‘You Measure What You Get’:
Towards a theory of process improvement and change

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April 1999

Version 0.3

DRAFT FOR COMMENT ONLY - NOT FOR QUOTATION OR CITATION

Support has been provided by the National Science Foundation, grant SBR-9422228, and the company described in this paper. Many thanks to Tim Tiernan, Bill Colwell, Laura Cranmer, Dave Lazor, Vic Leo, Frank Murdock, Roger Saillant and Ron Smith for their generous assistance. Thanks to John Sterman, Andrew Jones, Don Kieffer, Laura Black, Brad Morrison, Scott Rockart, Jenny Rudolph and seminar participants at MIT for helpful comments.

For more information on the research program that generated this paper, visit our World Wide Web site at http://web.mit.edu/nelsonr/www/.

Abstract

Despite their rapid proliferation and growing popularity among management practitioners, the existing understanding of operations-focused change and improvement techniques such as Total Quality Management and Business Process Re-engineering rests on a somewhat suspect theoretical foundation. With this in mind, in this paper I develop a theory of *participatory process improvement*. To develop such a framework, I define a class of improvement and change efforts called participatory process improvement initiatives (PPII), explain what conceptually separates members of this class from other change and improvement techniques, and suggest why these techniques can be so powerful. My goal is to provide a framework that helps better organize existing theory, deepens the current understanding of the phenomenon, resolves some of the current controversy surrounding TQM, and, ultimately, provides some guidance to practitioners selecting improvement methods.

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1. Introduction

1.1. Why a Theory of Participatory Process Improvement?

Managers seeking new tools and methods to aid them in improving organizational effectiveness face a dizzying array of choices. In the past two decades there has been rapid growth in both the popularity and proliferation of operations-focused improvement and change techniques. Management practitioners now face a literal alphabet soup of acronyms including Total Quality Management (TQM), Theory of Constraints (TOC) (Goldratt and Cox 1986), Business Process Re-engineering (BPR) (Hammer and Champy 1993), Total Productive Maintenance (TPM), and various flavors of leanness (e.g. lean production, Womack, Jones and Roos 1990; Lean Thinking, Womack and Jones 1996; and the Lean Enterprise).

The advent of such techniques has not been totally ignored by organizational scholars. TQM in particular has received extensive attention, including being the subject of numerous papers, books, and special journal issues (Dean and Bowen 1994 provide a review). Existing work draws on a variety of perspectives including sociology (Zbaracki 1998), institutional theory (Westphal, Gulati and Shortell 1997), strategic frameworks (Powell 1995), system dynamics (Sterman, Repenning and Kofman 1997; Repenning 1998a), economics (Wruck and Jensen 1994, Baron and Paulson Gjerde 1996, Repenning 1998b), contingency-based approaches (Sitkin *et al.* 1994), and psychology (Hackman and Wagemen 1995). Despite this growing collection of work, however, the existing understanding of the phenomenon rests on a somewhat suspect theoretical foundation.

The first major symptom of the lack of firm conceptual underpinning is the fact that, despite its widespread use as a vehicle for studying organizational issues, there is no accepted definition of TQM nor a taxonomy with which to relate it to other improvement and change techniques. TQM has alternatively been labeled a management fad (Harte 1992), "…[a set of] well defined organizational interventions that have clear rules for the analysis and use of information (Zbaracki 1998)", "… a managerial innovation (Westphal *et al.* 1997)", "…a philosophy (Dean and Bowen 1994)", and "…a historically unique approach to improving organizational effectiveness (Wruck and Jensen 1994)". Further, few scholars have provided a detailed account of how such techniques work at the operational level. Instead, existing work can be divided into two basic categories. First, some authors, relying on the writings of TQM proponents (e.g. Deming, Juran, Ishikawa) as their data primary source, use existing theory to understand the organizational dimensions associated with TQM (e.g. Dean and Bowen 1994, Hackman and Wageman 1995). Second, other researchers use actual TQM implementations as a source of data for studying more general organizational phenomenon (e.g. Zbaracki 1998, Westphal et al. 1997). Wruck and Jensen (1994) is the only paper that develops a theoretical understanding of TQM through the observation of practice at the operations level.

The second is symptom is the considerable controversy concerning the novelty of TQM (Zbaracki 1998). Spencer (1994:458) summarizes this debate by asking "Why do practitioners view TQM as a new paradigm, whereas many academics view it as old hat?" Analyses from a variety of organizational perspectives have concluded that TQM contains few organizational innovations (Dean and Bowen 1994, Hackman and

Wagemen 1995). But, if TQM represents nothing particularly new, then it is a bit difficult to understand the dramatic performance gains made by its adopters and the evangelic fervor of its proponents. Easton and Jarrell (1998), Hendricks and Singhal (1997), Barron and Paulson Gjerde (1996) and Powell (1995) all show that those firms with well-developed TQM programs outperform those without. The CEOs of many large U.S. companies view TQM (and similar initiatives) as an important advance in management theory (Robinson *et al.* 1991). The dramatic and sustained gains in the performance of its users present a significant challenge to existing interpretations of TQM that suggest little about it is new.

A third symptom of a weak theoretical basis for thinking about operations-focused improvement efforts is the fact that TQM has largely been considered as an isolated phenomenon. Although the number of alternative improvement methods has grown rapidly, no attempt has been made to understand them or their relation to TQM. For better or worse, however, such techniques have become a significant part of the practicing manager’s tool kit. Scholars seeking to understand and influence the practice of management need to acknowledge the existence of these methods, understand their popularity, and highlight which amongst them are theoretically sound. Hackman and Wagemen (1995) conclude that, in the case of TQM, researchers have neglected this oversight role and offer little assistance to the practicing manager in selecting those elements that are useful and ignoring the rest. The situation is only worse for those methods that have not been studied.

The purpose of this paper is to develop at least the beginnings of the needed conceptual foundation. The entry point into my theorizing is provided by the observation that at least two features of TQM are common to many other operations-focused improvement methods. First, TQM, like process reengineering, theory of constraints, and lean methods, emphasizes the *process*, rather than the function, as the appropriate unit of analysis for improvement (Garvin 1998). Second, TQM, theory of constraints, lean methods and (to a lesser extent) reengineering all rely on the on-going contributions of participants within the process as the source of improvements.

With this in mind, the primary aim of this paper is to develop a theory of *participatory process improvement*. In developing such a theory, I define a class of improvement and change efforts called participatory process improvement initiatives (PPII), explain what conceptually separates the members of this class from other change and improvement techniques, and suggest why these techniques can be so powerful. My goal is to provide a framework that helps better organize existing theory, deepens the current understanding of the phenomenon, helps resolves some of the current controversy surrounding TQM (including providing a definition, and explaining what's new about it and how it relates to other participatory process-focused techniques), and, ultimately, provides some guidance to practitioners selecting improvement methods.

1.2. Participatory Process Improvement and Improvisation

In addition, while I believe that it constitutes a phenomenon worthy of study in its own right, a theory that explains the content, practice, and consequent effectiveness of participatory process improvement techniques may yield more general benefits. In particular, theorists have long been interested in understanding organizations as something other than the deterministic outcome of rational decisions made by senior members. One recent manifestation of this interest is the increasing popularity of theatrical and musical improvisation as metaphors for understanding organizing (e.g. Weick 1993; Orlikowski 1996; Miner and Moorman 1998; Meyer, Frost and Weick 1998). While some have been content to argue that the improvisation usefully describes particular episodes in an organization's existence (e.g. Orlikowski 1996), others argue that such metaphors capture an essential feature of all organizational activity. For example, Weick (1998) writes, "My bet is that improvising is close to the core process of organizing…improvisation may be part of the infrastructure in all organizing."

Such a conception presents a radical alternative to theories built on the logic of stability, managerial control and fixed organizational structures, but, not surprisingly, many of the details in this alternative model remain to be specified. If improvisation is a core process of organizing, then much of management theory, which is built on the infrastructure provided by more static models, is called into question. What roles, for example, do the mainstays of traditional management activity such as leadership, strategic planning, measurement, and performance evaluation play in a model built on improvisation?

Participatory process improvement provides an excellent conduit into a more general understanding of improvisational processes for a number of reasons. First, techniques like TQM require the active participation of multiple participants, each modifying the structure of the work process through localized problem solving efforts. Thus, these efforts closely match the distributed nature of authority and decision making suggested by the improvisational model. Second, the notion of continuous improvement that runs through TQM and related methods highlights the fact that constant improvement and change is an integral part of these approaches. In particular, there is little discussion of process *design* in such methods. Rather, as my labeling suggests, the focus in on process *improvement*. Thus, just as Weick (1993) argues, the final design only emerges after the fact as the sum of numerous local improvements.

Third, while the improvisational activity is close to the surface in process improvement, and thus easier to analyze, such efforts do not totally depart from more traditional conceptions. PI efforts are often instigated, monitored, and evaluated by senior managers. Most such efforts have a very distinct beginning and many have an identifiable end. Some are dramatically successful, and many others are abject failures. The combination of traditional management approaches and improvisation inherent in process improvement provides an excellent opportunity to think about such questions as "what determines whether improvisational activity helps or hurts organizational performance?" and "what is the role of senior leadership in improvisational processes?" Thus, my theory also suggests potential refinements and enhancements to existing improvisation-based models of organizing.

The remainder of the paper is organized as follows. In the next section I briefly discuss the inductive methods I used to develop my theory. Section three develops the basic notion on which the theory is premised. In section four I develop the core of the theory.

In section five, drawing on a case study, I discuss how the theoretical constructs play out in practice. Section six contains discussion and concluding thoughts.

2. Methods

The theory presented here was developed inductively using a number of original case studies of process improvement efforts. The research is the product of a four year effort that involved the participation of four major companies, the Ford Motor Company, The Harley-Davidson Motor Company, Lucent Technologies (a division of AT&T when the research started), and Fairchild Semiconductor (a division of National Semiconductor when the research started). Each participating company provided an on-site team to assist in the research and review the findings. The theory development effort contained three main phases.

2.1. Case Narratives

Initial research efforts were targeted at developing a set of case narratives on both successful and unsuccessful change and improvement efforts. The initiatives studied were selected after extensive discussion with the on-site research teams. Selection criteria included the size of the effort and its impact on subsequent organizing practices. Some were successful and others were failures. Data on each initiative were collected by interviewing participants and through extensive review of archival data such as newsletters, promotional flyers, instructional material, reference handbooks, and promotional and instructional video and audiotapes. All interviews were recorded and coded by the field researcher who did the interview. After the initial interviews and data collection, the results were synthesized in a narrative description of the initiative written by the field researcher. These case documents were then circulated to all of those interviewed. Participants were asked to check their quotes for accuracy as well as to assess how well the document captured their experience. Participants were not allowed to change the content of their initial quotes unless there was a factual dispute. Modifications were made to the case documents to reflect elements that had been missed in the first set of interviews. In many cases additional interviews were performed to fill in gaps or resolve disputes between subjects.

2.2. Data Analysis and Theory Development

The next stage focused on using the case narratives to induce an explanation for the successes and failures that were observed. The ideas developed at this stage (which constitute the bulk of this paper) were developed by comparing the outcomes of the various initiatives. The critical turning point in understanding the narratives came when their comparison yielded an unexpected result. The successful efforts studied typically did not start with detailed training and aggressive implementation of a full suite of improvement tools (e.g. statistical process control). Instead, early efforts were characterized by casual, unsophisticated problem solving approaches, and more formalized methods were added only as the effort proceed to its later stages. In contrast, the unsuccessful efforts often contained an early and substantial emphasis on tool usage. This observation led me to examine more closely the conceptualizations of the role of improvement tools in the existing literature on TQM. I found that the role of improvement tools had largely been ignored in the literature, and when it was discussed, analysts did not probe into their cognitive origins. Based on this realization, I premised my theorizing effort on the assumption that the improvement tools were the products of human cognition (and thus subject to all its limits).

2.3. Connections to Extant Literature

Finally, having developed a framework built on the case narratives and subsequent modeling efforts, I compared my theory with the existing literature. In this case, the extant literature contains two quite different components. First, the theory was compared to the prescriptions of those connected with popular process improvement techniques, including Deming (1986), Shiba, Walden and Graham (1994), Goldratt and Cox (1986), Hammer and Champy (1993), and Womack, Jones and Roos (1990). This step proved particularly valuable since, with the theory in mind, I could determine whether what was observed in practice had any origin in the writings of the founders of the various initiatives. Second, the theory was compared to the existing literature on process improvement (mostly TQM) in the organizational literature (e.g Wruck and Jensen 1994, Dean and Bowen 1994, Sitkin *et al*. 1994, Hackman and Wagemen 1995, Westphal *et al.* 1997, Zbaracki 1998).

3. The Process Performance Model

3.1. The Production System and Mental Models

Drawing on Garvin (1998), a *process* is defined as a collection of tasks that convert inputs into outputs. Throughout this paper I will refer to such a collection as a *production system*. To develop my theory I make the critical assumption that the production system is sufficiently complex that fully understanding its dynamics is beyond the ability of its participants. In making such a statement it is important to distinguish between the structure of a production system and its consequent behavior. Experimental research suggests that, while people are capable of describing a system's structure, if it is characterized by *dynamic complexity*, they are incapable of correctly inferring the behavior it creates. The dynamic complexity of a system is determined by three structural elements– time delays, non-linearity, and feedback loops–all of which are present in most production contexts (Sterman 1994). Thus, for example, a supervisor can well describe the location and content of the different operations within a manufacturing process, but cannot reliably infer the impact of changing that structure on the system's performance. The source of low performance is attributed to the fact that the mental representations people apply to dynamic decision making tasks are incomplete, exclude important structural elements, and are dynamically naive (Sterman 1994, Paich and Sterman 1994, Brehmer 1992, Funke 1991).

Thus, the physical process is assumed to be a system of sufficient complexity that anticipating the consequences of a given change is beyond the ability of its participants. Further, participants are assumed to work from a cognitive representation of that system. I use the term *mental model*, in contrast to the plethora of alternatives (maps, scripts, schemas, etc.), to emphasize the fact that the cognitive representation is more than a map or state description. It also contains inferences based on those descriptions. Continuing the example above, in manufacturing, the mental representation contains not only a 'map' of where the machines might be located, but assumptions about how performance might change when one of those machines works more quickly or more slowly.

3.2. Tools and Techniques as the Product of Cognitive and Social Activity

Given such a system, my interest lies in how participatory process improvement techniques like TQM are used to improve it. Existing studies of TQM typically separate between its organizational and technical dimensions. For example, Zbaracki's (1998) observations of TQM practice led him to distinguish between a *technical* TQM, "…[that] incorporates some fairly well-defined organizational interventions…" and a *rhetorical* TQM that is subject to institutional forces and may ultimately stray far from its technical core. Other papers make similar (although often less explicit) distinctions, either lumping the technical elements of TQM under the heading of problem solving techniques (e.g. Dean and Bowen 1994) or ignoring them altogether (e.g. Weick 1999).

Curiously, organizational scholars have not considered the cognitive and social dimensions of the elements of TQM consigned to the technical category. Hackman and Wagemen (1995:313), for example, discuss the technical elements of TQM in some detail, describing them as the "Use of scientific methods for monitoring performance and to identify points of high leverage for performance improvement." and "…statistical tools to monitor and analyze work processes.", but offer no discussion of the appropriateness of these methods nor their impact on social and cognitive processing. That organizational scholars have not probed more deeply into the technical side of TQM is surprising given that the practice of science and development of technology is no less prone to social forces than other aspects of organizational life (e.g. Kuhn 1970). Simply by being the product of human activity, the technical elements of TQM are the product of cognitive and social processes.

The role of cognitive and social forces in determining the technical content of process improvement methods enters into my analysis in a straightforward way. Recognizing that TQM and other methods are the product of human cognition suggests that, just as operators in a production setting do not, and cannot, fully understand the complexities of their environment, the creators of improvement methods are similarly handicapped. Thus, just as each production operator must work from a mental representation of the production system, so must the creators of improvement methods. The central notion of my analysis is that underlying all process improvement tools and methods are a set of (perhaps implicit) assumptions about the structure and resulting dynamics of the production system being improved. These assumptions constitute a model that–like all models, mental or otherwise–represents an incomplete understanding of the production system.

An example of such a model is provided in Deming's discussion of statistical process control (SPC) (Deming 1986:Chp. 11). SPC is a set of techniques used to guide improvement activity within a production context via the analysis of variation in performance data. Deming begins his discussion of SPC by challenging the common practice of setting specification limits for the production of a given component ('this measurement must be between 1.01 and 1.02 centimeters') and using those limits as the basis for action ('if the part measures 1.025, adjust the machine'). He writes, "Maximum and minimum limits for the specification of a product are, by themselves a costly and unsatisfactory guide to the production worker (p.335)."[1] In contrast, he describes his own view:

> Costs go down as variation is reduced. It is not enough to meet specifications (p.334).
>
> [The production worker's] job...is to continually reduce variation. Under this system his output will meet specifications and in fact leave them beyond the horizon, reducing costs in subsequent operations, and elevating quality of the final product (p.335).

The two approaches are based on different models of the determinants of performance in a production system. In the conception that Deming challenges, performance is assumed to be a function of whether or not pieces are produced within specification limits. In the model underlying SPC, any instance of variability is assumed to reduce performance. The differing implications for action are clear: in the first case action is only required when specification limits are exceeded. In contrast, in the second *any* feature of the process that creates variation should be the subject of improvement effort.

It is important to note that Deming's prescriptions are based on the *assumption* that variation of any magnitude reduces quality and increases cost. That the connection between variation and performance is an assumption rather than a universal truth has been highlighted by Sitkin *et al.* (1994), who suggest many ways in which the connection between variance reduction and performance is context dependent. The model of system performance underlying Deming's method contains elements in addition to the impact of

[1] . Later in the book he shows, through his famous funnel experiment, how acting on specification limits when one fails to understand the inherent variability in a process leads to declining performance.

variation on performance (the distinction between special and common causes of that variation is another central contribution), but this example highlights how the technical elements of TQM are neither ‘neutral’ nor universally applicable, but instead are built on a set of assumptions concerning how the system being improved operates.

3.3. The Character of Models Underlying Process Improvement Methods

A process is, by definition, composed of a sequence of many operations. One way to decompose such a process is to distinguish between the overall or global objective for the performance of the process, and the subordinate or local objectives for each of the constituent operations. Critics of PI initiatives have argued that innovations like TQM provide little assistance to operators trying to achieve their local objectives, and, based on this observation, have concluded that such innovations have little useful content. In contrast to this view, I suggest that the principle benefit of such initiatives does not lie in suggesting ways to help operators achieve their local objectives, but, instead, in an alternative representation of how the elements of the production process *interact* to determine the system’s performance. Techniques like TQM are of little use to an operator trying to accomplish local objectives because the model underlying TQM contains little detail concerning the operation of specific tasks. Instead, what is common to all of the models underlying process improvement techniques is a focus on how the output of a specific task, however it might be accomplished, influences the performance of the system. Such models constitute theories of how to set local objectives given global ones. Thus, the essential, and defining, feature of process improvement techniques is that they are based on a model of how the outputs of individual tasks interrelate to determine the performance of the system.

The systemic nature of the models that underlie process improvement techniques is easiest to see in the popular Theory of Constraints (TOC) philosophy offered by Goldratt and Cox (1986) and used extensively in the initiative that will be discussed in section five. TOC is based on the assumption that one machine within a production process has the lowest throughput. Building on this idea, TOC suggests that this 'constraint' machine should be the focus of intensive improvement activities and also provides the basis for production scheduling and inventory reduction. TOC tells the user nothing about how to change a specific machine so as to achieve its local objectives. Instead, based on an alternative conception of how the machines interact to determine throughput, TOC suggests ways in which changes in the objectives set for individual operations (however they might be accomplished) might improve the performance of the production system.

Building on this discussion, a Process Performance Model (PPM) is defined as a set of assumptions concerning the structure of a production process and, more importantly, how those elements interrelate to determine the overall performance of the process. The two central assertions of my argument so far are that 1) a PPM underlies all process improvement methods and 2) the defining feature of such techniques (TQM, TOC, BPR, etc.) is that the primary content of their underlying models lies in how the various components of the process interrelate to determine the throughput of the process. Building on these ideas, in the next section I will argue that the PPM notion is central to understanding how a process improvement initiative creates change. In section five I will then discuss how a new PPM is introduced within an organization.

4. How the PPM Creates Change

To discuss how a PPM creates change and improvement, in this section I will (temporarily) assume that participants have already incorporated elements of the PPM into their own mental models. Of course, the process through which that model comes to be shared is of critical importance, and the changes that are made to the structure of the process and the state of the mental models of participants that make those changes cannot be separated. These linkages will be discussed in section five.

4.1. The PPM Facilitates the Alternative Uses of Local Knowledge

A mental model determines the pieces of information in the environment that are extracted as cues for action (Weick 1995, Sterman 1994). The changes in a process participant's mental model created by the introduction of a new PPM manifest in two ways. First, a new mental model changes the set of cues extracted from ongoing experience. For example, the PPM underlying Deming's method suggests that variation, summarized in the form of a control chart, should be the focus of information acquisition and analysis. In contrast, the previous model of system performance suggested that only events characterized by a failure to meet specifications required attention. Second, an alternative PPM changes the way cues are classified. Thus, not only does Deming's assertion that variation increases cost and reduces quality lead one to collect additional data on variation, but it also suggests that any variation that is observed be classified as undesirable and worthy of a change effort.

Given its system focus, a new PPM, once shared, focuses a process participant on a set of cues that highlight ways in which the output of her specific task limits the performance of the production system. By focusing attention on the performance of the production system, a new PPM reveals inconsistencies between the performance objectives for the entire process and the subordinate objectives for each of the constituent tasks. For example, a participant in an improvement effort guided by TOC will soon realize that, if her task does not represent the constraint or bottle neck within the production system, then efforts to maximize the throughput of her operation will not contribute to improving the performance of the production system.

While the PPM does suggest ways in which changes in the outputs of specific tasks may improve system performance, it provides no information about what changes participants must make to achieve those new objectives. Instead, participants must rely on their existing, locally accumulated experience to *improvise* ways to achieve the changes in their task outputs suggested by the new PPM. Process improvement techniques work because, by suggesting ways in which the output of specific tasks might be changed to improve system performance, they allow process participants to use existing, local expertise in new ways that better contribute to system performance.

Wruck and Jensen (1994) recognize that TQM allows the organization to better use the locally accumulated knowledge of its members (*specific knowledge* in their terminology). Sutcliffe and Sitkin (1996) push this idea a step further, and argue that improvisation is the process through which this knowledge is translated into action. The contribution of my analysis is to suggest that the PPM provides the problems towards which this activity is directed. The PPM notion also explains why process improvement initiatives are conceptually distinct from other types of improvement and change efforts. Process improvement efforts do not produce change by giving participants new knowledge about how to execute their individual tasks. Instead, they work by giving participants a better understanding of how the execution of their individual tasks influences the performance of the production system.

4.2. Coordination: The PPM as a 3rd Order Control

Process improvement in this conception is a distributed activity in which many participants within a given process may contribute through improvising solutions to the local problems highlighted by the alternative PPM. Similarly, numerous scholars have argued that TQM requires the dispersal of authority from managers to line workers, and some suggest that Deming (and others) offers an antidote to Taylorism and the separation between thinking and working (see Spencer 1994 for a summary). If improvisation is at the heart of process improvement, then such dispersion is necessary, since success requires that participants engage in activities that are non-routine and focus on problems for which appropriate solutions cannot be determined in advance (Wruck and Jensen 1994). More specifically, if process improvement techniques work by allowing participants to use local knowledge in new ways, then explicit local performance objectives may be counter-productive since, by definition, managers cannot evaluate the effective use of local knowledge except through its impact on overall process performance. Perrow (1986) makes a similar point when he suggests that when work is non-routine and unpredictable, direct surveillance, and bureaucratic constraints–1st and 2nd order controls–are likely to be ineffective.

Third order, or premise, controls guide the actions of members of an organization by restricting the information to which they attend and by limiting the set of alternative responses that are considered (Perrow 1986:129). In an improvement initiative the PPM, if it is widely shared, constitutes a form of 3rd order control, and as Weick (1993) suggests, guides improvisational activity. The PPM is a set of premises ('eliminating sources of variation leads to improved quality') that suggests which aspects of process performance should be monitored ('the variability of each process should be measured'). The PPM also provides socially legitimate justifications for actions directed at improving performance on the suggested dimensions ('I did this to reduce variability'). Thus, conceptualizing the PPM as a 3rd order control provides a link between the cognitive and social dimensions of successful participatory process change. Through its influence on individual mental models, the PPM suggests opportunities for improvement by changing the cues to which people attend and how those cues are interpreted. By providing a set of premises from which participants must justify their actions to others within the organization, the PPM also acts a coordinating mechanism.

4.3. Situational Adaptation: The PPM Creates Equivalent Interpretations

Conceptualizing the PPM as a form of 3rd order control suggests how the actions of process participants are still coordinated in the absence of direct surveillance and bureaucratic constraints. Besides requiring coordination, however, successful process improvement also requires local adaptation. Each participant in a typical process faces a different problem and set of constraints, and thus, to be successful, requires the latitude to create new solutions. In developing improvisational theatre as a metaphor for organizational design, Weick (1993) suggests one mechanism through which such coordination and adaptation can happen simultaneously. He writes:

> In improvisational theater, coordination occurs not so much because people have identical views of the design, but because they have equivalent views of what is happening and what it means...Equivalence allows both coordination and individual expression to occur simultaneously....people are able to accomplish collectively what they could not do individually, but also to cope individually with unexpected problems by virtue of their diverse capabilities. The design that produces this complex mixture tends to be emergent and visible only after the fact.

The notion of a PPM provides a more operational definition of equivalence and the role it plays in guiding change. A PPM, as embodied in a change initiative, is a simplified theory of process performance that abstracts away from the specifics of any individual operation with a process. The abstraction inherent in the PPM creates equivalence. Equivalent interpretations result from people applying the same model to different operations within a process and reaching similar conclusions about how the local outputs may be modified to improve system performance. Equivalence is created by a common PPM that is acknowledged to be a simplified representation of the real system and thus, to be useful, requires that participants adapt it to their own uses. Localized adaptation is *required* via the model's inherent abstractions. Thus, for example, two participants can look at two very different operations within a process, interpret the performance of those operations in terms of their variability, and both take situation-specific actions that reduce that variability.

4.4. Why Should a New PPM Lead to Improvement

Even if one takes the process outlined so far as given, nothing discussed to this point suggests why an improvement effort based on a PPM is desirable to an intervention focused on improving the execution of specific tasks. An answer to this question is provided by research, done in a variety of contexts, suggesting that people learn quickly and effectively when they receive feedback from their actions that is rapid, certain, salient, tangible and not confounded by factors outside of their control (Sterman 1994, Plous 1993, Brehmer 1992, Einhorn and Hogarth 1986). Conversely, when the consequences of one's actions are delayed, uncertain, and ambiguous, learning is at best slow and often spurious. These theories suggest that process participants will rapidly learn to execute their particular task so as to achieve the local objectives they perceive as important. The time delay between actions and outputs is short, the output is salient and tangible, and results are affected by few variables outside of their control.

In contrast, the conditions for learning how the output of a particular task affects the performance of the production system are very poor. There can be a substantial time delay between making a change and observing its final consequence; actions and outcomes are separated in space; and the quality of the final product and the efficiency with which it is produced are both determined by innumerable factors, few of which are under a given person's control. Thus basic features of human learning suggest that, with the passage of time, process participants will become exceptionally good at executing their tasks toward a particular, local objective–'doing things right'–and remain exceptionally poor at modifying those objectives to improve overall, global performance–'doing the right things'.

A process improvement initiative, as defined here, can dramatically improve performance precisely because the conditions for adaptive, 'single loop' learning are so poor. Exceedingly simple models such as 'variance creates defects' can lead to improved performance because the mental models they replace (1) ignore important elements of the system and (2) are incapable of correctly inferring the dynamic consequences of the structures that are retained. An improved mental model of the system's performance allows people to use locally accumulated knowledge, obtained under conditions that support accurate and rapid learning, in the better service of system wide objectives. Previous scholars (e.g. Wruck and Jensen 1994) have highlighted the role that TQM can play in bringing such locally accumulated knowledge to the fore, but have not realized how the initiative marshals and organizes such knowledge within the framework of an alternative model of system performance. What is new about TQM and other process improvement initiatives, and what previous organizational analyses have not acknowledged, is that embodied within the tools and philosophies of such efforts are radically different models of system performance that, coupled with local knowledge, significantly alter the content of on-going improvisation, and, as a consequence, create dramatic episodes of improvement and change.

5. How Process Performance Models Manifest

Having outlined the basic character of the PPM, defined its role, and suggested how it acts as a 3rd order control that guides locally adapted, improvised change, I now discuss how such models are introduced within an organization. The co-evolution of the state of the process and participants' mental representations of that process coupled with the limits on human comprehension in dynamic systems suggests sensemaking as a basis for understanding the propagation of an alternative model of system performance. With this in mind, drawing heavily on Weick (1995) I use one of the case studies from which the theory was developed as a vehicle to discuss how an alternative PPM might be introduced within an organization.

The case was chosen for two reasons. First, it was highly successful; second, it provides an excellent example of an improvement effort created by the introduction of an alternative performance model. The field research leading to the case was performed by the author in a division of one of the companies that participated in the study. The division manufactures electronic components that are then integrated into the final product at the company's main assembly facilities. At the time of this research, the division's annual sales were over two billion dollars, and it had major manufacturing facilities throughout the world. The initiative studied was targeted at reducing the cycle time of the manufacturing process–the Manufacturing Cycle Time (MCT) initiative–and was very successful. Over a period of approximately five years, the division was able to cut its cycle time from approximately twenty days to less than one day. Product quality and productivity also improved dramatically. Inventory holding costs were reduced by over eighty percent, and the savings in floor space alone was so substantial that the division, which had planned to build three new plants each costing many hundreds of millions of dollars, was able to accommodate rapid growth within its existing facilities.

Readers interested in more detail and a discussion of the data collection method can consult Repenning and Sterman (1998) and Repenning (1996a).

5.1. The Performance Model in Use Prior to the MCT Initiative

Like many companies whose business requires substantial capital investment and labor expense, prior to the MCT initiative, the dominant model guiding management practice was ‘increasing utilization leads to higher throughput’. As a consequence, line supervisors were explicitly charged with keeping each piece of equipment and each laborer busy. One line supervisor recalls:

> Before [MCT] if you were to walk out onto the floor and ask a supervisor how things were going, he would say “Great, all my machines are running” and you would see tons of WIP sitting around. They were using the theory of ‘Keep all My Machines Running’.

Consistent with the structuration view (Giddens 1993, 1984, Orlikwoski 1992), over time the utilization model had become increasingly embedded in both the physical and organizational structure of the process. Plants had invested in sophisticated and expensive automated retrieval and storage systems to help manage the high levels of WIP inventory required to keep all the machines running, and the measurement system had become increasingly detailed so that some facilities were required to report utilization on a per machine, per day basis. Thus, while the utilization-based model may have led to improvement opportunities when it was first introduced, locally improvised changes were almost entirely focused on circumventing the measurement system, not on improving throughput. For example, supervisors kept extra, some sometimes secret, supplies of work in process inventory so they could keep their machines running even if their output was *not* needed on a given day. One interviewee reported:

> Supervisors at that time were evaluated on labor performance on a daily basis. It didn't take long for them to develop a buffer in front of their line so that if the schedule called for 700 and their line was fully utilized at 800, they could still run 800 units every day, and still make their labor performance.

The high level of WIP caused a number of problems: it was expensive, it delayed quality feedback, and it was difficult for the manufacturing facilities to change their production schedules on short notice.

5.2. Initiating Improvement: Measurement and Meaning

A newly hired general manufacturing manager (GM) launched the MCT initiative. The GM had previously worked at a major electronics manufacturer and immediately noticed that the plants he now supervised were managed in a very different manner. He recalls:

> At [my previous employer], we really managed the facilities by focusing on inventory, both total dollars and turnover, and we always treated people as something that wasn't going away, as a fixed instead of a variable cost. We also didn't have the emphasis on machine utilization that they had in [this particular] industry.

He continues with his diagnosis of the division's problems at the time:

> I felt that nobody was looking at our manufacturing facilities as a system. They were looking at pieces, and, as a result, spent their time trying to optimize each piece. The guy running the solder equipment might be running boards through there like nobody's business, but did that improve the output of the system? I'm not sure anybody really knew that.

Based on this diagnosis the GM felt that performance could be improved by reducing the division's average manufacturing cycle time, then approximately twenty days.

Weick (1995) suggests that sensemaking is occasioned by interruptions, and citing Starbuck and Miliken, writes "…the basic occasion for sensemaking consists of

‘…events that violate perceptual frameworks.’” He further argues that there are two types of interruptions, those that create uncertainty via events that do not fit existing interpretations, and those that create ambiguity via the events that support multiple interpretations. In launching the MCT effort, the GM successfully created both types of interruptions, each of which led to episodes of improvement and change.

Measurement

Based on his alternative conception of system performance, the GM was able to create uncertainty by requiring new measurements of system performance. In the following quote, the GM describes an early meeting with his plant managers:

> We analyzed [for a sample product] the time elapsed between when a part came in the back dock until the time it left the shop floor, and asked the questions “How long did it take?”, and “What was the value added [fraction of time in which function or feature was being added to the product]?”. We found out [for this product] it took 18 days to make the product and we were adding value to the product 0.5% of the time. When I laid this out for everybody...they were astonished.

A plant manager reports his reaction to the new measurements:

> ...we had a gut feel that our cycle times were going to be pretty long...but what really got us was that even with the very crude definitions of value add time we were using–they are much stricter now–we had astoundingly low cycle efficiencies [the ratio of value add to total production time].

Both quotes highlight how measuring new aspects of the system’s performance created novelty by challenging existing mental models.

The introduction of the PPM via new measurements not only challenged existing interpretations; it also led to alternative action. The role of measurement in creating and guiding action is interesting and subtle. Measurements are often thought of as 1st and 2nd

order controls, and this was certainly the case prior to MCT when "…supervisors were required to report labor performance on a daily basis." When the MCT initiative was introduced, however, the role of measurement changed in two significant ways. First, there was a shift from measuring individual components such as the utilization of a particular machine, to measuring the performance of the system. The GM explains:

> ...the other important thing about cycle time and value add[ed]–and I'm not sure I really understood it in this context then–they are process measures, not point in time measures. So when you are looking at cycle time you are looking at a process measure and optimizing the system.

This shift is consistent with the notion that process improvement initiatives are based on a systemic orientation. Different types of action are facilitated by this shift since participants are more able to focus on global outcomes. Further, shifting emphasis away from task performance to system performance allowed participants more latitude in the operation of their individual tasks since they were no longer subject to such intense scrutiny.

A second and more important way that measurement created action was in the *creation* and *definition* of the measurement system itself. A critical element of the MCT effort was the fact that, although the GM required plants to report cycle time and value added percentage, he gave little information as to how the concepts were to be measured. A plant manager recalls, "[The GM] didn't give us a lot of the details...he probably knew more about it than he led us to believe, but I think he wanted us to take a fresh look." Allowing the plants to determine the way they measured themselves transformed the measurement process from a 2nd order control to a 3rd order one. The plants were expected to work under the premise that cycle time was important, but given considerable latitude as to how they used it, thus both new interpretations and new actions were required to develop the measurement system.

The actions induced by the need to create a measurement system based on an alternative set of premises led to almost immediate improvement and provides an example of the co-evolution of action and interpretation suggested by sensemaking (Weick 1995). As participants in the plants began to develop a measurement scheme to understand the system on the dimensions of cycle time and value-added percentage, they also were able to make substantial improvements. A plant manager describes the early phase of the effort in his facility:

> ...in the first year we started with simple counts at different times during the day, and we started to plot them and to try and understand what was happening. Very quickly our creative engineering personnel came up with clever ways to control the buffers that helped make big improvements.

How the engineering personnel ‘came up’ with these improvements is of interest since the measurement scheme itself did not suggest how to change specific machines to reduce cycle time or increase the value-added percentage. Instead, process participants relied on existing knowledge to improvise changes that might lead to improvement. A plant manager describes the character of early improvements:

> During the first two years almost everything we tried we picked up from our own people...by giving them the free reign to start to do some things, they were able to go back to textbooks, business cases, friends they had in other areas that were trying similar things, etc. We tried everything from the Toyota Production System’s Kan Ban to doing statistical process control on buffer sizes.

The quote highlights how the uncertainty created by the new measurements facilitated the alternative use of local knowledge leading to rapid improvement.

Meaning

The other antecedent to sensemaking, ambiguity, was also created by the GM's introduction of a new PPM. Whereas in the first case the GM's alternative approach suggested measurements that challenged the mental models of others, he was also able to use the new the PPM to provide an alternative interpretation of the acknowledged portions of past experience. For example, the GM's alternative approach to understanding manufacturing led to a debate over the meaning of existing terms. The GM recalls:

> One of the first debates we had was over how to measure cycle time. Many people thought of cycle time as the cycle time of the equipment. They were looking at reducing the time a part spent on a particular piece of equipment from 20 seconds to 10 seconds. My feeling was when you are at 18 days who gives a rat's ass about the cycle time of specific machines.

The change in the meaning attached to the term 'cycle time' was one critical way in which the dominant PPM of 'keeping all the machines running leads to improved throughput' began to shift towards a 'minimizing cycle time leads to improved throughput'.

The new meanings attached to common terms also played an important role in creating new actions. For example, a focus on process cycle time suggested that work in process inventories (which contributed to long cycle times) hurt performance. Thus, the meaning attached to inventory began to shift towards something that was undesirable. One manager described how improvements were made on his production line simply by redefining inventory as undesirable:

> We would look at the piles sitting around and ask "do we really need these?" and the answer was usually no. It really didn't involve that much effort.

Similarly, an improvement consultant discusses her approach in facilitating improvements made by machine operators:

> ...we always would focus on " look around you, where do you see parts and why are they there?" We didn't spend a lot of time (with the operators) on the exact calculation of buffer sizes. We didn't worry about whether the buffer should be x units or y units. It looked like a lot of units, so we started by trying to cut the pile in half. Then we would try to cut it in half again, and so on.

In both cases, the introduction of the new performance model suggesting excess inventory reduces performances led to change. The new performance model was introduced into the organization simply by changing the definitions that people attached to common terms.

5.3. Mapping

In the MCT effort, many of the easy and obvious improvement opportunities suggested by the performance model were exercised within the first year of the initiative. Having made these improvements, participants turned to more formal manifestations of the model to find new opportunities. In this case, process mapping represented the next level of sophistication. To continue the pace of improvement, the corporate staff promoting the initiative formalized the process of calculating the value-added percentage via the development of a process map. A staff member explains the approach:

> ...[to calculate the value-added percentage] you had to walk through the shop floor and ask the question, "Is this value added?" for every step in the process. By the time you were finished you had flow charted the entire process and really highlighted all the value add stations....After calculating [the value added percentage], we really started to understand

> the process flow of our products. We knew where value was being added, and, more importantly, where value was not being added.

The connection between the new PPM and the mapping process is highlighted by the fact that the division *already* had established routing diagrams that captured the sequence of production steps required for each product. These diagrams constituted a map of the production process. Spending valuable resources to create new process maps seems both redundant and inefficient until one realizes that the routing diagrams told the reader nothing about the time a product spent *between* specific production steps. In other words, the routing diagrams contained no information about the cycle time of the production process and were neither 'neutral' nor value-free representations of the production system. Instead, they reflected a performance model that did not contain cycle time as a relevant concern. Although the production process was not new, once the new PPM was introduced, the system had to be reinterpreted, and a new map drawn, in light of the new model of performance.

Similar to the discussion above, the mapping process facilitated both new interpretation and new action. As the quote above suggests, mapping the process in terms of cycle time challenged the existing understanding of the determinants of performance. It highlighted additional buffer inventories that could be reduced and non-value added steps in the process that could be eliminated. It further caused people to challenge constraints that had previously been taken as given. The following quote provides one example:

> The process made us challenge specifications and engineering requirements that we had previously taken as given. For example, it caused us to [ask] why did we need to protect a circuit board from the outside environment when it [resided

> within the product]? We finally decided after much thought and experimentation that we didn't, so we eliminated it [thus saving twelve hours].

5.4. Training

In contrast to many improvement efforts, formal training was introduced in the MCT effort only after more than two years of effort and success (at this point cycle time had already been cut by more than 50%). As the effort entered its third year, some of the senior participants felt the need for a more sophisticated method to guide future improvements since many of the easy opportunities provided by the new model had been exploited. In particular, the leader of the effort felt the need to move beyond static representations like process maps and develop a better understanding of the dynamics of the production process. To that end, he turned to the philosophy of Theory of Constraints (TOC). The appeal of the TOC training was both the utility of the underlying model, and the fact that its founder, Eli Goldratt, had developed a training program that relied on computer simulators to develop new intuition about the dynamics of production systems. The manager in charge describes the appeal of the TOC approach:

> It [TOC] allowed you to step back and understand the shop floor as a system rather than as a bunch of process areas, particularly if you worked inside of one. Even though your training would lead you to make decisions one way, it led you to a new intuition that helped you make decisions differently.

Once selected, TOC was spread rapidly throughout the division and within eighteen months of the initial visit, the Goldratt training was given to almost every supervisor and operator in the division. Later, a hands-on, board game version of the training was developed internally and spread to every machine operator and material handler within the division.

The role of the performance model in facilitating improvement and change is highlighted by the fact that the division employed a group of manufacturing simulation specialists that had already developed scheduling and coordination strategies that *outperformed* those provided by Goldratt. Further, the assumption of a fixed constraint machine was clearly incorrect for many of the division's production lines.[2] Yet, the TOC training was highly influential, not as a formal scheduling methodology, but as a model of system performance that guided improvement work. For example, one operations supervisor explained how the TOC notions helped operators produce change:

> We started the effort by trying to find the constraint. It turned out that the previous supervisors didn't know which machine was the constraint. As a result a lot of time was spent keeping non-constraint machines running while the constraint was idle.

The quote provides another example of how an alternative model of system performance provides a way for participants to better utilize local knowledge. In this case, the TOC model allowed participants to use locally accumulated knowledge about keeping machines running more effectively by focusing that knowledge on the machine that limited the throughput of the process. In this particular case, the area in question was able to improve it schedule performance from less that 70% to almost 100% in less than six months once they incorporated in the TOC notions in their improvement efforts.

5.5. The Declining Utility of a PPM

Finally, the MCT initiative also demonstrates that fact that any specific PPM will not produce improvement forever. PPM's are incomplete representations and any individual model suggests only a fraction of the total number of improvement opportunities. In the

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[2] . One supervisor said, "...[the designers of these production lines] did a phenomenal job of balancing

MCT effort, as the division's cycle time approached one day, additional improvements became increasingly difficult to make. After more than five years of steady improvement, the changes suggested by a focus on cycle time reduction and the theory of constraints created only marginal improvement. The highly simplified frameworks used to guide improvement activity abstract away from much the system's structure, and, as the system improved, those features left out of the model became increasingly constraining. A manufacturing engineer provides an example,

> Where do you want your MCT to go? You want to be as responsive as possible to your customers.... At [our plant], if you give us the raw material in the morning, the parts will be done that night....However, the biggest problem right now is how fast do we turn over raw materials. Our logistic system works in one day buckets, so cutting MCT any further [in the plants] isn't really going to help us serve the customer any better. There are other measurables which might drive bigger improvements now.

The limits of these models were compounded by the fact that, with the success of the effort, they were increasingly embedded in the organization's structure, routines and practices. For example, cycle time reduction is still a key measurement that plants are required to report. Another supervisor explains the dilemma created by the success of the effort:

> Sometimes these objectives start to take on a life of their own. People quit thinking about them, or asking whether they make sense. Now when people ask for further reductions I always ask "Why?"... We need to keep it in the back of our minds so is doesn't start to grow, but we shouldn't use it as a driver anymore.

An another expressed a similar sentiment:

> We can't target MCT directly anymore. We've reduced all the obvious inventory. Now we need to attack the problem from a different angle.

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capacity throughout the process and as a result we had interacting [moving] constraints all over the place."

6. Discussion

6.1. A Theory of Participatory Process Improvement

The theory developed here can be summarized as follows. A process is a collection of tasks that converts inputs into outputs. A process performance model (or PPM) is a theory of how the outputs of each individual task interrelate to determine the overall performance of the process. A participatory process improvement initiative is an attempt to introduce a new process performance model into the mental models of those that work within a given process. If successful, the introduction of a new PPM creates improvement and change by suggesting ways in which locally accumulated knowledge can be used to improvise changes in the output of individual tasks that improve process throughput. Change is coordinated by the PPM if it acts as a 3rd order control, and contextually adapted by virtue of the PPM's inherent abstractions.

Such a framework can resolve some of the outstanding issues and controversies concerning TQM and its relation to other operations-focused improvement methods. First, it provides a precise definition: TQM is a participatory process improvement initiative based on a model of system performance that suggests, among other things, that variation creates defects. Second, while scholars have argued that there is little new about TQM (e.g. Dean and Bowen 1994), they have paid little attention to its technical elements. What is new about TQM is an alternative performance model that suggests new uses for local knowledge, and an alternative organizational structure that allows such local knowledge to be more effectively used. TQM works because it combines an improved understanding of process performance at the system level with an organizational structure that allows participants to use locally accumulated knowledge at the component level in better service of system wide objectives.

Third, the common features underlying all PPI methods, including TQM, are: (1) an organization structure the allows participants considerable latitude in using their local knowledge to improve performance; (2) an emphasis on wide-spread training in both the underlying model and resulting problem solving methods; and (3) the use of measurement, data analysis, process mapping, and other methods to suggest improvement opportunities. What is unique to each method is the underlying PPM that manifests as different meanings, measurements, methods of data analysis, process maps, and more formal models.

6.2. The Life Cycle of Improvement

Besides providing at least preliminary answers to some of the outstanding issues concerning TQM and other process improvement methods, the theory suggests a different lifecycle for such initiatives than has appeared in either the academic or practitioner literatures. For example, in the MCT initiative the ease with which improvements were made and the lack of technical or structured methods used to make those improvements stands in stark contrast to existing interpretations of TQM and other PPI methods. In other analyses people have argued that improvement stems from 1) the use of structured problem solving methods (Hackman and Wagemen 1995), 2) improved control of the quality process (Sitkin *et al.* 1994), and 3) improved organizational structure (Wruck and Jensen 1994). As a consequence, researchers often expect to see the dedicated use of the full suite of improvement tools at the outset of an improvement program, and the success of a change effort is often measured via tool usage (as in Zbracacki 1998 and Westphal *et al.* 1997).

In contrast, a theory based on changes in an underlying performance model suggests that a successful initiative does not begin with formal manifestations of the underlying model such as sophisticated problem solving methods. Instead, in the early phases of an initiative one expects little use of formal methods, but potentially rapid improvement, as the new measurements and meanings highlight features of the process (such as obvious piles of inventory) that limit performance. Early improvements are made easily, quickly, and based on casual reasoning with little technical assistance. Later, as the early opportunities highlighted by the new model are exploited, more sophisticated manifestations of the model are needed to continue the pace of change. Eventually, the tempo of improvement declines as factors outside of the underlying performance model become increasingly constraining.

6.3. The Content and Quality of Improvisation

Building on the idea of a life cycle to an improvement initiative, the framework developed in this paper also provides at least a preliminary answer to an outstanding question concerning improvisation in organizations. Weick (1998) writes, "Order through improvisation may benefit some organizations under some conditions and be a liability under other conditions. These contingencies need to be worked out." In the theory developed here, improvisation is beneficial as long as it is driven by a performance model that suggests useful improvements. No PPM, however, suggests improvement opportunities forever. In the case study presented above, prior to the MCT effort, the dominant utilization model had long since run its course and did not suggest significant improvement opportunities. Similarly, the ability of the cycle-time based model to suggest improvements also declined. In the process improvement setting, improvisation ceases to help the organization in improving performance when the underlying model guiding such activity no longer suggests useful changes.

The question of under what conditions does improvisation become a liability is more subtle and also provides an important connection between the framework developed in this paper and Repenning and Sterman's (1998) theory of process improvement failure. There are two components to Repenning and Sterman's (1998) argument. First, drawing on the judgement and decision making literature, they suggest that managers overseeing a given process are more likely to attribute the cause of low performance to the attitudes and dispositions the workforce than to the structure of the process itself (an example of the widely studied fundamental attribution error). Second, they construct a model to suggest that, having reached such a faulty attribution, managers take actions whose subsequent outcomes provide powerful evidence confirming their initial attribution. This 'self-confirming attribution error' creates a powerful reinforcing cycle that drives managers to implement increasingly rigid 1^{st} and 2^{nd} order control structures and eliminates any of the freedom or initiative required for successful process improvement.

The connection between the two theories comes as the performance model runs its course and the pace of improvement begins to diminish. The Repenning and Sterman (1998) framework suggests that managers observing the decline in the rate of improvement are likely to blame the workforce rather than the declining utility of the current performance model. The Repenning and Sterman (1998) model also suggests that, having reached such a conclusion, managers, to continue the pace of improvement, will try to increase their control over the activities of the workforce through additional surveillance, increasingly detailed and frequent reporting requirements, and more bureaucratic procedures.

Their model does not, however, suggest which measurements managers might choose nor what activities that they might try to emphasize through bureaucratic constraints. The answer to this question is, however, made clear by the framework developed in this paper: the newly instituted 1^{st} and 2^{nd} controls will be based on the dominant performance model that has so successfully produced improvement in the past. During the pre-MCT period, for example, managers having successfully used the utilization-based model in the past, increased both the frequency and granularity of their measurements to the point where manufacturing facilities were required to collect and report utilization on a per machine, per day basis.

The irony of this situation is, of course, that through the increase in 1^{st} and 2^{nd} order controls, the performance model becomes increasingly embedded in the physical and formal organizational structure as a *consequence* of its declining utility in suggesting improvement opportunities. The problem is further compounded by the fact that, as managers come to rely on 1^{st} and 2^{nd} order controls, process participants find it difficult, if not impossible, to achieve their increasingly specific local objectives because the model, on which the control structures are based, now suggests few opportunities for improvement. At this point, to continue to achieve their objectives, participants may feel the need to ‘cheat’ the measurement system, and improvisation, which previously was focused on improving process performance, must now be directed at circumventing the newly instituted 1^{st} and 2^{nd} order controls. Thus, to continue the example from above, in the pre-MCT days, machine operators were sometimes forced to surreptitiously accumulate secret stocks of work-in-process inventory that could be used on days when low machine yield rates might have otherwise prevented them from achieving their daily performance objectives.

The most debilitating and dangerous feature of this shift in the focus of activity (and the connection back to the Repenning and Sterman (1998) model of failure) is that the attempts of process participants to improvise ways to circumvent the control structures, once discovered, provide powerful evidence confirming the managers’ initial assessment that the attitudes and dispositions of the participants were the source of the low rate of improvement. With this evidence in hand, managers will further increase the strength of the 1^{st} and 2^{nd} order controls, thereby forcing participants to improvise new ways to circumvent those structures. Such a vicious cycle will prevent improvement, as it did for many years in the pre-MCT phase of the company studied, until an alternative model is introduced

6.4. Improvisation and Leadership

The theory and previous discussion also have implications for current conceptualizations of leadership. In the change process described so far, the final structure of the process cannot be anticipated in advance, and instead emerges as the sum of numerous local adaptations and changes. Thus, leadership cannot be characterized by the popular teleological formulation (e.g. Van de Ven and Poole 1995) in which managers establish a desired state (or vision) and monitor progress towards it. Further, as just discussed, such an approach can be quite debilitating since enforcing progress towards a predetermined process structure both ignores the accumulated experience of process participants, and can, potentially, turn the focus of improvisation towards circumventing the various control structures.

To date a conceptualization of leadership built on an improvisational model has not been suggested. The model developed here suggests one way to fill this gap. In the process outlined, leaders influence the change process via the performance models embodied in the vocabulary they use, the meanings they attach to common terms, the measurements they require, the training they provide, and the formal methods they suggest. Thus, the theory developed here suggests a potential link between improvisational models and more traditional approaches to induced organizational change (e.g. Kotter 1995) in which leadership plays a critical role. In such a conception managers are not goal setters or visionaries, nor are they responsible for evaluating the performance of individual tasks. Instead, their unique responsibility is to set system level objectives and to improve the collective understanding of the dynamics of that system so that those objectives can be achieved. Managers are systems thinkers and theorist, and their primary role is to provide improved models of the *systems* they oversee.

6.5. Implications for Practitioners

"You Measure What You Get"

Finally, there are two implications for process improvement practice. First, many in management science and economics have argued that "You Get What You Measure ". and have concluded that the key to change is simply a modification to the measurement and incentive system. Similarly, it would be tempting, based on the early phase of the MCT initiative, to conclude that all that was necessary for change was the alternative measurement scheme. These arguments imply that creating uncertainty via cues that don't fit existing frames is sufficient to generate change.

Managers have, however, shown a tremendous capacity to ignore measurements that contradict their mental models, and a review of the existing literature suggests that such anomalous data is often not sufficient to induce change. For example, early visitors from the Harley-Davidson Motor Company to Japanese plants experienced data violating their perceptual frameworks when they found that these plants did not have substantial piles of work-in-process inventory, did not have rework areas, and did not have sophisticated computer systems for scheduling production. The novelty was fleeting, however, as they concluded that the facility had been 'cleaned up' for their visit and that all the missing items were simply hidden in back rooms (Reid 1990). Thus, uncertainty may not be sufficient, and insuring that managers take such interruptions seriously requires an alternative interpretation that they are willing to consider. Successful change may require both the *uncertainty* created by an event that violates a pre-existing framework and the *ambiguity* facilitated by an alternative interpretation in which the focal event is more plausible. Thus, one might argue that instead of "You get what you measure", "You measure what you get ." To create successful change, an alternative measurement scheme may require a complementary alternative process performance model.

Benchmarking and Training: From how to why

A second implication for practice concerns two common elements of operations improvement strategies: benchmarking and training. Current benchmarking practice often consists of selecting an organization with a process similar to the one being improved, documenting the structure of that process in detail, and then replicating that process as closely as is possible. Collecting information on exactly *how* a process is structured, however, may be of limited value since that structure represents the distributed efforts of many participants responding to local contingencies. In contrast, collecting information on *why* the organization made the changes that it did may reveal the underlying performance models that led to the collection of changes from which the existing process emerged. These models could be a valuable source of new ideas to catalyze change within the organization.

Similarly, the theory of change developed here suggests that training may be more profitably focused on the 'whys' of the underlying model rather than the 'hows' of the resulting methods. An interesting feature of the training used in the MCT initiative is that it did not emphasize the details of a specific problem solving method, but instead focused on developing the intuition underlying the performance model. Thus, the theory suggests that training should focus not on the rote learning of problem solving steps or methods, but rather on developing an intuitive understanding of the model on which the methods are based.

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