Explaining the Start and Fizzle of Organizational Change: Co-evolving Process and Content

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ABSTRACT

The theme that sustaining efforts to change is difficult appears in many guises throughout the organizations. The tendency for change processes to run out of energy and momentum is widely recognized. In this essay, I offer an inductive study of the dynamics of organizational change that describes situated human interactions to explain the observed trajectory of organizational behavior. As a window through which to view change, I study a manufacturer adopting production practices based on concepts of lean manufacturing and the so-called Toyota Production System (TPS). I develop a grounded theory based on extensive fieldwork observing a change effort that began with temporary improvement but subsequently entered a phase of decline, the characteristic start and fizzle of change. I examine how the actions of various groups interact with each other and with characteristics of the workplace. I then induce a model that characterizes the dynamics of participatory change. The model draws on a close examination of how people do the work of process improvement to identify a set of mechanisms through which process and content interact to constitute the patterns of organizing that result. I find that front-line participation led workers to generate ideas, but the work of implementing those ideas placed demands on key support personnel such as manufacturing engineers. The support personnel quickly become overwhelmed, facing a growing backlog of ideas to implement. As the support personnel modified their work practices to address the mounting workload, the change process evolved and so did the content of the changes it produced.

"It was the best of times, it was the worst of times, it was the age of wisdom, it was the age of foolishness, it was the epoch of belief, it was the epoch of incredulity, it was the season of light, it was the season of darkness, it was the spring of hope, it was the winter of despair, we had everything before us, we had nothing before us…" (Charles Dickens, A Tale of Two Cities, 1859).

When Charles Dickens penned what was to become one of the most famous of all opening lines in English literature, he was writing about conditions in Victorian England, not about the state of affairs in the modern organization. Yet, his intriguing opener captures a fundamental paradox relevant to life in organizations. Things may be going well and at the same time going poorly. And even more vexingly, it is often difficult to know how things are going. Gareth Morgan (1986, p. 339) proclaimed: "Organizations are many things at once!" Such is often the case when organizations attempt to implement change. Consider for example a common co-occurrence in the dynamics of organizational change: a change process starts and subsequently fizzles. The organization achieves some short-term objectives, yet simultaneously fails to establish an underlying capability to sustain improvement (Beer & Eisenstat, 1996). It is the best of times based on immediate results, yet it is also the worst of times as revealed by the subsequent course of events.

The theme that sustaining efforts to change is difficult appears in many guises throughout organization theory. The tendency for change processes to run out of energy and momentum is widely recognized (Beer, Eisenstat, & Spector, 1990; Pettigrew, 1998; Pettigrew, Woodman, & Cameron, 2001; Repenning, 2002). Quite simply, "*it is hard to make changes stick*" (Kanter, Stein, & Jick, 1992, p. 5). Temporary adoption followed by ultimate rejection of new behaviors necessary to achieve enduring change is a common dynamic pattern in change initiatives (Armenakis & Bedeian, 1999). In studies of innovation implementation, analysts increasingly identify unsuccessful implementation rather than ineffectiveness of the innovation itself as a cause of failure to achieve intended benefits (Hackman & Wegeman, 1995; Klein & Sorra, 1996; Repenning, 2002). Some authors refer to gaps between knowing and doing in organizations (Pfeffer & Sutton, 2000) or an improvement paradox as good ideas do not reliably help organizations achieve improved performance (Sterman, Repenning, & Kofman, 1997). Others document the frequency of abandoning business tools (Rigby, 2001; Rigby, 1994) or describe the

faddish nature of administrative innovations (Lawler & Mohrman, 1985). More broadly, the liabilities of undertaking organizational change have been implicated in organizational failure rates (Amburgey, Kelly, & Barnett, 1993; Hannan & Freeman, 1984).

Despite the attention of scholars from a wide range of disciplines and the pervasive concern among practicing managers, the difficulty organizations have putting administrative innovations into use remains a key issue facing organizational theory (Pfeffer, 1997). Scholars concerned about the limits of existing theory of organizational change have called for research to resolve two deficiencies in our current theories. First, there is a need for increased attention to both the process and content of change. Content refers to "what" changes, and process refers to "how" change occurs (Barnett & Carroll, 1995). "Enough research has been conducted on organizational change to make it clear that, in most contexts, both content and process factors ought to be evaluated. Yet theories and analyses of organizational change often tend to only one dimension." (Barnett et al., 1995, p. 210). "One particularly worthwhile domain in which process and content concerns converge is the translation of knowledge into action. There are many instances in which organizations know what to do (content) but have difficulty in actually implementing that knowledge (action). … The challenge for organization studies in the future is to find ways of understanding the connection between content and process, between knowledge and action, and between theory and practice" (Pfeffer, 1997, p. 202). Pfeffer suggests that such a line of inquiry will lead to better understanding of "why well-informed individuals and organizations within them pursue ineffective activities and promote dysfunctional policies and practices" (Pfeffer, 1997, p. 202).

The second deficiency is a shortage of attention to the link between macro and micro perspectives. Organizational theorists have been intrigued for some time by the observation that apparently small inputs or events can lead to dramatic outcomes. Scholars in many other domains such as economics, system dynamics, and physics have also pointed out similar connections between small initial changes and largely different consequences (Arthur, 1989; David, 1992; Forrester, 1961; Nelson & Winter, 1974; Prigogine & Stengers, 1984). The phenomenon is sometimes described as amplification or the enlargement of small cues (Weick, 2000). The scholarly call is to shift more attention to the ordinary activities in organizations in

search of explanations for interesting outcomes. "Because of the magnitude of some changes in organizations, we are inclined to look for comparably dramatic explanations for change, but the search for drama may often be a mistake. (March, 1981, p564). Echoing the need, Weick noted that "macro perspectives are hollow unless linked with micro dynamics" (Weick, 1993b, p.34).

To address some of these deficiencies, I offer an inductive study of the implementation of innovation that details how key feedback relationships that arise from situated human action explain the observed trajectory of organizational behavior during change. The central research question guiding this study is to understand how the actions of various groups in organizations interact with each other and with physical characteristics of the workplace to give rise to the observed pattern of behavior. What physical and social structures and processes influence how situated action at a micro level contributes to organizational outcomes? How do the behaviors of social actors in one organizational locale interact with those in others to yield observed patterns of organizational behavior?

Organizational researchers over the past decade have made some inroads into understanding the connection between situated action and observed macro outcomes. Scholars following the structuration perspective have been increasingly interested in models of organizations based on notions of recursive interaction between organizational actors and the resources available to them (Giddens, 1984; Orlikowski, 1992). Some work has been concerned with understanding the appropriation of various aspects of technology or the enactment of technology-in-use as users go about their day-to-day activities, thus conceptualizing emergent change in organizations (Barley, 1986; DeSanctis & Poole, 1994; Orlikowski, 2000; Orlikowski & Gash, 1994). Other work has used improvisation as a metaphor for organizational activity, emphasizing the unplanned and ongoing nature of organizational activity (Crossan & Sorrenti, 1997; Hatch, 1997; Orlikowski, 1996; Weick, 1993a; Weick, 1998). These scholars view change as evolving through the course of ongoing organizational action. Such emergent change is not anticipated or planned, but rather is the realization in action of a new pattern of organizing in the absence of explicit, a priori intentions (Orlikowski, 1996; Weick, 1995; Weick, 2000). Studies in the emergent change school have been largely descriptive in nature, concerned mostly with establishing the existence of the emergent change phenomenon. They describe changes over time that lead to

organizational situations or states that do not correspond to those that were anticipated or intended at the beginning of the change process. The authors offer these descriptions as examples of emergent change and generally distinguish these processes from alternative views embodying a designed or planned outcome, one that is anticipated or intended by leaders or technology designers.

An emerging stream of research explicitly applying feedback theory to understanding phenomena in organizational change serves as another foundation for the present work. Early work in this tradition applied a feedback lens to investigate phenomena such as the growth and demise of a corporation and the theory of punctuated equilibrium (Forrester, 1968; Hall, 1976; Sastry, 1997; Tushman & Romanelli, 1985). More recently, scholars have studied the challenges of sustaining process-focused improvement technologies, such as total quality management (TQM) and business process reengineering, in both manufacturing and product development (Keating & Oliva, 2000; Oliva, Rockart, & Sterman, 1998; Repenning, 2002; Repenning & Sterman, 2002; Sterman et al., 1997). Repenning and Sterman (2002, p. 292) describe how difficulties that organizations face in the implementation of improvement are "rooted in the ongoing interactions among the physical, economic, social, and psychological structures in which implementation takes place." The study calls attention to the critical importance of the interactions between physical characteristics of the workplace and the actions and beliefs of organizational actors. However, like the previous work, the authors treat the work of improvement activity at an aggregate level in order to focus on tradeoffs between activity in production and activity in improvement. A close examination that includes the work of doing improvement activity at a micro level is still needed.

In this paper, I use the implementation of planned change through process improvement as a window through which to study connections between the process and content of change and between situated action and organizational trajectories of change. Process improvement efforts are a useful context in which to study how micro processes contribute to broader organizational change (Repenning et al., 2002). Dynamic behavior during implementation of such organizational improvement activities often exhibits a pattern characterized by an initial burst of successful activity followed by a decline in performance levels. "Start and fizzle" describes a

problem in the sustainability of organizational change initiatives that is of interest to both scholars and practitioners. I develop a grounded theory that explains the start and fizzle pattern, drawing on data from field work I have conducted at a manufacturing firm as it attempted to adopt production practices based on concepts of lean manufacturing and the so-called Toyota Production System (TPS). I begin with a description of research methods followed by background on the research setting and an overview of the change initiative. In the following section, I develop an explanation for the observed pattern – start and fizzle – by examining how the actions of various groups (e.g., managers, production workers, and other shop floor workers) interact with each other and with the physical characteristics of the workplace. I then induce a model of these critical interactions and use it to explain some consequences of these interactions for organizational outcomes. I conclude with a discussion of implications for managers undertaking change efforts and for scholars concerned with organizational change.

METHODS

The organization I observed is an automotive vehicle manufacturer in the United States. The site of the research is a plant that manufactures parts and assembles engines used in the company's vehicles. In the spring of 2000, the general manager of the plant became interested in "taking [the company] to a new level" of manufacturing performance. He began efforts in his plant to learn about and adopt new practices, drawing heavily on approaches identified as "lean manufacturing" (Womack, Jones, & Roos, 1990) or the Toyota Production System (Monden, 1983). I had the opportunity to begin data collection with the general manager and the plant in the early stages while the general manager was beginning to think about how to introduce new production practices to the company.

Data Collection

The field research began in June of 2000, as the general manager was beginning to formulate his approach, and continued for 20 months. Data collection comprised ethnographic material, documentary and archival data, and in-depth interviews (Pettigrew, 1990). My early efforts were focused on understanding the context, setting, and culture within which the focal change efforts were taking place. I spent several days shadowing the general manager and the production

managers (direct reports of the general manager) of the facilities. I attended at least one of each of the various meetings that take place regularly at daily, weekly, monthly, quarterly, and yearly intervals. I attended several dozen daily production meetings, known as "hot meetings," in which representatives of the various production units and support activities meet at the beginning of the morning and evening shifts to report daily status information and to coordinate activities. I attended many other meetings related both to ongoing plant activities and to the implementation initiative. In some cases, I made audio recordings of the sessions. For many others, I took detailed field notes. I also participated in a group organized by the general manager comprising representatives from both salaried management and elected union leaders at each of the company's six production facilities. The group was chartered to lead efforts across the enterprise to adopt new and better production practices and met monthly for two-day sessions. I attended all of these monthly meetings. My later efforts brought me on to the shop floor observing and engaging in conversations with workers. I followed the production of key component parts from start to finish through a production cell and the assembly of an engine along the entire assembly line, talking with workers at each step. I spent upwards of 100 days on site, observing managers and workers in their daily activities. Over the course of this field research, I have had many informal conversations or unstructured interviews with informants, recording these conversations in field notes. I gathered documents, electronic files, and emails generated during the course of the research, among other archival data. I also conducted a series of semi-structured interviews with management personnel, union leaders, and front-line workers. The data I gathered includes more than 1200 pages of field notes and over 200 hours of audio tapes of meetings and interviews.

I interviewed selected individuals who were directly involved with the change initiative. Respondents included the plant general manager, the plant production managers, other members of the plant management team (direct reports of the general manager), both work group advisors for the production cell selected as the pilot area, elected union officials, hourly production workers, members of an implementation team assigned to the change initiative, and other support personnel such as a plant engineer. The interviews lasted from 45 minutes to 2 hours, and some respondents were interviewed more than once. The interviews generally began by asking respondents to describe what they first remembered about the focal change initiative and then

requesting they construct a timeline of the course of events. During these accounts of the change initiative, they were asked to describe their own roles, the factors that helped or hindered the efforts, and their impressions about progress and the success of the initiative. I often asked for their opinion about the persistence of the problems that they identified, which in hindsight seemed somewhat obvious. Finally, I asked them how the initiative had affected them personally, in particular what they may have learned through the experience. The interviews were audio taped, then transcribed.

Together, these methods draw on the strengths of the various methods and facilitate verification through an iterative process. In particular, the interviews provided opportunities for in-depth examination and the use of audio recording for accuracy, while the extensive direct observation allowed for comparisons between what people said in interviews and casual conversations and what they actually did (Pettigrew, 1990). These methods contribute to a rich database that I have developed comprising longitudinal data that includes both contemporary and retrospective reports from respondents. The resulting data meet four of Pettigrew's (1990) five ideal characteristics for longitudinal field research on changes: the data are processual, pluralist, historical, and contextual. The data fall short on the fifth characteristic because they are not based a range of studies for comparative purposes.

Data Analysis

As Barley (1990, p. 234) notes, "the analysis of field data actually begins during a study's observational phase." The ongoing analysis of field data offers the possibility of developing interim hypotheses and directs attention to relevant data (Glaser & Strauss, 1967). My data analysis followed traditional qualitative methods (Eisenhardt, 1989; Miles & Huberman, 1984; Yin, 1994). I also made frequent use of a graphical representation technique known as causal loop diagrams that is especially useful in the analysis of complex systems (Masuch, 1985; Sterman, 2000; Weick, 1979). The diagrams capture the feedback structure of a system of interacting elements and help to reveal the potential dynamic behavior of the posited relationships. During the course of my fieldwork, I made frequent sketches of such causal loop diagrams, often in the evenings during my trips to the research site. The diagrams were one

explicit means by which I was "always trying to make sense of one's data and thinking about what more one can find out" (Feldman, 2000, p. 615).

Data analysis included listening to the recorded interviews and reading the transcriptions, coupled with a review of field notes. I identified patterns of interest and recurring themes in the data, bounding the analysis with a focus on efforts to implement change in the first production cell. As is typical in developing grounded theory, I organized the data into categories, which I represented with variables and causal relationships between them (Glaser et al., 1967). I combined variables and causal relationships to begin identifying causal loops as a description of the feedback processes gradually emerging from this analysis. During the data analysis, I occasionally translated portions of the emerging feedback structure into formal mathematical models and simulated their behavior in order to gain a richer understanding of the relationship between the feedback structure and the dynamic behavior. The iteration between the grounded data, causal loop diagrams, and formal mathematical models led to additional insights and generated new questions that I could explore in the available data or pursue with my respondents. On occasion, I reviewed interim results of my analysis with members of the plant management team, who often identified examples that were useful to fill in some gaps. My data analysis approach follows methods used by other researchers applying a feedback lens to the study of organizational phenomena (e.g.,Perlow, Okhuysen, & Repenning, 2002; Repenning et al., 2002).

OVERVIEW OF THE IMPLEMENTATION CHALLENGE

The Research Setting

The company I observed manufactures and markets a line of motor vehicles and related products targeted at automotive enthusiasts. The company has a rich heritage and a well-known brand. Market demand for its product continues to be strong. Despite this success, management recognizes the need to stay competitive. It is commonly acknowledged that the company's manufacturing costs are higher than those of their competitors.

The engine plant, like the company's other manufacturing facilities, employs a unionized workforce. Management and union leaders alike attest to a strong, cooperative relationship between the union and the management. For several years, work practices have been guided in

part by the collective bargaining agreement, which details elements of the organization structure and responsibilities of the union leaders and workers and the salaried management. Elements of the agreement include work groups organized around production units, "work group advisors" rather than supervisors, joint representation in many decision processes, and a high degree of information sharing with employees, as well as other practices typically characterized as high-involvement work practices (Pil & MacDuffie, 1996).

Stalled Change: The Pattern of Start and Fizzle

Managers in the plant recognized a need to improve the manufacturing capabilities in their organization. They discussed the idea with union leaders at the plant and agreed to proceed. As one union leader said:

> I came to understand that we are archaic in the way we do our manufacturing here. We all know that competition is always knocking on our door. We know that if we're going to be competitive, especially here at this plant, because we are such a low-budget, low-profit margin, here, that we're going to have to continuously improve to be competitive, and keep the [product] at a price where we can get people, … first time buyers, into our family

The workers throughout the plant were already organized in work groups corresponding to manufacturing cells that produced various engine parts. The plant managers and union officials jointly selected one work group to be "a pilot area that we're going to try this on" in the words of a production manager. The work group runs a production cell that comprises machining and some assembly operations to make several parts used in the company's engines. After several months of work in the pilot area, the management and shop personnel were proudly pointing to the initial success of the effort: A union official describing the early progress said, "It was going along pretty good there. The area was starting to really look uniform over there." Enthusiasm was high, as one hourly employee said:

> The people that were there, they seemed very excited about it. When they saw the results, and what could happen, got a visual look, basically, of how we're doing things today and how it can actually be, they got kind of excited about it.

And the work group was beginning to show tangible evidence of business results, as noted by an engineer on the implementation team:

> They got people looking at the machines, finally fixing them. We got the layout running. You got a pull system in place. And – start looking at some of the overall numbers – they're outstanding. Scrap has come down [thousands of dollars]. Performance went up from 70% to 94% [in-stock levels of finished goods inventory meeting or exceeding target minimums].

Yet several months later, some new work practices had been abandoned and performance had deteriorated. One informant described the situation as “the wheels are coming off." Another said, "If you go over there a couple of months later, after all this stuff, the [physical appearance] started to deteriorate." Several respondents reported similar characterizations of the improvement activity in this work group: an early phase of improved performance followed by a plateau and then decline, the start and fizzle pattern. As noted in the introduction, similar patterns are well documented in the literature on organizational change. The purpose of the following analysis is to develop a dynamic model that captures the ongoing interaction between the work of improvement activity and the organizational context. The model describes a processual theory that explains how the recursive relationship between process and content gives rise to the start and fizzle pattern observed in the improvement initiative of the pilot work cell.

In what follows, I draw on my field data to induce a model that describes how the interactions of various organizational members and the physical characteristics of improvement activity can generate the observed pattern of behavior. I represent the model using causal loop diagrams to describe the feedback structure enacted by the organization and discuss how this structure gives rise to the observed pattern of start and fizzle. I develop the model in stages, presenting the relevant data and then interpreting the data in diagrammatic form.

A MODEL OF ORGANIZATIONAL CHANGE

Learn a Little, Do A Little

A distinguishing feature of most participative improvement programs is that employees working in their own situated environments make significant contributions to improving the work processes that they perform on an ongoing basis. “The core of a high-performance work system (HPWS) in manufacturing … is that work is organized to permit front-line workers to participate in decisions that alter organizational routines. This may be achieved by using shop-floor production teams or through employee participation in problem solving or quality-improvement teams and statistical process control” (Appelbaum, Bailey, Berg, & Kalleberg, 2000). In TQM companies, employee involvement mechanisms are invariably introduced. “According to the Conference Board (1991), 65 percent of TQM organizations create employee suggestion

systems, and 70 percent have quality meetings between managers and employees and/or focus groups to solicit ideas about quality" (Hackman et al., 1995, p. 317).

Similarly, authorities on lean production and the Toyota Production System assert the importance of the front-line employee as the key contributor to the problem solving at the center of process improvement. After studying some forty production plants in the United States, Europe and Japan, Spear and Bowen (1999) attempted to discern the essence of the Toyota Production System:

> "Indeed, in watching people doing their jobs and in helping to design production processes, we learned that the system actually stimulates workers and managers to engage in the kind of experimentation that is widely recognized as the cornerstone of a learning organization. That is what distinguishes Toyota from all other companies we studied" (Spear & Bowen, 1999, p. 98).

This ongoing experimentation leads both to process improvements and to increases in the skill, motivation and involvement of the work force. "Indeed, the term 'lean production' … captures the minimization of buffers but neglects the *expansion* of work force skill and conceptual knowledge required for problem solving under this approach" (MacDonald, 1995, emphasis in original). Moreover, as the skill of the workforce increases, workers are able to generate and implement more improvement ideas. As they do so, they continue learning, acquiring even more skill, generating even more ideas, and thus more learning as the process continues.

In the organization I studied, the general manager and many other managers espoused their intent to follow an approach of learning and discovery rather than a top-down, directive approach to change. The general manager expressly articulated his belief that the workforce must be actively involved and that people learn by doing. One production manager described the strategy they chose to follow:

> I think that the strategy … that we took here was to try to create demand for this [program]. Let's educate people. Let's give them some knowledge. Let's train them and let's encourage their intellectual curiosity and then let's channel their thoughts and their ideas into things that are consistent with the tools of lean manufacturing and the process of lean manufacturing.

Moreover, the managers also recognized that they themselves were not experts. Thus, they decided to begin with the idea that they would learn along the way. The production manager continues:

> What are the first steps? What do we do? Do we just go down there and say – ok folks, we're going to implement lean and we're the experts here? We're going to tell you what to do and you

> just trust us. We won't mislead you. We may make a few mistakes, but just stick with us. Do what we tell you and we'll be ok – all right? And we said – no, we can't do that. We don't have enough knowledge to go down there, … succeed, and create a demand for this [program] that we hope to create. So how do we do this? Well, what if we all learn this stuff together, you know? And that's where the bus analogy came from. Let's get everybody on the same bus and let's all agree where we are today and get some fuzzy idea about where we want to go. Then let's see what we can learn along the way to bring clarity to where it is that we want to go. We may make a few left and a few right turns along the way. We may have to back up the bus a couple of times here and there. So that's where [someone] came up with the concept – learn a little, do a little. Let's teach these folks a little bit. Let's learn a little bit about this stuff ourselves. Let's put our heads together. Let's decide what our needs are and what our priorities should be within this workgroup and see if we can't apply some of these tools and some of these skills we've learned to bear on some of the issues that we identify.

The plant managers and union officials jointly selected one work group as the pilot site for the initiative. The selected work group comprises approximately 15 hourly production workers who run a machining and manufacturing cell that produces several parts used in the engines assembled in this plant and at another engine assembly facility in the company's production network. Due in part to quality and cost problems, the company had recently considered discontinuing the in-house manufacturing of these parts and had begun purchasing a portion of their needs from a supplier. Plant management and the union leaders had convinced the company to continue internal production of these parts, but there was a clear sense that performance improvement was needed or the company would indeed discontinue the operation. Moreover, because some production volume had recently been shifted to outside suppliers, there was a surplus of worker time that could be dedicated to improvement activity. Thus, this cell was chosen because the need for improvement was clear and because resources for improvement were available.

The managers formed a full-time implementation team, dedicating people to work with the pilot work group. Two of the team members were engineers from an internal consulting group in the company that works with the company's manufactured parts suppliers to implement lean manufacturing practices and who also had experience with lean manufacturing at previous employers. The manufacturing engineer already responsible for that area was assigned to the team. The work group advisor – the plant has no "supervisors" – had significant experience with lean manufacturing from a previous employer and was quite enthusiastic. The team recruited two volunteers from the work group to work three-fourths to full time on the implementation.

The union asked an hourly worker, whose job title is union analyst, to join the team. A union analyst examines work processes and contributes to setting quantitative standards for work output in the various production jobs. The team also had some support from an external consultant who conducted some training and provided expertise in lean manufacturing techniques.

The implementation team provided some training for the workers and then asked them to generate ideas for ways to improve the manufacturing processes. Lean manufacturing systems aim to reduce various forms of waste in the system, often by implementing processes such as just-in-time production, kanbans, production smoothing, improved process layouts, reduced set-up times, and standardization of operations (Monden, 1983; Womack & Jones, 1996; Womack et al., 1990). The early training was focused largely on improvements such as workplace organization and redesign of the production layouts. Specific tools, analytical techniques, or structured problem-solving methods were used to help generate these improvement ideas. An hourly production worker described the prevailing approach of high employee involvement:

> I mean I've worked at a number of other companies. [This company] really goes out of their way for employee involvement. It's not just lip service. Some of the ideas we discussed as a group, but a lot of the stuff that we came up with came from the hourly employees. Roller racks was one of the things that we introduced. Where it's essential for some of the products that we use to be first in, first out. Actually, the roller racks were designed by hourly people that actually worked on the jobs. So that was something. … The company says you guys use it, you tell us what you want. So they did give us that leeway and that was very helpful as far as myself doing my job. … Let's make these things easier and more efficient, of course. That was one of the big things.

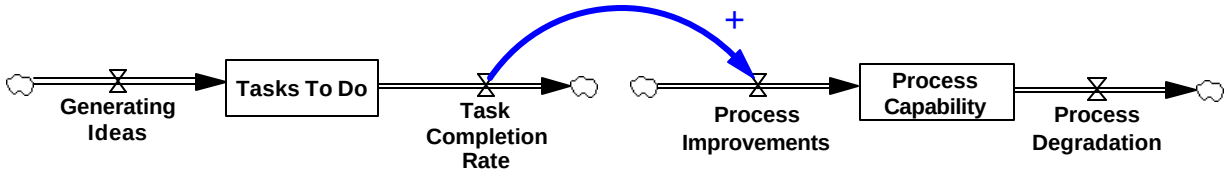
The hope was that as ideas got generated and implemented, workers would learn and improvements would accrue, setting in motion a process of continued improvement and learning propelled by the involvement and knowledge of the workers.

Figure 1 shows the way that improvement activity contributes to process capability. Workers contribute by *Generating Ideas*, which accumulate in a stock of *Tasks To Do*. The rectangle icons in Figure 1 represents stocks, which are integrations (accumulations) of inflows that increase the stocks less outflows that decrease the stocks. The pipe-and-valve icons represent the flows into and out of the stocks. Thus, *Generating Ideas* increases the stock of *Tasks To Do*, and *Task Completion Rate* decreases the stock. The diagrams I develop here use stocks and flows along with feedback loops to represent the system structure. Stocks give a system memory and

inertia, create delays, and are critical to the dynamics of the system. As accumulations of past actions, stocks influence future actions which in turn influence the rates of flow that change the stocks, thus closing the feedback loops (Repenning et al., 2002).

As the work proceeds, *Task Completion* generates *Process Improvements* that increase the *Process Capability.* Figure 1 represents *Process Capability* as a stock. *Process Capability* is the ability of the firm to generate output that is valued by the market. In this case, *Process Capability* refers to the throughput of manufactured parts that the work cell can accomplish for each unit of production labor employed. The stock of *Process Capability* is increased by *Process Improvements* and decreased by *Process Degradation*, a natural consequence of ongoing use and changes such as customer requirements and supplier factors. The diagram shows that ideas lead to improvement tasks, and the successful completion of improvement tasks results in the intended increase in the organization's capability. *Process Capability* increases as long as *Process Improvements* exceed *Process Degradation*. The representation of *Process Capability* as the cumulative difference of improvement and degradation follows earlier models of process improvement (Repenning & Sterman, 2000; Repenning et al., 2002).

Figure 1: Basic Stock and Flow Map of Lean Manufacturing Process Improvement Activity



Stocks are represented by rectangles, and flows are represented by "pipes with valves." A stock is the accumulation of the difference between its inflows and outflows (see Sterman, 2000).

The Process of Doing a Little

An important characteristic of many of these improvement suggestions was the varied nature of the tasks required to implement them. Although the vast majority of the ideas originated as suggestions from the work group and the dedicated implementation team, the tasks required to execute these ideas frequently required assistance from other people in the plant. One manager

summed up the pattern regarding who gets assigned responsibility for doing the tasks: "Very rarely is it the person that came up with the idea."

Consider for example the efforts to organize the finished goods produced by the work group by establishing and properly configuring an area they called the supermarket. The parts the work group makes are used by two engine assembly lines, one located in the same facility and one at another manufacturing location. Better organization of the finished goods supermarket would enable better signals about what parts the engine assembly lines needed based on timely and accurate information about what is currently available, and support a simple and effective process to replace what was used as parts are drawn from the supermarket. The work group developed plans to organize the finished parts in an area specified for the supermarket. The work plan comprised several tasks. One task was to mark lines on the floor, clearly delineating the space for the supermarket and sections within it. The size of each section would be based on the capacity deemed necessary for each of the various parts they produced. Another task was to make and hang overhead signs that would identify the parts in each section and other information such as the desired stock level and the capacity of the section. These are tasks that are normally done by personnel from the maintenance department or other skilled trades. Thus, the ideas generated by the work group created demands for work by other people in the plant. As one work group member described, this was a common occurrence: "Like just for little things like hanging signs for a supermarket, we need signs for a supermarket. We need somebody who can do that." In this example, the critical support personnel were people from the maintenance department. As one manager observed, this was a common scenario: "Maintenance. [The workers] have got a great idea for maintenance to do. And then when it doesn't get done, maintenance is bad, right?"

The work group I studied frequently needed support from the plant's manufacturing engineers. Manufacturing engineers are typically responsible for tasks such as choosing, purchasing and installing new equipment and specifying the manufacturing processes required to use the equipment. In the supermarket example, a set of such tasks was to design, purchase, and install appropriate storage containers, such as rolling carts or flow racks. Another planned improvement was to redesign the layout of the manufacturing equipment, modifying the flow of

work in process through the cell. The redesigned layout included a new piece of equipment, which the manufacturing engineer would need to purchase. "Engineering" was one type of support personnel who were needed, and often not available, as noted by a member of the implementation team:

> So we went up there and did the analysis, got some of the tools ordered, and did some of the basic things. Then we were starting to require more and more engineering. … That's where it really fell down. I think probably the biggest thing we were missing on that team is we had no one to go to.

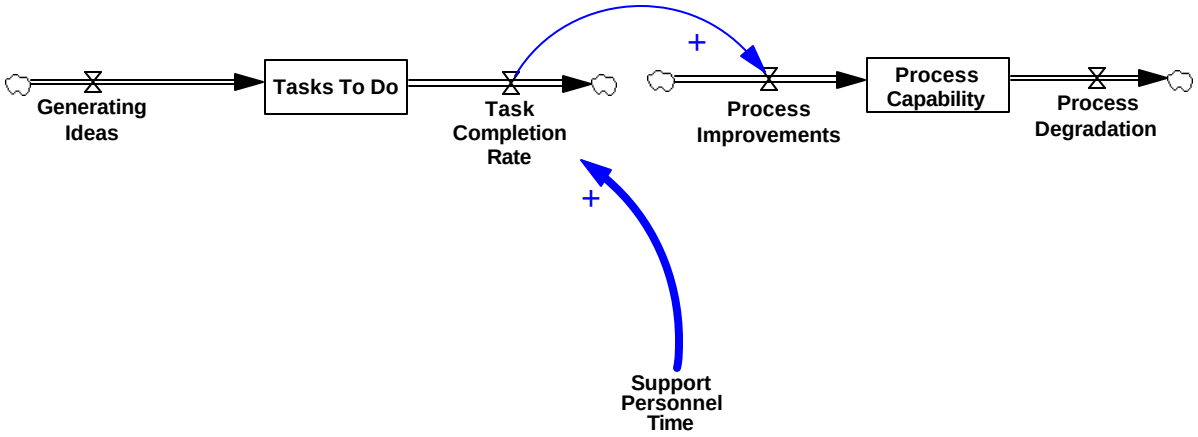
The process of matching tasks with various individual people to accomplish them was rarely given much explicit attention. Rather, the plant personnel drew upon their knowledge of the specialization and expertise of individuals, specific constraints in the union contracts, and socially understood role definitions to associate a responsibility for a particular task with an individual or group. Tasks were "engineering jobs" or "maintenance jobs." The nature of the tasks combined with a taken-for-granted understanding of who does what in such a manner that a large number of tasks fell upon a limited number of people. For example, a manufacturing engineer described his role: "So I would be responsible for taking that, [this improvement], whoever came up with it, and putting it into the actual process." The norms about who did what were powerful, yet unspoken, as evident in this description from another manufacturing engineer:

> When you are sitting in a group, … [with] some work group members and … work group advisors … and you are talking about how you are going to change this process and you are talking about moving machines around and talking about changing the manual work … You knew what your part of that job was. You had to do the process documentation. You were responsible for moving the equipment and making the layouts and stuff.

Figure 2 incorporates a new link to depict how tasks get done. I use the term support personnel to refer to the various plant personnel, external to the production work group, who are responsible for executing specific tasks associated with the improvement ideas. Support personnel include the plant engineers, the maintenance department, the materials handling department, the tool room, the work group advisors, plant management, and even in some cases production workers in other work groups such as the assembly line that is the proximate customer of the subject work group. To capture the idea that support personnel must do the work required to complete tasks, Figure 2 adds a positive link between *Support Personnel Time* and the *Task Completion Rate.* The link depicts the idea that, all else equal, as more (less) *Support*

Personnel Time is spent doing improvement tasks to support the work group, the *Task Completion Rate* will be higher (lower).

Figure 2: Support Personnel Are Responsible for Task Completion



The arrows connecting the variables are labeled with "+" signs to signify that an increase (decrease) in the first variable leads to a increase (decrease) in the second variable, all else equal (see Sterman, 2000).

The rectangle around the variable name *Tasks To Do* indicates that when ideas are generated, they accumulate, so we can think of the variable as a backlog of tasks that need to be done but have yet to be executed. *Tasks To Do* will grow as long as *Generating Ideas* exceeds the *Task Completion Rate*, which was the common circumstance. As one manager said, "The workers will always be able to generate ideas faster than we can implement them." Thus, the backlog of tasks continued to accumulate. An implementation team member discussed how the group continued generating ideas:

> So we just kept on plodding on with our stuff. Had the people creating things. I think we got the work group so far ahead of engineering that – it was bad, but there was no way that I was going to wait for a support organization to give me resources while I got the people engaged. You can't. It's like – they have to catch up.

Moreover, in addition to ideas that were consistent with the premises of lean manufacturing, other ideas such as ideas that arose simply to satisfy individual wants and desires were included and became the responsibility of these support personnel. One of the support personnel, a manufacturing engineer, noted the continuing inflow of ideas and said, "You know some of the stuff might not have even been a part of the lean manufacturing plant. It is just [that] everything

is labeled under [this program]." So, the support personnel fell further and further behind. The manufacturing engineer, for example, described the challenges he was facing as the work backlog grew:

> I still saw us coming up with all these new ideas, new plans for improvements. You know we hadn't finished the first new improvement. … You have all of these things but you didn't get anything accomplished because you have so much you have to do. You are trying to do it all in one span of time. … You have to work with one thing at a time and that was the missing piece to the puzzle. … You kept pouring in more improvements. People kept coming in with more inputs and that was before you had one output.

The work group and the implementation team were keenly aware that the things they wanted done by support personnel were not getting done and complained about it often, as evidenced in the following statements from union representatives, implementation team members, and work group members:

> If we had to have something from maintenance, they said you have to put a [requisition]. It took a month to put lines on the floor. With this kind of thing that we're going through, you can't do that. (Union official).

> But getting the people responsible to do the stuff we asked for, we still have stuff stored in our work areas that don't belong to us. Our space is being cluttered. That's one of the big things that's always a stickler. We'd get promised, oh, by tomorrow that stuff will be out of there. A week later it will be sitting there. Who's responsible? Whose stuff is this? Right now we don't need the space. So that's why they had it there. But our department never looked neat because we had just junk in there. (Production worker).

> How do you [get something done by maintenance]? Send in a work order. Well, you send in a work order and it disappears. How do you get the priority? Because we are trying to show some speed and show some commitment, but we didn't know who to plug into. (Implementation team member).

> It wasn't really [anything] overt that we're not going to do this and not going to do that, but it was just like [pause] you're pulling an ox cart through a mud pit is basically what you felt like. (Implementation team member).

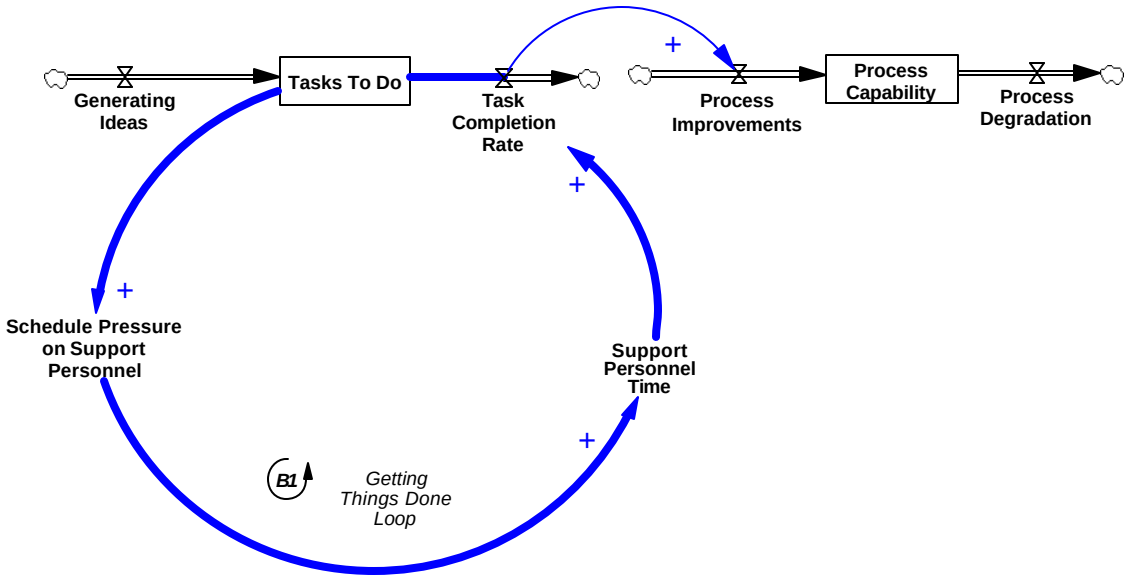
The model thus far captures three basic relationships: 1) improvement activity leads to increases in process capability; 2) tasks accumulate in a backlog when the rate of idea generation exceeds the rate of task completion, 3) support personnel are required to complete improvement tasks. The field data also show that the rate at which workers generated ideas exceeded the rate at which support personnel completed tasks, so the backlog did indeed grow. Taken together, these relations imply that a key challenge in the implementation of an administrative technology for process improvement, such as lean manufacturing, is found in the manner in which the

organization addresses the accumulated backlog of improvement tasks. Next, I turn to a discussion of the behavioral responses from support personnel, production workers, and managers.

Do A Little and Do A Little More: Responses to a Backlog of Work:

Support personnel have several options to regulate the *Task Completion Rate.* I represent each option as a balancing feedback loop that works to adjust the *Task Completion Rate* to achieve an implicit goal, such as the size of the backlog or the time lag for acting on worker suggestions. Figure 3 shows the first and simplest option. As the backlog of *Tasks To Do* grows, it exerts *Schedule Pressure on Support Personnel*, such as the engineers and maintenance personnel in the examples described above. In the manufacturing plant, schedule pressures arise from several sources. The members of the work group that have generated the ideas have expectations that the ideas will be addressed. Some members of the implementation team were themselves assigned for a limited duration of time and were striving to make meaningful progress before they had to move on to another assignment. Because this was a pilot project, it had a high degree of visibility, and, as one respondent said, "You know, management has a tendency to get impatient." In response to the *Schedule Pressure,* support personnel might increase their *Support Personnel Time* supporting the work group. More *Support Personnel Time* doing tasks leads to an increase in the *Task Completion Rate,* which in turn works off the backlog of *Tasks to Do*, thus easing the *Schedule Pressure*. The feedback loop is named the *Getting Things Done* loop and labeled Loop B1.

Figure 3: Balancing Feedback to Regulate Task Completion



The loop identifier, B1, indicates a balancing (negative) feedback loop (see Sterman, 2000).

The option in Loop B1 to increase the *Task Completion Rate* by increasing *Support Personnel Time* is limited by the total support personnel time available. In the situation of a fixed or limited resource such as an engineer's time, the additional workload created by the accumulating improvement suggestions stretches personnel to their limits. Support personnel have many demands on their time. As one union member describes, "A guy like [our engineer] and those guys, those guys are busy. They've got so many things on their platter that they can't devote the time that you need for that process." Nevertheless, as one of the implementation team members said, "Any time there was a problem it fell back on the engineers. … Everything came down to the engineers." A similar challenge arose with support personnel from other areas. Support personnel, facing task demands from other areas as well, were frequently unable to respond quickly to the needs of the work group. Another respondent, noting the sluggish responses from several groups, said, "You couldn't get anything fixed. Do you hear what I am saying? I mean, simple things like putting lines on the floor and getting things moved, it just didn't happen." As described by a production manager:

> So, [imagine] I'm in a work group. I need to get something done on my machine, and I ask maintenance to go deal with that. And I want it done right then. Right? I am empowered to do that. I am behaving in a way that is consistent with this principle. Maintenance then says, "OK, I

> have got this work group that has asked just me for some help, but I have a down machine over here. I've got to make a choice as to where I am going to work, because I am a scarce resource."

In the face of this accumulating backlog of *Tasks To Do* and in the absence of any slack time available, the options were limited. When asked what he could do about the many tasks that were piling up, one of the support personnel, a manufacturing engineer said:

> Nothing. You have to wait. That is pretty much it. You could have a meeting. Well, … we had this action item review every week … and we said, OK, here is the list of stuff that we want to get done. … Whatever resources involved will report how much time it is going to take. And every week, you know, things hadn't happened. So that was just a follow-up. What we'd do is try to push the pencil on some of the issues, and that's about all you can do.

Pressure to get work done under conditions of time, budgetary, and resource constraints is commonplace in organizational life. Yet, resourceful, dedicated individuals find ways to make do with what is available. As one team member described:

> You're given a problem and you're told to solve it. Your training says solve it. So you analyze it. You put your heart and soul into it, and you're going to work your butt off all the while getting hammered for things left and right. By God, I'm going to get this thing and its going to work. So you invest a lot.

So, the support personnel find other ways of getting things done. Some scholars view this process as one of improvisation or *bricolage* - the "use of whatever resources and repertoire one has to perform whatever task one faces." (Weick, 1993a, p. 352) The accumulating work to do challenges the support person, the *bricoleur* in our example, to respond. One option is to accept a lower rate of task completion, but this only leads to mounting pressure as ideas continue to accumulate. Another option is to increase the amount of time spent doing improvement tasks for this work group (as in Loop B1), but we have already seen that the support person (e.g., manufacturing engineer) is fully loaded with work to do. Allocating more support personnel is an option that might be available to managers but not to this person. So under the prevailing condition of fixed resources, the only remaining options available to the overworked person facing this challenge must take the form of somehow increasing the *Productivity of Support Personnel*, which implies finding a way to accomplish more tasks in the same amount of time.

It is useful here to unpack the "doing" of improvement tasks by separately recognizing what gets done from how it gets done, a distinction that echoes the pairing of the content and process of change (Pfeffer, 1997). One way for support personnel to do a task is to do most of the work

collaboratively with production workers to gain the benefits of their input and to enlist their support in making the indicated changes, engaging the work group as a partner. Another way for support personnel to do the task is to do the work alone and hand over the work product in the form of a mostly completed task. Both of these approaches are in the repertoire of how work gets done in the plant. Doing the work collaboratively is the prescribed process, consistent with the high involvement principles of lean manufacturing. But doing it alone is quicker. As a manufuacturing engineer describes:

> You'd kind of lay it out as an engineer yourself and come down and talk to the operators and they'd sign it and it's a done deal. [With] more input [from the work group], of course the process is going to be a lot longer. The process is longer to implement than actual layout moves.

The passage highlights the relative effects of the two approaches on the *Productivity of Support Personnel*: collaborating takes longer. For another example, consider a proposal to install a new piece of equipment that will improve the flow of parts through the manufacturing cell. One important set of tasks relates to selecting, purchasing, installing, and setting up the machine and specifying the actual procedure for using it to conduct the necessary machining operations. An engineer might accomplish these tasks without any worker involvement, a tactic that would more quickly result in accomplishing the specific physical tasks than a more drawn out approach that relies on active worker involvement in many of the decisions that need to be made. Consider the apparently simple question as to where on the floor to install a piece of equipment, as described by a manufacturing engineer tasked with procuring and installing the new machine:

> You've got, in some cases, three to five operators across two or three shifts and every one of them has got their own idea of how they should do this. The machine needs to be three inches to the left. No, the machine needs to be 8 inches forward. No, this machine needs to be turned 90 degrees. No it doesn't. Ok, and it just goes on and on and on and on and on and it's never ending.

By reducing the amount of collaboration and focusing on executing the operational content of the improvement tasks, the support personnel can increase their productivity. An apparently subtle change in how the support personnel does the work, not what work he or she does, influences the rate at which the work gets done. A production manager described the tendency to shortchange the amount of collaboration:

> People love to take shortcuts. [For example, I've seen people say] screw it. I'm just going to tell the operator what to do and I'm not going to go find the steward so that we can do it together. … I want this operator to do something, right? Rather than talk about the idea with the steward and then jointly go and tell the operator that this is what we need to do, I'll just go and tell them. … Rather than me go to the steward and say … you know, we've got this problem, what if we were

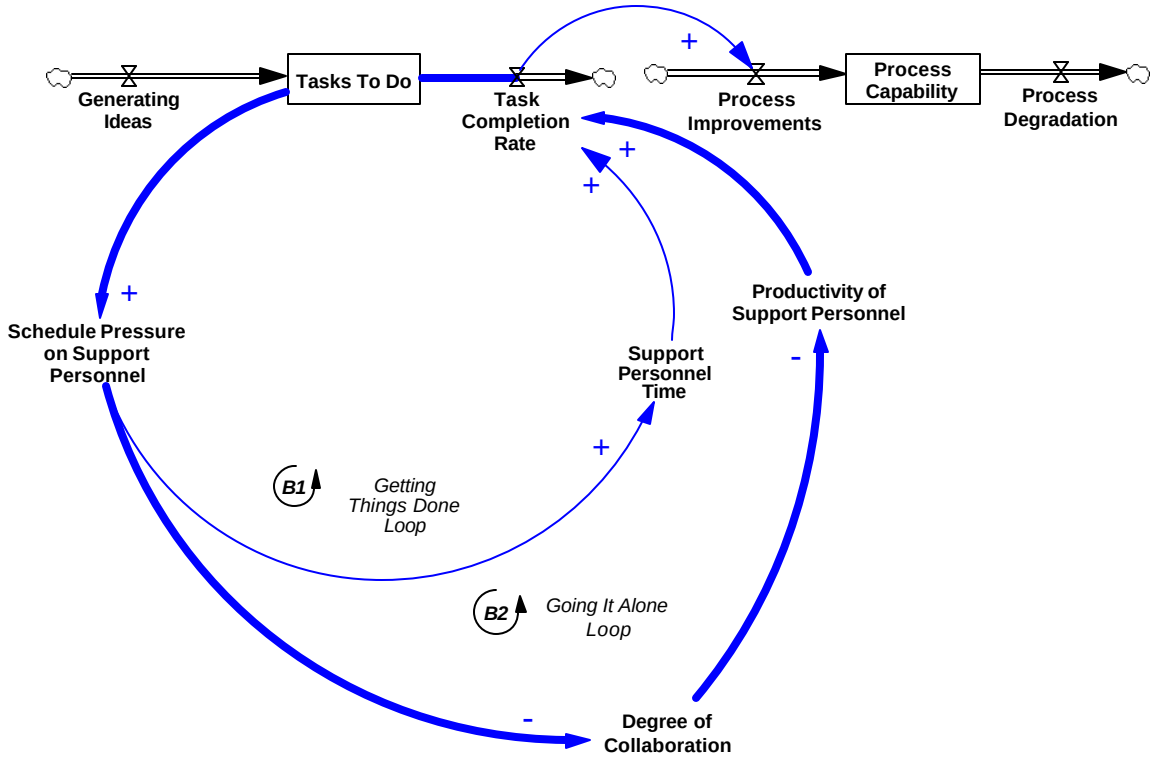
> to do this and what if [we were] to ask [the production worker] to go and do this, this, this and this? What do you think? You know -- we just say no, just screw it. [Production worker] just go do this. And [the production worker] goes, "You know, I'm not sure I want to do this." "I want to go talk to the steward." And the steward says, "Well shit, I don't know anything about it." Well that implies that, you know, don't do it, right? "Wait until I go and talk to the work group advisor about this." And then the steward goes and sees the work group adviser and says, "What the hell are you doing telling [the production worker] to go and do this for?" "You know, I mean that doesn't make any sense. I mean [jeez], if you had talked to me -- now you haven't. Now he's all pissed off and gee, I can't support this." Right?

Working in a less collaborative manner is one type of shortcut. Other researchers have documented the use of shortcuts in response to time pressure. For example in a commercial bank, lending officers facing work pressure from a backlog of orders cut corners to reduce the time they spend on each customer order (Oliva & Sterman, 2001). Another shortcut is to do the easiest work first, as an engineer describes:

> You keep adding to the action register list and you keep completing the first item. … We didn't put an actual priority that I can remember on any specific issue. The easiest thing always got completed first. The hardest thing got completed last. It didn't matter if the hardest thing was the first thing coming along. It was the easiest thing that got completed first.

The use of shortcuts to increase productivity creates another balancing feedback loop, as shown in Figure 4. An increase in *Tasks to Do* causes an increase in *Schedule Pressure on Support Personnel*. In response, the support personnel conduct their work in a less collaborative manner, spending more of their time working alone and consequently less time working collaboratively. The character of how the support personnel do the improvement work changes, captured in Figure 4 as a reduction in the *Degree of Collaboration*. Because the less collaborative way of working is quicker, the lower *Degree of Collaboration* yields a higher *Productivity of Support Personnel*. The resulting increase in the *Productivity of Support Personnel* raises the *Task Completion Rate*, which draws down some of the backlog of *Tasks To Do* and thus relieves some of the *Schedule Pressure.* The balancing loop thus formed is named the *Go It Alone* loop and designated Loop B2 in Figure 4. The accumulating backlog of *Tasks To Do* is a different set of specific tasks for the various support personnel in the plant, but the basic dynamics are similar. The accumulating backlog yields pressures that increase the likelihood of executing tasks through less collaborative or participative means to complete them in a timely (or less tardy) manner.

Figure 4: Balancing Feedback from Support Personnel's Response to Schedule Pressure



The essential cha racteristic of these shortcuts is they accomplish similar content in the completion of an the instrumental task at hand, but they do so with a different process. They contribute to the *Task Completion Rate* but they are not based on the involvement of the work group members. Equipment gets purchased, but workers may not have been involved in their selection. Layouts get designed, but the work group does not participate in the active discussions they would have with a high involvement approach. The instrumental character of the task is completed, but the social elements are given lower priority. The responsible individual is able to claim the task is completed. As a production manager said, "[You can tell your boss that you] got the machine." However, the benefits of engaging the workforce in the process have been circumvented. The production manager continues, "You believe that you'll be able to take the shortcut, but in the long run the shortcut is going to set you back." Indeed, it is the long run consequences of these shortcuts that are critical to the pattern of start and fizzle.

Do It Alone, Learn A Little Less: Consequences of the Shortcuts

Reducing the *Degree of Collaboration* leads quickly to a reduction in *Schedule Pressure*, but circumventing the involvement of the workforce has delayed costs. Two such costs arise from losing experience in the practice of collaborating and experience with the updated production process.

Collaborative work between support personnel and production workers is a source of experience in the practice of collaborating. As they accumulate experience doing work collaboratively, they build a resource available to them to facilitate future collaborative work, a form of social capital (Coleman, 1988). Collaborative work enables the development of trust, enhances social relations that can facilitate the flow of information, and may foster the formation of norms for how collaborative work is done (Coleman, 1988). Collaborating also facilitates the emergence of transactive memory systems (Wegner, 1986). Previous research has shown that team members who train together rather than separately trust each other's expertise more, coordinate task activity better, and develop more accurate perceptions of who knows what, with consequent improvements in performance (Liang, Moreland, & Argote, 1995; Mooreland, Argote, & Krishnan, 1996; Mooreland, Argote, & Krishnan, 1998). Performance may also be improved as individuals develop more skill with collaborative work in general, for example through learning to adjust their behavior to complement other team members (Reagans & Argote, 2002).

Figure 5 adds a new construct to the model: *Collaborating Experience*. The link from *Degree of Collaboration* to *Collaborating Experience* captures the relationship between doing work collaboratively and building experience. As the support personnel do work collaboratively, they learn by doing collaboration, and they build skill and social ties. The rectangle around *Collaborating Experience* represents the accumulation of this experience as the support personnel work collaboratively with production workers. The link from *Collaborating Experience* to *Productivity of Support Personnel* captures the effect on performance: the more *Collaborating Experience*, the greater the *Productivity of Support Personnel*. The new links close an important new feedback loop, named the *Social Capital* loop (Loop R3 in Figure 5). In contrast to the balancing loops described before, the social capital loop is a reinforcing (deviation-amplifying) loop that tends to reinforce and amplify an initial disturbance (Masuch, 1985; Merton, 1948; Weick, 1979). Consider a reduction in the *Degree of Collaboration*, which

might result from the response of the support personnel to *Schedule Pressure*. As the support personnel decrease their *Degree of Collaboration*, the level of *Collaborating Experience* declines, which in turn decreases the *Productivity of Support Personnel* and lowers the *Task Completion Rate. Tasks To Do* decrease more slowly, maintaining higher levels of *Schedule Pressure on Support Personnel* and leading to an even further reduction in the *Degree of Collaboration.* The cycle continues as support personnel further reduce their collaborative time, undercutting collaborating experience and reducing productivity still further. However, a reinforcing loop can operate in the favorable direction as well, as a virtuous cycle. As support personnel increase their *Degree of Collaboration,* they build more *Collaborating Experience*, increasing their *Productivity* and boosting the *Task Completion Rate*, which drains the stock of *Tasks To Do* more quickly, easing the *Schedule Pressure on Support Personnel* and favoring an even further increase in the *Degree of Collaboration*.

Figure 5: Consequences of How Improvement Work is Done (Collaborative Time per Task)

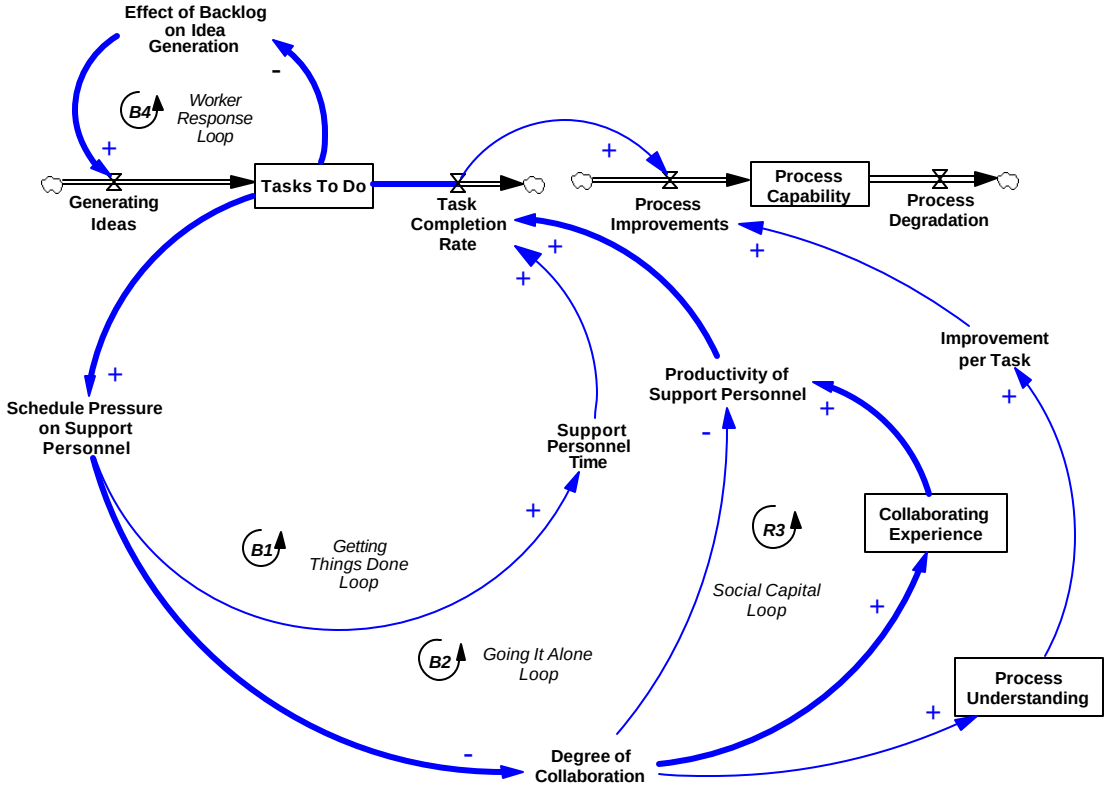


Figure 5 shows a second delayed consequence of collaboration. Collaborative work between support personnel and production workers enables the production workers to develop experience with both the particular production process and the improvement activity. With more such experience, the production workers are able to generate better ideas for future improvements. In contrast, when workers are not involved in implementation activities, their understanding of the modified production processes may even decline. For example, consider what happens when a newly acquired production machine experiences problems. A machine operator who has participated in the specification and selection of the new equipment is more likely to suggest effective solutions than an operator who has not been involved. A production manager described how the operator and manufacturing engineer collaborate to solve problems:

> If something's wrong, all right, [the manufacturing engineer will] definitely tap into the operator's knowledge to help try to understand, to help him understand what could possibly be going wrong with this piece of equipment.

Yet the ideas from the production workers vary in how much they contribute to improvement. In the following quote, a production manager explains how production workers use a new system to identify improvement ideas. A suggestion with adequate detail is actionable and useful, whereas a simple note, such as "winder down," is not.

> Identify what the problem is. I'm very specific. It's not just "winder down." Okay? It's brass tag [number so and so] and it's fault code F9, wire tension fault. Okay? So if I collect that data and I can turn that into usable information, in other words, at the end of the week you know what? My number one downtime issue was fault code F9, low wire tension fault, right, on brass tag [so and so], I know that that's what I need to fix, right? … "Winder down" doesn't help us. "Winder down, fault code F9 low wire tension" is what we need.

An interconnection between the process of change and the content of change arises because more worker involvement through collaboration (process) builds worker understanding, which in turn influences the improvement ideas (content) they generate. Collaborating with the support personnel in improvement activities provides production workers with an opportunity for learning by doing, leading to a subsequent boost in the quality of ideas for further improvements. As shown in Figure 5, when the support personnel increase the *Degree of Collaboration* (i.e., support personnel spend more time with production workers), the production workers gain *Process Understanding* enabling them to generate ideas that contribute more *Improvement per Task*, leading to a higher rate of *Process Improvement*. The additional links through *Process Understanding* do not close any new feedback loops, but the accumulation by the workers of

Process Knowledge introduces an important delay that contributes to the dynamics. The effect of a change in the *Degree of Collaboration* on *Improvement per Task* will not be felt for some time. Thus, if support personnel decrease their *Degree of Collaboration*, there will be a gradual reduction in the workers' *Process Understanding*, a form of organizational forgetting (Argote, 1996). However, the *Process Knowledge* accumulated based on earlier collaborative work will remain useful and continue fostering good ideas for some time. Eventually, lower *Process Understanding* will compromise the quality of the workers' ideas, so *Improvement per Task* will decline, leading to a slower rate of *Process Improvements.* If the rate of *Process Improvement* falls below the rate of *Process Degradation*, then *Process Capability* will also decline.

The notion of learning by doing has a long tradition in research starting from Wright (1936) who documented learning curves that describe the link between cumulative experience and some measure of performance. Although there is wide variation in the rates at which organizations learn from experience (Dutton & Thomas, 1984), learning curves have been found in many industries (Argote, 1996; Pisano, Bohmer, & Edmondson, 2001) and in a range of functions including manufacturing (Argote & Epple, 1990), services (Baum & Ingram, 1998), surgery (Pisano et al., 2001), product development, and process innovation (Hatch & Mowery, 1998).

For ease of presentation, Figure 5 represents one specific shortcut, reducing the *Degree of Collaboration*, but there are other examples of shortcuts that lead to a short-term increase in the *Task Completion Rate* at the expensive of undermining the collaborative involvement of the workers. One example comes from an implementation team member who was getting impatient about a lengthy delay in getting a new piece of equipment (a lathe). Rather than waiting for the assigned manufacturing engineer (a support person) to work through the collaborative process of developing a new work process, designing a machine layout for it, and developing the associated work standards, the implementation team member chose to do these tasks on his own. Because he himself is an engineer with strong background in lean manufacturing, one alternative for executing the design tasks was to take matters into his own hands. He describes how he reacted to the long delay:

> Still no lathe. Still no standard for the lathe. This thing was supposed to be in there in December. We don't know how long it takes to do this and to do that. I can estimate it, but I can't estimate it in [our] system [laughter]. …Then it was the first couple weeks in January. I just got so

> frustrated. I finally took their standards and I created a layout for them, and I created a work path for them as options.

Note in the following quote how the support personnel follow an approach that shortchanges collaboration, how the result compromises the workers' ability to get involved, and how nevertheless the approach leads to a perceived outcome of task completion. A production manager describes how a group of support personnel, including himself, took an approach with a low degree of collaboration"

> We didn't do a good job of sharing what we were doing. The vision, the knowledge, the tools, so that they [the work group] could then apply their thinking and have input into this process.
>
> Q. Who's we?
>
> You know, a few of us. [The work group advisor], the engineer, one operator, me, and [an outside consultant] actually did it. Okay? And, the intern. And so you know, we did it, right? We implemented this new layout and the work group seems to be working reasonably well with it.

Responses of the Work Group

Support personnel manage *Tasks To Do* through balancing loops that work by adjusting the rate at which tasks flow out of the backlog. Because they are the primary idea generators, workers have an additional option: to adjust the rate at which tasks flow into this accumulation. Workers may become disillusioned when the response to their ideas is slow or nonexistent. Workers may also recognize that support personnel are overworked and perceive they are unable to handle any additional workload. The feedback from the backlog to the rate of Generating Ideas is another balancing loop, the worker response loop B4 shown in Figure 5. When the backlog of *Tasks To Do* is high, the *Effect of Backlog on Idea Generation* is to slow down the rate of *Generating Ideas*. In the extreme, *Generating Ideas* will reach a standstill. As one production worker said, "It got to the point where people [were] thinking about dropping out because we can't get things done." A union official noted how the production workers reacted to the slow rate of getting improvement tasks done:

> The people get disinterested. … They see the results, they get somewhat excited about it. But that dissipates over time when you're not making progress. That's just the way it is. They were running into all kinds of obstacles out there, in terms of trying to get things done.

The presence of the worker response loop has a stabilizing effect on the behavior of the system. Moderating the flow of new ideas into the backlog when the support personnel are already experiencing high levels of pressure to get their work done prevents the backlog from growing so large as to overwhelm the support personnel. Without the worker response loop, a sustained rate of *Generating Ideas* much greater than the *Task Completion Rate* would cause the continued growth of the backlog and a concomitant continued increase in *Schedule Pressure*. *Degree of Collaboration* would drop and stay low, leading to the eventual loss of *Collaborating Experience* as well as worker *Process Understanding*, forcing the support personnel into habitual reliance on working without collaboration to implement ideas that became less and less helpful. The organization would be working harder and harder to get less and less done. Despite the stabilizing effect of the worker response loop, it has other consequences. Workers suppress their otherwise good ideas, so there is an opportunity cost associated with the ideas they do not contribute. Worse yet, the unspoken idea is also unrecognized, so actors in the system are unaware of the opportunity cost they are incurring.

Interaction with the Managers

The description so far has emphasized the activities among the work group and the support personnel. As events unfolded, support personnel were in great demand, and their limited availability was an issue. In this section, I turn my attention to the managers (or others who have influence on the support personnel in question) and how they dealt with this issue.

The work group and implementation team were continually frustrated by the delays in getting assistance from support personnel and called this problem to the attention of management. As one production worker describes:

> We always had updates to the leadership group on how things were going. … They asked what we needed, and our request was we need a list of people that we can go to, maintenance, facilities, that we can call on the phone or whatever and get things done.

Thus, the request from the implementation team to management was to somehow increase the *Support Personnel Time*, as shown in a new balancing loop, the *Hear What They Say* loop B5 in Figure 6. The request if for managers to notice an increase in *Schedule Pressure on Support Personnel* and therefore increase the *Managers' Allocation of Resources*. The extra *Support*

Personnel Time would increase the *Task Completion Rate,* thus reducing the backlog of *Tasks To Do* and easing *Schedule Pressure*. The allocation of more personnel as *Schedule Pressure on Support Personnel* goes up and is perceived by the managers balances the original increase in *Schedule Pressure*.

The production workers and implementation team members were quite aware of the lack of adequate response from support personnel to execute tasks in a timely manner. They frequently raised the issue, but the managers did not alleviate the situation. A union official described how pervasive this issue was:

> [The managers] are running 99 miles per hour trying to get this done, but they are not thinking about all the things that need to be in place to get it done. I said you've got to stop and smell the roses. They said we're going to get this done. I said well who is going do it. Well, we're going to get that done. Well, by who? Right? The answer is kind of always to just blow over that question. I said you know what, this is amazing, why you won't listen to what I'm trying to say to you? But it all comes down, again, to the resources, in my mind, … but they won't commit to them.

The support personnel needed to support the improvement efforts were not readily available in the plant, but the managers could have freed some of these internal personnel by setting priorities. Alternatively, the managers could have turned to other areas in the company to secure personnel. Although the managers did not do so, one production manager explained that it could have been done:

> We've got some resources internally and if we don't have internal resources, we've got capable people at the [other facility] that if we really needed to, we could make a case for re-appointing some people or asking for some support from the [other facility].

Were the managers simply being unresponsive to the requests from the workforce? Or, is there another explanation? To explore this question, consider how the actions of the work group and implementation team may have influenced the managers.

An important consequence of the shortcuts described earlier is that in most cases, these efforts generated signals that improvements were being made and even led to positive business results (e.g., improvements in cost, quality, or delivery). The most salient performance problem is a stock-out of parts when needed by the assembly line. The situation in the work group before the improvement initiative started, as described by the production manager was that:

> We were not doing very well in [this manufacturing cell]. It was almost a daily phone call from [the other engine plant about] the fact that we shut them down for some reason or other because of a quality issue or lack of product. So we weren't feeling really good about what was going on down in [that manufacturing cell].

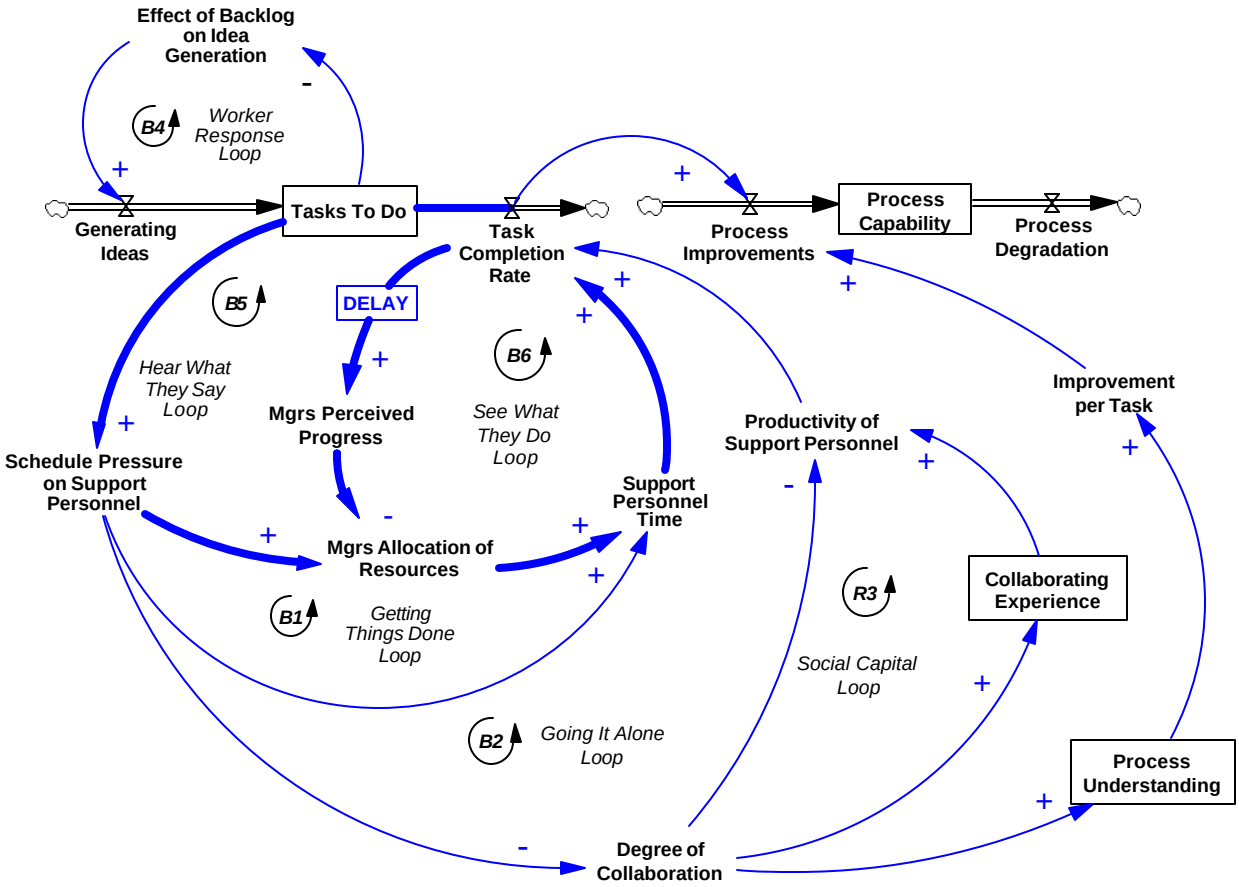
But, the efforts in the work group had begun to significantly improve the situation. As one union member described:

> They were making the right part at the right time. … You didn't have all of these emergencies [such that] if we don't run Saturdays and Sundays, the [assembly] line isn't going run on Monday. The things in the supermarket were being filled, and they were holding up pretty decent.

The performance improvements were thus quite salient. So, from the perspective of the managers, the improvement initiative was beginning to show tangible signs of progress and some meaningful business results.

These signs of progress are another source of feedback to managers and give rise to additional interconnections shown in Figure 6. An increase in the *Task Completion Rate,* after some delay for the outcomes of the task to become visible and the managers to notice them, leads to an increase in the *Managers Perceived Progress*. All else equal, as *Managers' Perceived Progress* goes up, the managers perceive less of a need for resources, so *Managers' Allocation of Resources* goes down. These new links from *Task Completion Rate* through *Managers' Perceived Progress* to the *Managers' Allocation of Resources* close another important balancing feedback loop, labeled the *See What They Do* loop (Loop B6 in figure 6). To continue tracing around this loop, note that as *Managers' Allocation of Resources* goes down, *Support Personnel Time* also falls, leading to a slower *Task Completion Rate.* The *See What They Do* Loop is a balancing loop that seeks to adjust the availability of personnel to achieve an implicit rate of task completion desired by the managers. It works to offset an initial increase (decrease) in the *Task Completion Rate* by tightening (loosening) resource constraints, thereby causing a balancing decrease (increase) in the *Task Completion Rate.*

Figure 6: Interactions with Managers and Resource Allocation



The See What They Do loop shows an important unintended consequence of the local efforts of the participants to do what they could under the constraints they faced. Consider an increase in *Schedule Pressure* as *Tasks To Do* increases. With increased *Schedule Pressure*, the support personnel reduce their *Degree of Collaboration*, which accomplishes the immediate objective of increasing the *Task Completion Rate.* But the very success the support personnel have in accomplishing these tasks with the shortcuts they improvise, such as doing things less collaboratively, sends a signal to managers that the work is indeed getting done. Seeing the work get done, the managers feel less pressure to allocate more personnel, so the support personnel get locked in to a pattern of working with less collaboration. The more productivity gained from reducing collaboration, the stronger the boost in getting tasks done will be. The more effective the shortcuts are at increasing productivity, the more they undermine the fundamental solution to the problem they are addressing - excess work to do.

The managers face a difficult challenge to marshal an appropriate level and mix of personnel availability. Balancing the supply and demand for support personnel is complicated by many factors, such as the costs of the personnel, the complex array of skills that may be required, the irregular temporal pattern of demand for them. Commenting that the cost of personnel should be obvious, a production manager said:

> People lose sight of that [idea that personnel aren't free] They think it's other people's money which means it's somehow not money.

Indeed, another production manager explained how a perceived personnel shortage was not only commonplace, but expected:

> We're never going to have enough resources to do everything that everybody wants when they want it done. It just ain't going to happen. So, it's not a problem that we can solve with resources. Really, it's a tension that exists in the business. … We have to manage it by indicating that people are going to have to make choices, and it's not that they're just blowing you off. … We're never going to have enough maintenance people to be responsive to every idea that every operator has on the shop floor. Right? It ain't going to happen. That's just part of the reality of how it works.

The challenge is more than just making more support personnel time available. The challenge is to make the right person with the right skills available at the right time. When asked why the managers did not allocate more support personnel, one answer from a production manager is simply that it is difficult to anticipate the needs:

> We [management and front-line workers] are not as good at defining what resources are needed. … I don't think that we do a very good job of being clear about what is the work we need to do … or when does it need to be done …and who are the resources to get it done [and] how we support that work to get it done when we said it was going to get done. Around here it seems to be it'll get done when it gets done

Moreover, in many situations the key person is a "shared resource" with duties that span many areas in the plant. As another production manager explains:

> People are going to wrestle with the fact that others need to be responsible to others. … The people need to be able to accept the fact that right now I can't be responsive to that work group because I have a more urgent need for the business, and I have to be willing to accept that.

But despite some complaints about slow responsiveness and requests for more support personnel, changes were getting implemented, which provided the managers with tangible evidence that allowed the managers to believe that the personnel shortages were not that critical. Over the first several months of the change efforts, managers frequently described positive outcomes and made favorable assessments of progress. One production manager described other improvements he saw:

> The actual flow of material through the workgroup. The actual staging of material. I mean, we [used to] run out of stuff because we couldn't find it, not because we didn't have it. And that's been a big improvement. Certain things go in certain places now that used to pretty much just be anywhere before. It's not as good as it needs to be. There still is a lot of work that needs to be done there, but we are not – it looked that somebody had just dumped a dump truck of cardboard boxes in the inbound supermarket, or on the inbound inventory side of the business. Things are a little more orderly than that now.

Figure 6 shows that two balancing loops, B5 and B6, work to influence the *Managers' Allocation of Resources*. These two loops often will be working in opposite directions. For example, high *Schedule Pressure on Support Personnel* indicates a need for more personnel, yet a high *Task Completion Rate* and thus high *Perceived Progress* indicates less need for personnel. The managers' policies for allocating personnel depend on relative strength of these two influences. There are many reasons to explain why the managers favored the salient and optimistic interpretation described in the See What They Do loop. First, the optimism is plausible. Managers were exposed to signals that may give them a mistaken impression about the progress of the improvement initiative. In light of a support personnel shortage, the people focused on the improvements chose tactics that circumvented the high involvement approaches that were the intent of the program. These efforts did indeed generate some positive and salient results, even if temporary. Managers were thus given a false sense of the progress of the program. Second, accomplishing tasks is more salient than doing work collaboratively. Research has repeatedly shown that people overweight salient and available information (Taylor & Fiske, 1975; Tversky & Kahneman, 1982), a bias that has been implicated in failures to learn and in the pathology of process improvement (Repenning et al., 2002; Sterman, 1994). Third, reporting practices exacerbated this optimistic interpretation of progress. The work group and implementation team themselves often reported with pride the accomplishments they were making. Indeed, in the very presentations during which they asked the managers to assist with the shortage of support personnel availability, the implementation team reported continued progress to the managers. Several months after the start of the initiative, the work group and implementation team presented a progress report to the plant management. Using 23 PowerPoint slides, seven production workers conducted a presentation complete with before and after pictures, graphs and charts of progress. They reported improvement activity and claimed savings from reductions in floor space, set-up time, overtime and scrap materials and benefits from increases in in-stock percentages of finished goods. The presentation emphasized progress, success, enthusiasm, and

positive business results. The group did raise the issue of the need for support personnel - in one bullet point on one of the 23 PowerPoint slides that was discussed for less than 2 minutes out of the 30-minute session. The plant management was so impressed with the progress that they arranged for the workgroup to make the presentation to three other groups of managers from the company, including the senior executive team of the manufacturing division. By the time the work group presented to these senior executives, the presentation had grown to 42 slides. The slide that noted the need for support personnel had been dropped, and a new slide showed an email to the plant managers and the work group from their main customer in the other production facility:

> As you can see from the attached chart significant improvement has occurred over the last month. Keep up the good work!

Moreover, the managers themselves frequently described the successes of the improvement program in presentations to peers, conversations with plant employees, and discussions with each other. Both the individuals doing the work and the managers put a positive spin on the results.

DISCUSSION AND IMPLICATIONS

In the preceding analysis, I have drawn from a field study of process improvement at a manufacturing plant to elucidate key feedback relationships and induce a model of organizational change. Following Repenning and Sterman (2002), I have posited a feedback structure that calls attention to critical interactions between characteristics of the workplace and the behaviors of the agents acting in the system. I offer a more finely grained analysis that examines the interactions among the work of several groups of personnel on the shop floor and the work of managers. The model explains how people's well-intentioned actions interact to determine the observed pattern of behavior at the organizational level. I find that a high involvement improvement program, such as lean manufacturing, constitutes a feedback structure with the potential to be self-limiting. The generation of ideas through high involvement activities generates demands on key personnel and induces the people involved to find ways to work around the resource constraints they face, but the workarounds undermine the effectiveness of future implementation. I have examined four consequences of these workarounds, the ways people make do with what they have available to do the best they can under the circumstances. First, the efforts do generally yield

results - that is, the intent of getting the work done is realized. Second, the approaches they take include ones that circumvent the intended high involvement of the work force, thus precluding the development of resources in the form of human and social capital that benefit future implementation. Third, circumventing the high involvement of the workforce also compromises worker understanding of the new production processes. Fourth, the successes they generate with their ways of working around the support personnel constraints send signals to management that more personnel are not needed and thus counteract their requests for more support personnel.

The analysis draws on data from one longitudinal case study and thus carries the usual limitations for studies of this sort. Questions about limits to the generalizability of the results point to directions for future research. While additional longitudinal studies of the implementation of lean manufacturing would enrich the empirical database from which to induce more general theory, studies of other administrative technologies that rely on high involvement are also called for. Another dimension of generalizability relates to social capital. Future work might investigate the relationship between social capital and positive feedback, paying particular attention both to processes by which social capital is built, analogous to working collaboratively in the present study, and to other influences of the social capital, analogous to enhanced productivity of collaborating. Despite the limitations, the paper offers another longitudinal study of change to contribute to our empirical data set and responds to a recognized need in the scholarly literature. "The most compelling [challenges] are the requirement to link context with action and the concomitant need to expose processes and mechanisms of change through temporal analysis. … The task becomes to identify patterns in the process of changing" (Pettigrew et al., 2001, p. 700).

My analysis identifies a set of reciprocal interactions between the process and content of change that highlights the mutual causality between action and structure (Barley, 1986; Giddens, 1984; Orlikowski, 1992). My analysis suggests that actors in the production facility drew on knowledge of their prior action, embodied in socially understood norms and rules about who does what, to assign tasks to individuals. In doing so, they reinforced rules for assigning work, constituting and reconstituting a process of changing. They applied deeply embedded rules regarding who does what in a manner that overloaded some agents (support personnel, such as

manufacturing engineers) who bore responsibility for implementing many ideas. The ongoing process of accomplishing these tasks evolved, as overburdened actors were increasingly likely to forgo collaboration with other actors who had suggested the tasks in the first place. The recurrent practice of support personnel executing these tasks with a low degree of collaboration reconstituted and reinforced a rule that support personnel conduct such tasks. Moreover, the less collaborative process shortchanged opportunities for both the support personnel and the work group to learn and cultivate skills in collaborating and implementing ideas. As the change process evolved, so did the content of the modifications it produced, as the nature of the improvement ideas drew on the accumulated knowledge of the workers.

This study has several implications for understanding organizational change. First, the study suggests that consequences arising from personnel shortages during periods of change may be far more insidious than we realize. The study highlights the problems that managers face in allocating support personnel. Managers know that fewer support personnel will mean less work gets accomplished in a given timeframe. However, my analysis identified another consequence of personnel shortages, one that managers are unlikely to account for in their allocation decisions. Under conditions of personnel shortages, industrious employees find ways to make due with what is available and indeed somehow manage the ongoing challenges of organizational life. But the short term solution to a personnel shortage may have undesirable long term consequences, especially in the erosion of organizational capability. The ongoing accomplishment of work under these conditions enacts a structure that influences the way work continues to get done. Under conditions of constrained support personnel, organization members learn ways of working and develop social relationships that determine the future course of organizational life.

The notion that building organizational capability requires an investment of resources is not new, but the study here adds two points to suggest that managers may be unwittingly undermining their own futures. First, the self-reinforcing nature of alterations in how work gets done recasts the magnitude of the concern. Initial changes in work practices to meet the challenges of constrained personnel can easily become locked in. Second, because managers are likely to be slow to recognize personnel shortages, the shortage conditions are likely to persist. Work does

get done, and changes do get implemented, so managers see tangible evidence that things are not that bad. Negative consequences of personnel shortages are often less salient, less certain, and result only after a significant delay compared to the vivid, certain, and immediate outcomes they notice. Researchers have documented the tendency of people to overweight salient and available information, to fail to recognize important delays, and to exhibit an aversion to risk (Dawes, 1988; Kahneman, Slovic, & Tversky, 1982; Sterman, 1994). Repenning and Sterman (2002) discuss how these effects yield a preference for work for which the outcomes are salient and are achieved with short delays and greater certainty. Taken together, these additional insights suggest that much of organizational life may take place in the aftermath of personnel shortages.

A second important implication of recognizing the co-evolution of process and content is that imitating another organization's practice is far more difficult than organizational theorists or practitioners often appreciate. An examination of another organization's current practice reveals the nature of their practices in the present, but it reveals only partial information about the trajectory through which the organization has evolved. Popular techniques such as benchmarking and the documenting of best practices focus attention on a static view of current practice, at the risk of missing the importance of the co-evolution that has preceded current practice. Moreover, an implicit assumption is that the imitating organization copies the other organization's practice. But such copying is fundamentally different from copying the co-evolution through which the organization has gone. Such a difference has important implications for framing the challenge. The former suggests the approach is one of implementing or adopting a change. The latter suggests more attention to the importance of making a transition. The transition challenge is apparent in the present study. A production system with highly developed participatory work practices may indeed reduce the need for support personnel, in the short run developing the system requires more support personnel. This study suggests that a richer appreciation of this transition problem is needed, not only among managers of organization change but also among the scholarly community.

The model presented here has several implications for improving how we manage planned change. Under some conditions, the organization begins to implement process improvements, enjoys a period of superior performance, and then subsequently enters a phase in which

improvement implementation stalls and performance eventually declines. However, the feedback theory of this model suggests that under different conditions the organization would begin a similar pattern of improvement activity but would then be able to lock in a sustained level of superior performance. The key difference in the two outcomes is that for sustained change the organization makes a transition to a regime that continues accomplishing a higher rate of process improvement. Because the human and social capital built through the experience of collaborating makes working collaboratively more efficient, the pressures to take shortcuts are small, working collaboratively is favored, and the human and social capital are maintained or built further. The transition is a form of "tipping" in which the system passes a threshold beyond which the new behavior becomes entrenched. Tipping behavior is observed in many systems, such as disease epidemics, product development, and in collective behavior (Granovetter, 1978; Repenning, Goncalves, & Black, 2001; Sterman, 2000). The challenge for managers is to orchestrate the conditions that favor tipping toward the desired regime. In this model, tipping results from the interaction of the Going It Alone loop (the balancing loop B2) and the Social Capital loop (the reinforcing loop R3). There is some critical combination of support personnel, decision rules, and social capital such that the reinforcing loop is just able to dominate the balancing loop. The next essay in this dissertation develops a formal mathematical mode to examine the tipping phenomenon more closely.

The suggestion to shift attention away from explicit improvement tasks and toward building the capability for future improvement echoes themes in organizational learning. The sustainable advantage is found not so much in improving the primary work processes but in improving the more general ability of the organization to continually improve itself (Senge, 1990). For example, in an empirical study of performance outcomes associated with TQM, Powell (1995) found that it was not the TQM tools and techniques but the tacit resources - such as an open culture, employee empowerment, and executive commitment - that can produce competitive advantage. Accomplishing tasks that lead to improvements in process capability can be considered a form of first-order change, whereas building experience so as to collaborate more effectively in the future can be considered second-order change (Bartunek & Moch, 1987). The way in which support personnel interact with shop floor workers is governed by organizational routines (Cyert & March, 1963; Nelson & Winter, 1982), and "engaging in organizational

routines can be a process of learning" (Feldman, 2000, p. 625). Routines that are learning processes are examples of double-loop learning (Argyris & Schon, 1996). The present work builds on the organizational learning literature in two ways. First, it locate locates the organization's capability to improve as a component of a critical positive feedback process. Second, it describes one process, in the balancing shortcut loop, that can undermine efforts to build such learning capabilities.

This work has implications for how we study change in organizations, because it focuses our attention on the interactions between managers, shop floor workers, and other groups of employees. The groups, apparently acting in their own best interest, generate outcomes that are in conflict with their apparent objectives. Similarly, this work has implications for practice, since it calls attention to some of the potential pitfalls in a high involvement improvement program. In particular, this work highlights the critical importance of support personnel. Moreover, the feedback structure posited here describes some potential barriers to the organization's ability to sustain momentum for change. The interactions are subtle, masked by the apparent progress that effective shortcuts generates, and embedded in complex feedback processes. Powerful biases favor interpreting the course of events as the best of times, even when the critical resource of social capital is deteriorating, so also enacting the worst of times. Managers and researchers both stand to gain from a shift of attention away from the salient content of improvement activity and toward the way in which work gets done builds the capability for future success.

REFERENCES

Amburgey, T. L., Kelly, D., & Barnett, W. P. 1993. Resetting the Clock: The Dynamics of Organizational Change and Failure. ***Administrative Science Quarterly***, 38: 51-73.

Appelbaum, E., Bailey, T., Berg, P., & Kalleberg, A. L. 2000. ***Manufacturing Advantage: Why High-performance Work Systems Pay Off***. Ithaca, NY: Cornell University Press.

Argote, L. 1996. Organizational Learning Curves: Persistence, Transfer and Turnover. ***IJTM, Special Publication on Unlearning and Learning***, 11(7/8): 759-769.

Argote, L., & Epple, D. 1990. Learning Curves in Manufacturing. ***Science***, 247: 920-924.

Argyris, C., & Schon, D. A. 1996. ***Organizational Learning II: Theory, Method, and Practice***. Reading, MA: Addison-Wesley.

Armenakis, A. A., & Bedeian, A. G. 1999. Organizational Change: A Review of Theory and Research in the 1990s. ***Journal of Management***, 25(3): 293-315.

Arthur, W. B. 1989. Competing Technologies, Increasing Returns, and Lock In by Historical Events. ***Economic Journal***, 99: 116-131.

Barley, S. R. 1986. Technology as an Occasion for Structuring: Evidence from Observation of CT Scanners and the Social Order of Radiology Departments. ***Adminstrative Science Quarterly***, 31: 78-108.

Barley, S. R. 1990. Images of Imaging: Notes on doing Longitudinal Field Work. ***Organization Science***, 1(3): 220-246.

Barnett, W. P., & Carroll, G. R. 1995. Modeling Internal Organizational Change. ***American Review of Sociology***, 21: 217-236.

Bartunek, J. M., & Moch, M. K. 1987. First-order, second-order, and third-order change and organizational development interventions: A cognitive approach. ***Journal of Applied Behavioral Science***, 23: 483-500.

Baum, J., & Ingram, P. 1998. Survival Enhancing Learning in the Manhattan Hotel Industry, 1898-1980. ***Management Science***, 44: 996-1016.

Beer, M., & Eisenstat, R. A. 1996. Developing an Organization Capable of Implementing Strategy and Learning. ***Human Relations***, 49(5): 597-619.

Beer, M., Eisenstat, R. A., & Spector, B. 1990. ***The Critical Path to Corporate Renewal***. Boston: Harvard Business School Press.

Coleman, J. S. 1988. Social Capital in the Creation of Human Capital. ***Amercian Journal of Sociology***, 94: S95-S120.

Crossan, M., & Sorrenti, M. 1997. Making Sense of Improvisation. ***Advances in Strategic Management***, 14: 155-180.

Cyert, R., & March, J. 1963. ***A Behavioral Theory of the Firm***. Englewood Cliffs, NJ: Prentice Hall.

David, P. A. 1992. Heroes, Herds and Hysteresis in Technological History: Thomas Edison and 'The Battle of the Systems' Reconsidered. ***Industrial and Corporate Change***, 1(1): 129-180.

Dawes, R. M. 1988. ***Rational Choice in an Uncertain World***. New York: Harcourt Brace Jovanovich.

DeSanctis, G., & Poole, M. S. 1994. Capturing the Complexity in Advanced Technology Use: Adpative Structuration Theory. ***Organization Science***, 5(2): 121-147.

Dutton, J. M., & Thomas, A. 1984. Treating Progress Functions as a Managerial Opportunity. ***Academy of Management Review***, 9(2): 235-247.

Eisenhardt, K. M. 1989. Building Theories from Case Study Research. ***Academy of Management Review***, 14(4): 532-550.

Feldman, M. S. 2000. Organizational Routines as a Source of Continuous Change. ***Organizational Change***, 11(6): 611-629.

Forrester, J. W. 1961. ***Industrial Dynamics***. Cambridge, MA: Productivity Press.

Forrester, J. W. 1968. Market Growth as Influenced by Capital Investment. ***Industrial Management Review***, 9(2): 83-105.

Giddens, A. 1984. ***The Constitution of Society: Outline of the Theory of Structure***. Berkeley, Ca: University of California Press.

Glaser, B., & Strauss, A. 1967. ***The Discovery of Grounded Theory: Strategies for Qualitative Reserach***. Chicago: Aldine.

Granovetter, M. 1978. Threshold Models of Collective Behavior. ***American Journal of Sociology***, 83: 1420-1443.

Hackman, J. R., & Wegeman, R. 1995. Total Quality Management: Empirical, Conceptual, and Pracitical Issues. ***Administrative Science Quarterly***, 40: 309-342.

Hall, R. I. 1976. A System Pathololgy of an Organization: The Rise and Fall of the Old Saturday Evening Post. ***Administrative Science Quarterly***, 21(2): 185-211.

Hannan, M. T., & Freeman, J. 1984. Structural Inertia and Organizational Change. ***American Sociological Review***, 49: 149-164.

Hatch, M. J. 1997. Jazzing Up the Theory of Organizational Improvisation. ***Advances in Strategic Management***, 14: 181-191.

Hatch, N. W., & Mowery, D. C. 1998. Process Innovation and Learning by Doing in Semiconductor Manufacturing. ***Management Science***, 44(11): 1461-1477.

Kahneman, D., Slovic, P., & Tversky, A. 1982. ***Judgment Under Uncertainty: Heuristics adn Biases***. Cambridge: Cambridge University Press.

Kanter, R. M., Stein, B. A., & Jick, T. D. 1992. ***The Challenge of Organizational Change: How Companies Experience It and Leaders Guide It***. New York: The Free Press.

Keating, E., & Oliva, R. 2000. A Dynamic Theory for Sustaining Process Improvement Teams in Product Development. ***Advances in Interdisciplinary Studies of Work Teams***, 5: 245-281.

Klein, K. J., & Sorra, J. S. 1996. The Challenge of Innovation Implementation. ***Acadmemy of Management Journal***, 21(4): 1055-1080.

Lawler, E. E., III, & Mohrman, S. A. 1985. Quality Circles After the Fad. ***Harvard Business Review***, 63(1): 65-71.

Liang, D. W., Moreland, R., & Argote, L. 1995. Group Versus Individual Training and Group Performance: The Mediating Role of Transactive Memory. ***Personality and Social Psychology Bulletin***, 21(4): 384=393.

MacDonald, S. 1995. Learning to Change: An Information Perspective on Learning in the Organization. ***Organization Science***, 6(5): 557-568.

March, J. G. 1981. Footnotes to Organizational Change. ***Administrative Science Quarterly***, 26: 563-577.

Masuch, M. 1985. Vicious Circles in Organizations. ***Administrative Science Quarterly***, 30: 14-33.

Merton, R. 1948. The Self-Fulfilling Prophecy. ***Antioch Review***, 8(193-210): 193-210.

Miles, M. B., & Huberman, A. M. 1984. ***Qualitative Data Analysis: A Sourcebook of New Methods***. Newbury Park, CA: Sage Publications.

Monden, Y. 1983. ***Toyota Production System***. Atlanta, GA: Institute of Industrial Engineers.

Mooreland, R., Argote, L., & Krishnan, R. 1996. Socially Shared Cognition at Work: Transactive Memory and Group

Performance. In J. L. Nye, & A. M. Brower (Eds.), ***What's So Social About Social Cognition? Social Cognition Research in Small Groups***: 57-84. Thousand Oaks, CA: Sage.

Mooreland, R., Argote, L., & Krishnan, R. 1998. Training People to Work in Groups. In R. S. Tindale, & L. Heath (Eds.), ***Theory and Research on Small Groups: Social and Psychological Applications to Social Issues***. New York: Plenum Press.

Morgan, G. 1986. ***Images of Organizations***. Beverly Hills: Sage.

Nelson, R., & Winter, S. G. 1974. Neo-Classical vs.Evolutionary Theories of Economic Growth. ***Economic Journal***: 886-905.

Nelson, R. R., & Winter, S. G. 1982. ***An evolutionary theory of economic change***. Cambridge, MA: Harvard University Press.

Oliva, R., Rockart, S., & Sterman, J. 1998. Managing Multiple Improvement Efforts: Lessons from a Semiconductor Manufacturing Site. In D. B. Fodor, & S. Ghosh (Eds.), ***Advances in the Management of Organizational Quality***, Vol. 3: 1-55. Stamford, CT: JAI Press.

Oliva, R., & Sterman, J. D. 2001. Cutting Corners and Working Overtime: Quality Erosion in the Service Industry. ***Management Science***, 47(7): 894-914.

Orlikowski, W. J. 1992. The Duality of Technology: Rethinking the Concept of Technology in Organizations. ***Organization Science***, 3(3): 398-427.

Orlikowski, W. J. 1996. Improvising Organizational Transformation Over Time: A Situated Change Perspective. ***Information Systems Research***, 7(1): 63-92.

Orlikowski, W. J. 2000. Using Technology and Constituting Structures: A Practice Lens for Studying Technology in Organizations. ***Organization Science***, 11(4): 404-428.

Orlikowski, W. J., & Gash, D. C. 1994. Technological Frames: Making Sense of Information Technology in Organizations. ***ACM Transactions on Information Systems***, 12(2): 174-207.

Perlow, L. A., Okhuysen, G. A., & Repenning, N. P. 2002. The Speed Trap: Exploring the Relationship between Decision Making and Temporal Context. ***Academy of Management Journal***, 45(5): 931-955.

Pettigrew, A. M. 1990. Longitudinal Field Research on Change: Theory and Practice. ***Organization Science***, 1(3): 267-292.

Pettigrew, A. M. 1998. Success and Failure in Corporate Transformation Initiatives. In R. D. Galliers, & W. R. J. Bates (Eds.), ***Information Technology and Organizational Transformation***: 271-289. Chichester, England: Wiley.

Pettigrew, A. M., Woodman, R. W., & Cameron, K. S. 2001. Studying Organizational Change and Development: Challenges for Future Research. ***Academy of Management Journal***, 44(4): 697-713.

Pfeffer, J. 1997. ***New Directions for Organization Theory: Problems and Prospects***. New York: Oxford University Press.

Pfeffer, J., & Sutton, R. H. 2000. ***The Knowing-Doing Gap: How smart companies turn knowledge into action***. Boston: Harvard University Press.

Pil, F. K., & MacDuffie, J. P. 1996. The Adoption of High-Involvement Work Practices. ***Industrial Relations***, 35(3): 423-455.

Pisano, G. P., Bohmer, R. M. J., & Edmondson, A. C. 2001. Organizational Differences in Rates of Learning: Evidence from the Adoption of Minimally Invasive Cardiac Surgery. ***Management Science***, 47(6): 752-768.

Powell, T. C. 1995. Total Quality Management as Competitive Advantage: A Review and Empirical Study. ***Strategic Management Journal***, 16: 15-37.

Prigogine, I., & Stengers, I. 1984. ***Order Out of Chaos***. Boulder: New Science Library.

Reagans, R., & Argote, L. 2002. Individual Experience and Experience Working Together: Predicting Learning Rates from Knowing What To Do and Who Knows What. New York: Columbia University.

Repenning, N. P. 2002. A Simulation-based Approach to Understanding the Dynamics of Innovation Implementation. ***Organization Science***, 13(2): 109-127.

Repenning, N. P., Goncalves, P., & Black, L. J. 2001. Past the Tipping Point: The Persistence of Firefighting in Product Development. ***Califronia Management Review***, 43(4): 44-63.

Repenning, N. P., & Sterman, J. D. 2000. Getting Quality the Old-fashioned Way: Self-confirming Attributions in the Dynamics of Process Improvement. In R. Cole, & R. Scott (Eds.), ***The Quality Movement & Organization Theory***. Thousand Oaks, CA: Sage.

Repenning, N. P., & Sterman, J. D. 2002. Capability Traps and Self-Confirming Attribution Errors in the Dynamics of Process Improvement. ***Administrative Science Quarterly***, 47: 265-295.

Rigby, D. 2001. Management Tools and Techniques: A Survey. ***California Management Review***, 43(2): 139-160.

Rigby, D. K. 1994. Managing the Management Tools. ***Planning Review***, 1994(Sept/Oct): 20-24.

Sastry, M. A. 1997. Problems and Paradoxes in a Model of Punctuated Organizational Change. ***Administrative Science Quarterly***, 42: 237-275.

Senge, P. M. 1990. ***The Fifth Dispcipline: The Art and Practice of the Learning Organization***. New York: Doubleday.

Spear, S., & Bowen, H. K. 1999. Decoding the DNA of the Toyota Production System. ***Harvard Business Review***, 77(5): 96-106.

Sterman, J. D. 1994. Learning In and About Complex Systems. ***System Dynamics Review***, 10(2): 291-330.

Sterman, J. D. 2000. ***Business Dynamics: Systems Thinking and Modeling for a Complex World***. Chicago: Irwin-McGraw Hill.

Sterman, J. D., Repenning, N. P., & Kofman, F. 1997. Unanticipated Side Effects of Successful Quality Programs: Exploring a Paradox of Organizational Improvement. ***Management Science***, 43(4): 503-521.

Taylor, S. E., & Fiske, S. T. 1975. Point of View and Perceptions of Causality. ***Journal of Personality and Social Psychology***, 32: 439-445.

Tushman, M. L., & Romanelli, E. 1985. Organizational Evolution: A Metamorphosis Model of Convergence and Reorientation. In B. M. S. a. L. L. Cummings (Ed.), ***Research in Organizational Behavior***, Vol. 7: 171-222. Greenwich, CT: JAI Press.

Tversky, A., & Kahneman, D. 1982. Availability: A Heuristic for Judging Frequency and Probability. In D. Kahneman, P. Slovic, & A. Tversky (Eds.), ***Judgment under Uncertainty: Heuristics and Biases***: 163-178. Cambridge: Cambridge University Press.

Wegner, D. M. 1986. Transactive Memory: A Contemporary Analysis of the Group Mind. In B. Mullen, & G. R. Goethals (Eds.), ***Theories of Group Behavior***: 185-208. New York: Springer-Verlag.

Weick, K. E. 1979. ***The Social Psychology of Organizing*** (Second ed.). New York: McGraw-Hill.

Weick, K. E. 1993a. Organizational Redesign as Improvisation. In G. P. Huber, & W. H. Glick (Eds.), ***Organizational Change and Redesign***: 346-377. New York: Oxford University Press.

Weick, K. E. 1993b. Sensemaking in Organizations: Small Structures with Large Consequences. In J. K. Murningham (Ed.), ***Social Psychology in Organizations: Advances in Theory and Research***: 10-37. Englewood Cliffs, NJ: Prentice-Hall.

Weick, K. E. 1995. ***Sensemaking in organizations***. Thousand Oaks, CA: Sage.

Weick, K. E. 1998. Improvisation as a mindset for organizational analysis. ***Organization Science***, 9(5): 543-555.

Weick, K. E. 2000. Emergent Change as a Universal in Organizations. In M. Beer, & N. Nohria (Eds.), ***Breaking the Code of Change***: 223-241. Boston: Harvard Business School Press.

Womack, J. P., & Jones, D. T. 1996. ***Lean Thinking: Banish Waste and Create Wealth in Your Corporation***. New York: Simon & Schuster.

Womack, J. P., Jones, D. T., & Roos, D. 1990. ***The Machine that Change the World.*** New York: Harper Collins.

Wright, T. P. 1936. Factors Affecting the Cost of Airplanes. ***Journal of Aeronautical Science***, 3: 122-128.

Yin, R. K. 1994. ***Case Study Research: Design and Methods*** (Second Edition ed.). Thousand Oaks, CA: Sage Publications.