweg and Pil, 2004]. If you are Dell, where the company was founded using build-to-order, this is another case of business process improvement. On the other hand, if you are Ford or GM, adopting build-to-order affects the whole enterprise. Manufacturing, supply chains, and distribution have to change; e.g., you do not really need a traditional dealer network any more. You have to look at the whole enterprise, particularly because the overall cost structure changes significantly once you no longer build cars "on spec."

Systems engineering and management have long been strong suits of defense companies. The concepts, principles, methods, and tools have been applied successfully to definition, design, development, and deployment of complex platforms ranging from aircraft to ships to command and control systems. However, the emphasis has shifted recently from platforms to capabilities, e.g., from airplanes to airlift, for instance [Rouse, and Boff, 2001; Rouse and Acevedo, 2004]. This requires an airlift enterprise, not just airplanes. Further, the airlift enterprise will be a transformation of current enterprises for selling airplanes and providing cargo capacity as well.

Thus, enterprises and their transformation are central constructs and phenomena in the complex systems addressed by systems engineering and management. The theory outlined in this paper provides a foundation for thinking about and addressing these challenges. The transdisciplinary perspective inherent in systems engineering and management provide us with an inherent competitive advantage in tackling complex problems.

## 10. CONCLUSIONS

This paper has outlined an initial formulation of an overarching theory of enterprise transformation. This theory is very much a work in progress. A wide range of colleagues from numerous disciplines has offered comments and suggestions on the evolving theory, providing rich evidence of the diversity of perspectives that different disciplines bring to this broad problem area. Indeed, it can reasonably be argued that there are few problems so central to our society and economy as the problem of how complex systems address fundamental changes.

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