EFFECTIVE METAROUTINES FOR ORGANIZATIONAL PROBLEM SOLVING

MANIMAY GHOSH and DURWARD K. SOBEK II[*]

Mechanical and Industrial Engineering Department
Montana State University, Bozeman, MT 59717-3800
Tel. 406-994-7140
Fax 406-994-6292
Email: dsobek@ie.montana.edu

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[*] Corresponding Author

Abstract

Short-term approaches are the predominant mode of solving process related problems in organizations. As a result, problems recur and impede smooth functioning. Organizational leaders have embraced various quality regimes to produce sustainable change, but the existing literature suggests that many initiatives have met with limited success or have found limited acceptance. The "A3 Process," adapted from Toyota Motor Corporation, is proposed as a metaroutine for creating sustainable organizational change. This paper presents an empirical study that shows a correlation between following the steps of the A3 process and the degree of success. Using a grounded theory approach, this study also offers two contrasting models to explain why short-term approaches were common prior to introduction of the A3 process, and how the A3 Process became instrumental in motivating deeper investigations into the problem and producing lasting change. Based on the empirical data, three essential characteristics of an effective metaroutine are presented.

Key Words: Metaroutines, Organizational Problem Solving, Healthcare, A3 Process

Introduction

The topic of how to deal with process-related problems and produce sustainable change continues to challenge organizational researchers. Scholars assert that organizations, when faced with a problem, should adopt short-term measures as a first step to tide over the immediate crisis, but as a second step should investigate the process critically and jointly to find and remove the root causes to prevent a recurrence (Hayes et al. 1988). Yet, Feigenbaum (1991) reports rarity in applying the second step, and it appears that the trend persists even today (Tucker et al. 2002, Tucker and Edmondson 2002, 2003). Organizations, therefore, continue to find sustainable change of work systems a significant challenge.

The organizational routines that result in short-term fixes to operational problems have been termed “first-order problem solving.” For example, a nurse who detects a shortage of a medical supply in the supplies closet may enact any number of routines – asking others, looking in other places or borrowing from another department – to minimize the interruption in patient care. If the nurse or the nursing team stops there, however, the immediate crisis may be resolved, but the same scenario will likely recur because the root cause(s) to the problem have not been addressed. If, on the other hand, the nurse/nursing team investigates why the stock out occurred and implements countermeasures to prevent recurrence, the result would be a more long-term solution to the problem (i.e., a sustainable change) that improves operational performance. Researchers term the organizational routines that produce these higher levels of insight, and thus sustainable improvement, as “second-order problem solving.”

Improving healthcare work processes has received considerable attention in recent years. Healthcare is an important and vital sector of the economy, but one that continues to grapple with systemic issues (Tucker 2004). Healthcare organizations face the difficulty of providing the right quality of service to its customers, i.e., the patients. Healthcare workers often experience difficulty in communicating and coordinating activities across departments as they lack common knowledge and values, resulting in delays in providing services to their customers. Addressing these issues requires second-order problem solving. But researchers find that most healthcare workers do not routinely engage in collaborative second-order problem solving (Tucker and Edmondson 2003), a difficulty that persists in many other sectors of the economy (Feigenbaum 1991, Argyris 1993).

We argue that effective *metaroutines* can facilitate second-order problem solving to produce sustainable change and therefore continuous improvement within organizations. According to Adler and his colleagues, a metaroutine is a standardized problem-solving procedure to improve existing routines or create new ones (Adler et al. 1999). They find that Toyota has enjoyed long-term success in the market because it continually improves existing work routines, and that use of metaroutines is at the heart of their improvement approach. On a similar note, Tucker (2004) advocates development of problem solving procedures to address work related failures. Nevertheless, the concept of metaroutines is still not well understood. In an effort to examine the impact of metaroutines on organizational work processes, a metaroutine was adapted from Toyota and applied in healthcare to induce second-order problem solving. The central purpose of this research was determine whether this metaroutine, the "A3 Process," produces sustainable change; and if so, explain its efficacy. To conduct the investigation, the effects of implementing the A3 Process in diverse functional departments within a hospital were systematically studied using a grounded theory approach.

In the next section, we review the literature on process-related problem solving and the role of two widely known quality initiatives: Total Quality Management (TQM) and Six Sigma. Then, after reviewing some background information and the research methodology, we present results from 18 cases that suggest adherence to the steps of the A3 Process significantly correlated with higher-order improvements. Next, we offer two models to explain, on one hand, why members of this organization tend to adopt first-order problem solving when a metaroutine is not in place; and on the other hand, how the A3 Process produced the necessary motivation for second-order problem solving for a lasting resolution. We conclude by offering three characteristics of an effective metaroutine as implied by the models.

Literature Review

Many organizational procedures or routines exhibit abnormal variation or problems. From extensive field research in manufacturing enterprises, researchers observe that organizational members address process-related problems by two kinds of process control: reactive control and preventive control. Reactive control involves some immediate measure (or work around) to bring the process back within its acceptable range when it strays outside due to some abnormal variation. In preventive control, effort is focused on pinpointing and eliminating the underlying sources of the abnormal variation through deeper investigation of the causes and their effects. In most real world situations, organizational members must implement some form of reactive control to tide over the immediate crisis of maintaining production before a deeper investigation of the real sources of the problem can ensue (Hayes et al. 1988).

Thus, reactive control often precedes preventive control because it helps people accomplish their immediate objectives. But such improvements tend to be ephemeral in nature since they rarely prevent recurrence. As a consequence, sustainable process change fails to materialize unless subsequent deeper investigation takes place. The key to enduring process improvement hinges on challenging the assumptions of the existing processes and developing new ways to accomplish the work. This distinction between reactive control and preventive control is analogous to Repenning and Sterman’s (2002) first-order versus second-order improvement, Argyris and Schon’s (1978) single-loop versus double-loop learning, and Tucker and Edmondson’s (2003) first-order versus second-order problem solving. For convenience, we will use Tucker and Edmondson’s terminology throughout this paper.

We argue that a metaroutine can be very useful for challenging prevailing conditions by developing and implementing new shared understanding, which is at the heart of preventive control and sustainable change. A metaroutine is described as a standardized problem solving procedure for changing existing routines and for creating new ones (Adler et al. 1999). However, for a metaroutine to promote second-order problem solving, it needs to capture certain elements: communication, shared investigation, and experimentation (Tucker and Edmondson 2003). Adler et al.'s (1999) empirical study in NUMMI finds that the workers achieved high efficiency in their day-to-day work and yet were very creative in improving routines collaboratively using a six-step standardized problem solving procedure, i.e., a metaroutine. Though metaroutines may inhibit innovation by systematizing the creative process, Tyre et al. (1995) find from their field study in a manufacturing environment that organizational members achieved better quality and robust solutions using a systematic approach compared to intuitive approaches.

Metaroutines have been around for at least several decades. In fact, Total Quality Management (TQM) and Six Sigma quality initiatives each advocate a specific metaroutine. The management literature on TQM can be viewed at three levels: a philosophy, a set of tools, and a metaroutine that integrates the tools with the philosophy. TQM philosophy, as espoused by quality gurus such as W. Edward Deming, Joseph Juran, and Kaoru Ishikawa, suggests that the primary purpose of an organization is to remain in business by producing products that satisfy its customers and at the same time promoting the satisfaction and growth of its members (Juran 1969, Ishikawa 1985, Deming 1986 as cited in Hackman and Wageman 1995). Central to satisfying internal and external customers is reducing the variability in work processes. At the tool level, TQM is viewed as a collection of seven classical quality tools (Pareto charts, cause-and-effect diagrams, histograms, control charts, scatter diagrams, check sheets, and run charts) and seven management tools (affinity diagrams, tree diagrams, matrix diagrams, matrix data-analysis diagrams, process decision program charts, and arrow diagrams). Connecting the philosophy with the tools is a systematic approach to solving process-related problems called the plan-do-check-act, or PDCA, cycle (Deming 1986). PDCA can be seen as a metaroutine that governs the use of statistical tools in achieving the TQM philosophy.

Likewise, the primary philosophy of Six Sigma is to reduce variability in processes (Harry and Schroeder 2000). The DMAIC (Define, Measure, Analyze, Improve, and Control) cycle embedded in Six Sigma is a structured problem solving methodology patterned after the PDCA cycle, which can also be seen as a metaroutine. Like PDCA, DMAIC governs the use of statistical process control and other advanced statistical tools (such as hypothesis testing, multiple regression, and design of experiments) to achieve the Six Sigma philosophy.

Extant research literature on TQM reports that, even though TQM has been in existence for many years, in most cases, its success has been limited (Hackman and Wageman 1995, Zbaracki 1998, Keating et al. 1999, Rigby 2001, Repenning and Sterman 2002). Some scholars report that TQM over the years has gradually shifted from scientific problem solving, perhaps the most distinctive feature of TQM, to rhetoric (Hackman and Wageman 1995, Zbaracki 1998). In his study of 69 TQM programs in five sectors (defense, government, healthcare, hospitality, and manufacturing), Zbaracki reports surprisingly limited use of statistical tools and little evidence that organizational members followed the PDCA cycle in problem solving. In fact, PDCA is rarely mentioned in much of the literature on TQM. This might explain why second-order problem solving and lasting change in organizations using TQM are rare. On a similar note, little empirical research on Six Sigma, other than the “best practice” studies by consultants or practitioners (Linderman et al. 2003) exists, so our understanding of Six Sigma and the DMAIC metaroutine is limited.

Thus, TQM and Six Sigma are powerful quality initiatives but their effectiveness in eliciting second-order problem solving appears to hinge upon their respective embedded metaroutines. The existing literature on TQM and Six Sigma suggests that the importance of the metaroutine as an effective medium of second-order problem solving still remains largely unclear to managers. The role of metaroutines in achieving enduring change also appears underemphasized in academic research. Therefore, although metaroutines seem important to lasting process improvement, much remains unknown about what characteristics of a metaroutine are important and how to make them effectual.

Metaroutines in Healthcare

The context for this paper is healthcare, a vital sector in the U.S. economy. United States healthcare spending is expected to reach $3.4 trillion (18.4% of GDP) from $1.8 trillion in 2004 (15.5% of GDP) in just a decade (Biotech Week 2004). Despite its critical role in the U.S. economy and its impact on the lives of people, it lacks sound operating systems. Many experts say that the United States has the most expensive healthcare system in the world and its costs are rising (Berry et al. 2004, Bodenheimer 2005). Even though costs are rising, service quality continues to remain unsatisfactory and uneven (Porter and Teisberg 2004). A significant body of literature addresses numerous cases of medical errors and injuries due to poor service. A recent article even reports that adults receive only 55% of the recommended care for their health conditions (McGlynn et al. 2003). In simple terms, healthcare is in crisis.

Like many other sectors, healthcare leaders employed TQM to address the systemic issues. And similarly, the literature reports diminishing levels of scientific problem solving (Ovretviet 1997, Blumenthal and Kilo 1998, Shortell et al. 1998), and dominance of short-term approaches or work arounds to address problems (Tucker et al. 2002, Tucker and Edmondson 2002, 2003). Compounding these findings is a lack of empirical research to examine its efficacy (Bigelow and Arndt 1995, 2000; Ovretveit 2002). However, Walley and Gowland's (2004) study is a notable exception. They find that the managers in one research site misinterpreted the key steps of the PDSA (Plan-Do-Study-Act – an adaptation of PDCA approach used in healthcare); for example, members assumed the causes of the problem without prior analysis and did not measure the performance of the implemented solutions.

The question that confronts us is how to design a metaroutine that promotes second-order problem solving and sustainable change in organizations. In an effort to answer that question, we investigated the effectiveness of a metaroutine and offer some characteristics that drive such change. By doing so, this paper addresses a significant gap between research and practice on metaroutines. Even though this work focuses on one research site, a healthcare facility, we argue that the model has relevance for other organizations as well. We studied the intervention process in diverse functional departments of the hospital – operations (clinical and non-clinical), finance, and support services. In addition, the healthcare sector, like most sectors, faces challenges of "fighting fires" by using first-order problem solving to keep the services running and yet needs to address the systemic issues using second-order problem solving to remain competitive in a dynamic environment.

Background

From prior research, the second author found that Toyota Motor Corporation, one of the most successful car manufacturing companies in the world, uses a structured problem solving methodology as a metaroutine to improve its internal work routines. The metaroutine, inspired by the PDCA approach, is a source of its competitiveness in the market place. The metaroutine is often used in conjunction with a tool, the A3 problem solving report, which captures the key results of the major steps of the metaroutine on one side of size A3 paper (metric equivalent of 11"×17"). The Toyota's problem solving methodology was codified into nine essential steps, and termed the A3 Process (citation removed to preserve author anonymity). The nine steps of the A3 Process are:

1. Observing the current process;
2. Drawing a diagram to represent the current process;
3. Determining the root causes to the problem by asking the "5 Whys;"

4. Developing the countermeasures to address the root causes to the problem;
5. Drawing a diagram of the envisioned (or target) process based on consensus with the affected parties;
6. Planning the implementation;
7. Discussing all of the above with the affected parties;
8. Implementing the actions planned; and
9. Collecting follow-up data on the outcome of the new process and comparing against pre-specified targets.

Steps 1 through 7 refer to the "Plan," step 8 refers to the "Do," and step 9 refers to the "Check" stages of the PDCA cycle. The "Act" step is the creation of new organizational work routines when they prove worthy in step 9. These nine steps provide an approximate order of solving problems. In reality, the steps are iterative, as the problem solver may need to go back to previous steps in order to refine them.

In the initial stages of a collaborative effort with a hospital in the Rocky Mountain region of the United States, the second author, a professor of Industrial Engineering, and his colleague, an experienced trauma care nurse, applied the adapted A3 tool and metaroutine in the cardiology department of the hospital, and refined them based on their field experience. They then developed a seven-week introductory training course, and subsequently tested and refined the metaroutine in the pharmacy department. Over the next 1.5 years, the second author's colleague provided hands-on training to over 150 employees of the hospital on how to apply the metaroutine and additionally wrote a workbook to accompany the training course. Furthermore, she and others also experimented with the metaroutine at other hospital sites.

When the first author joined the team, he spent six months at the site as a participant-observer to learn the problem solving methodology. Using the metaroutine, he then facilitated many problem-solving exercises that were strategically important, and observed the change in behavior of individuals as they participated in those change efforts. While facilitating, he also trained future “coaches” on how to use it. Through this experience, he obtained first-hand understanding of how the employees in the hospital were addressing problems in the absence of a metaroutine. These field-based activities shaped his understanding for framing the research question and formulating the research methodology.

Research Methodology

The work noted above provided preliminary evidence that the metaroutine seems effective in healthcare. However, we wanted more explanation for why it worked; but to our knowledge, no empirical research existed that examined its effectiveness. Thus, to generate novel and accurate insight about why the A3 Process is effective, a grounded theory approach was adopted (Strauss and Corbin 1990, 1998; Cresswell 1998).

Data Collection

After a five-month absence, the first author returned to the hospital site to collect data on his research intent and selected eighteen cases that involved addressing process related problems using the A3 Process. Cases were selected where employees who had been trained in using the A3 Process and the A3 Report, and where a process improvement effort was finished or nearly so. They were chosen from diverse functional departments such as Heart Center, Laboratory, Intensive Care Unit, Rehabilitation Unit, Registration, Hospital Information Management (H.I.M.), Transport, Quality Risk Management, Patient Financial Services, and Facilities.

As part of the primary data collection, the first author conducted semi-structured interviews. The informants represented every level in the organizational hierarchy (directors, managers, registered nurses, therapists, technicians). The questionnaire asked participants to describe in detail the process they used to address the problem. Additional questions probed participants about what they thought was important about the metaroutine as a process improvement technique in their facility and why. The intent was to gain a deeper understanding of any step they thought essential to problem solving and the reasons thereof. For example, if an informant mentioned "observation" as a critical step, the first author sought to understand why s/he thought it to be critical. Similarly, if an informant claimed that s/he carried out an experiment, s/he was asked to explain why s/he felt it was important to conduct an experiment and what s/he learned from it.

Before conducting the interviews, the second author, who has significant experience in qualitative research methods, checked the list of interview questions for reliability. A number of hospital employees also reviewed the questions for face validity. All informants were informed in advance about the intent of the interview. The interviews lasted between 60-90 minutes and took place in a neutral location such as the informant's office, a conference room or the hospital's cafeteria. In some cases, multiple interviews were conducted to complete the collection of data. During the interview, the first author took field notes by hand, and immediately thereafter typed up an interview report based on the field notes and his memory and gave it to the informant to check for factual errors. The informants returned the reviewed document within 48 hours.

Though the primary data were the interview notes from the lead problem-solvers, the investigator, in order to triangulate the data obtained from the interviews, also collected A3 problem solving reports from each informant, conducted informal interviews with other individuals who had some stake in the processes studied, and collected a wide range of other artifacts such as electronic mails and meeting minutes of Quality Council and Safety Council. Finally, he maintained contact with informants by email or phone for 12 months following the interview to obtain follow-up quantitative data on process performance and to clarify questions that arose in case development.

Analysis Approach

The data were analyzed at two levels: (1) a first-order cross-case comparison and (2) an in-depth analysis using a grounded theory approach. The objectives behind first-order analysis were to ascertain how well the participants adhered to the A3 Process to ensure its effectiveness. The A3 Report and interview notes were carefully reviewed to make an objective assessment as to which steps of the metaroutine were followed. If a step was executed as trained, we construed that as "completed." If the participants did not skip the step but failed to follow it as per the instructions provided during training, or partially completed it when reviewed last, we labeled that step "partially completed." If we could find no evidence that a particular step in the metaroutine was attempted, we considered it "not completed." A comparison chart was then prepared (Table 1) to summarize the findings.

In order to explain the results of the first-order analysis, a deeper investigation was carried out using a grounded theory approach (Strauss and Corbin 1990, 1998; Cresswell 1998). Though the interview report from each informant was the primary source of data, all of the artifacts related to a case were considered to get a comprehensive picture of what the problem was and how it was resolved using the metaroutine. Thus, all documents related to a problem were linked together and entered into Atlas Ti software for coding.

First, all the artifacts (interview reports, emails, meeting minutes) were read several times for salient categories of information related to problem solving and were open coded. After completing all eighteen cases, the data were revisited to look for additional themes, until no new insight was found. Some of these codes were then grouped into a higher order category due to similarity. Next, the categories derived from open coding were divided into "Without A3 Process" and "With A3 Process" groupings. Axial coding was then performed on the "Without A3 Process" categories to try to understand the relationships among categories to explain what inhibited second-order problem solving at the research site and to develop a model. Likewise, similar coding was performed on the "With A3 Process" categories to explain why it did or did not prompt second-order problem solving. From the axial coding, a model to explain the phenomenon of instituting second-order problem solving was developed. The second author examined the artifacts and documents against the analysis provided by the first author to check any interpretive errors. The resultant models were then tested against the interview notes and A3 Reports to check their validity.

Results

The results of the first-order analysis indicate that ten of the eighteen cases studied followed all the steps of the metaroutine, and that the magnitude of improvement ranged from 77% to 100% (see Table 1). In contrast, those that skipped one or more steps realized improvements that ranged between 17% and 60%. These results seem to indicate that adherence to all the steps of the A3 Process significantly correlated with higher order improvement, and that sacrificing even one of the steps resulted in a significant decrease in its effectiveness.

Insert Table 1 about here

The grounded theory analysis of the data from the 18 problem solving efforts resulted in two contrasting models. In the following sections, we present the two models in the context of an actual case. For each model, we first describe a case of labeling specimens collected from a patient in the operating room (OR), and transporting the specimens to the hospital’s laboratory for diagnosis and testing. We then critique the case to elicit the key features of the model.

Problem-Solving Without an Effective Metaroutine

The first case description illustrates typical problem-solving routines when an effective metaroutine for problem solving is not enacted.

> The physicians in the OR collect samples (blood, bodily fluids, human tissue) from patients for various diagnostic tests. They handed specimens over to the OR circulator, who was responsible for recording information, dispatching specimens, and managing equipment in the OR. Usually, the physician verbally provided all pertinent information (name of the patient, medical record number, body site, body side, date, time, and sample number) to the circulator who labeled the specimens. The circulator then handed the labeled specimens to a transporter, an OR person, for transporting to the laboratory. As the OR was located on a different floor from the laboratory, the OR personnel transported specimens by various modes: hand carried, sent through pneumatic tube system, or transported by elevator.
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> However, there were delays in transporting the specimens. Microbiology and Clinical laboratory specimens were sometimes placed in the elevator, which was not always checked by the laboratory staff because they did not expect to receive the specimens that way. Similarly, certain types of specimens such as "STAT" were not always sent by hand which caused delays in transport and immediate attention by the laboratory technicians. When the specimens were sent by an unacceptable mode, the laboratory personnel would bring this issue to the attention of the surgery department by sending them an internal occurrence report or reporting to the director of laboratory. The superiors of the two departments discussed at their levels to resolve the issue. But the problem was not resolved as the transporters continued to transport specimens by various modes.
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> There were problems with the labeling of specimens as well. The information provided to the laboratory was occasionally incomplete and/or incorrect. The laboratory personnel expediently attempted to resolve such problems by making multiple phone calls to obtain the information about the specimens. However, the problems were not eliminated and laboratory personnel continued to face similar problems at regular intervals.

We observe from this case strong evidence of first-order problem solving and lack of second-order problem solving. Both problems recurred at sufficiently high frequency to be a perennial source of frustration. Interestingly, we also observe a behavior that seems to resemble an individualistic behavioral pattern. The individualistic behavioral pattern is characterized by three elements: unclear work expectation, limited communication, and inadequate accountability.

First, each individual with same job function completed tasks differently, suggesting the work expectation was unclear to many individuals. For example, STAT specimens were sometimes sent by modes other than hand, which delayed immediate action by the lab personnel. Analogously, specimens were sent to the Microbiology department by elevator, which was unacceptable to the lab personnel. Thus, every transporter tended to have his or her own preference of transporting specimens depending on his or her convenience and understanding, often oblivious to the implications.

Unclear work expectations were common across the sample of cases. A manager of the transportation department, for example, described how the members from the diagnostic department requested patients from the clinical floors.

> There was no written information about a patient to be transported: the transporter only knew a patient was needed and no record of where the patient was to go. One staff person from the diagnostic department called the transporter, another the floors, and another wrote it on a board somewhere and was checked when a transporter got there. A great deal of time was wasted on patient search and rescue (just patient name, no room number, bed number, or floor or area).

In this case, the requester from the diagnostic department did not have any clear understanding of how to place requests for transporting a patient. Therefore, every requestor had his or her own way of placing requests, which created considerable confusion for the clinical departments and the transporter.

Second, it seems that the individuals communicated little *within* the department to successfully accomplish a task, which further reinforced their individualistic behavior. One individual mentioned that the transporter did not always verify from others in the OR to make sure that the information on the specimen labels were in order or that the transportation mode was acceptable before taking or sending them to the laboratory. Another informant mentioned that the OR circulator did not always verify from the physician on the exact specimen details before handing the specimen to the transporter.

To cite another example from a different case, a speech language therapist who examined the issue of inconsistent group meal therapy treatment explained that the therapy treatment differed from one therapist to another due to a lack of proper communication between the person performing the therapy and the primary therapist, who determined the therapy goals upfront. Consequently, patient care was not satisfactory and the productivity of the therapists suffered.

An absence of communication *across* departmental boundaries was also a common trend. When lab specimens were brought by hand, the delivery did not always result in direct face-to-face interaction as the specimens were brought to the lab without prior intimation and left on the counter. Hence, there was a lack of communication between the two departments to ensure that the specimens arrived with the right information. To cite a second example from a different case:

> The diagnostic department and the nursing stations (clinical floors) never communicated as to the expected patient transport times or procedure times. The patient's nurse often did not even know the patient was going to a procedure and so the patient's medical needs were not always met for the procedure, i.e. IV change, medicines, etc.

These examples suggest that there was a general lack of communication among the members within or across departments in accomplishing work on a day-to-day basis.

Third, the inconsistent level of task performance and limited communication within and across functional departments seemed to be exacerbated by inadequate accountability. For instance, even though certain specimens that needed immediate transport by hand were delivered by other modes, resulting in delays in its transporting, testing, and reporting, there were few consequences and so the processes continued for years. On a similar note, the hospital leadership team did not seem to hold OR staff accountable even when important information on specimen labels was missed resulting in testing and reporting delays, potentially compromising patient care.

In sum, different individuals with the same job function executed the same task differently. This unclear work expectation was further reinforced because they communicated little with others to clarify work expectation. Unclear work expectation and limited communication were further exacerbated by inadequate accountability. Their superiors did not always question them for unsatisfactory performance, which in turn did not place demand on an individual to clarify work expectation and produce consistent and superior performance. Thus, the interaction of these three dynamics – unclear work expectation, limited communication, and inadequate accountability – resulted highly individualistic behavior.

In addition to the individualistic behavior, we observed a superficial understanding of work among respondents, also manifested in three elements. First, we find that in many cases individuals inherited functional knowledge orally without questioning the validity of the processes. There was no mechanism for an individual to ensure that whatever tasks s/he did would lead to satisfactory process performance. For example, a nurse who examined the issue of lost charges on medical supplies in one of the clinical departments noted, “No policy in place. Nobody questioned. The process has continued this way for years.” Similarly, the transport manager, when asked how the patient request process evolved over the years remarked, “It is anybody’s guess. It was just an inherited process that evolved differently in each department. All anybody knew was to page a transporter and when they arrived they told them what was to be done.”

Second, members did not have a sound knowledge of the work practices within the department because they lacked shared understanding of how those work practices needed to be successfully accomplished day-to-day. To illustrate, the members in the OR did not effectively communicate with other members about the specimen labeling and its transporting. Neither did they have any well-defined policies, even for the routine tasks such as specimen labeling, so that every OR circulator could gain a common understanding of what entails successful specimen labeling. A physician mentioned, “The steps [for specimen labeling] were touched upon but not clearly laid out step-by-step.” The existing work description was not very explicit on the information that was needed on the labels prior to dispatch. For similar reasons, the transporters did not have adequate shared understanding of similar routine tasks of how different types of specimens collected in OR should be transported to the lab.

Third, poor understanding of the routine processes made working across functional boundaries even more challenging because the members in one department did not understand what information they needed to provide for smooth execution of work in the other department. As a result, they could not attune their internal processes accordingly for smooth execution across boundary lines. For instance, the OR circulator had some understanding of the activities in the lab but she did not always provide all the necessary information to the laboratory personnel. A supervisor in the laboratory expressed his reaction to this lack of understanding of work across functional boundaries as follows:

> Not all specimens that come from OR are just a "SPECIMEN." The specimen may require clinical lab testing, (i.e., cell count), microbiology cultures, or a pathologist's examination. The OR staff need to be aware of what these specimens are and what area of the laboratory they are to be sent for what type of testing.

In short, individuals continually cycled through a process of oral inheritance of functional knowledge from their predecessors, which in the absence of an appropriate validation mechanism, precipitated a lack of shared understanding within the department and limited understanding of work at the functional boundaries. Absence of boundary knowledge reinforced the individual's desire to acquire new knowledge without validation, commencing another cycle of superficial understanding.

In sum, the general pattern that emerges from the data is that problem solvers did not get beyond first-order problem solving because of limited understanding of the work processes, combined with individualistic behavior. Unclear work expectation, limited communication, and inadequate accountability fostered an environment of individualistic behavior, which resulted in lack of shared understanding within the department and limited knowledge of work at the boundary. Inversely, absence of shared understanding and limited boundary knowledge did not place strong demand on the members to challenge the assumptions of the existing processes to clarify work expectations, thus reinforcing individualistic behavior. Furthermore, oral inheritance of functional knowledge supported inadequate accountability in work because there were no consequences for poor performance. These cycles, illustrated in Figure 1, interacted to discourage second-order problem solving.

Insert Figure 1 about here

The lab specimen example illustrates this dynamic. Due to the existence of individualistic behavior and superficial understanding, members from the laboratory and operating room did not seem to have had any motivation to engage in second-order problem solving efforts. Hence, they could not objectively understand the current specimen labeling and transportation processes, and how they impeded effective performance at the boundary. When the processes failed to perform satisfactorily, the actors tended to enact ad hoc approaches (e.g., laboratory personnel communicated with the OR personnel for additional information or submitted an internal occurrence report to the OR). These first-order problem-solving strategies usually resolved the immediate issues and allowed the members to continue with their daily work routines, but were not very effective in the long run because the problems kept resurfacing at regular intervals and were a continuous source of concern and frustration for the laboratory personnel. There was no endeavor to jointly understand the underlying causes to the problems they encountered on a day-to-day basis and eliminate them. This pattern of first-order problem solving existed across all the cases we studied, and helps explain why second-order problem solving was rare and why enduring change was difficult to achieve.

Metaroutine Enabled Problem-Solving

With the introduction of the A3 Process in the hospital site, some of the individuals from the laboratory and OR underwent training in using it. The training was the first step in the behavioral transformation process as they became very interested in addressing the problems associated with specimen labeling and transporting that had confronted them for years. A team was formed under the tutelage of a coach, an employee from the Quality Risk Management department. The other participating members were from OR, laboratories, information system, and education.

> The first step the problem solvers adopted was to gain a detailed understanding of the current specimen labeling and transporting process through first-hand observation. One of the problem solving team members obtained permission from the OR leadership team to interview the OR personnel and observe the proceedings. She spent 10 hours talking with OR staff (circulators, secretaries, surgery techs, nurses, and administrative personnel) and another 6 hours observing surgeries. While she observed in the OR, others observed specimen transport and specimen labeling in the lab as specimens arrived.
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> After observing the proceedings in the OR, she drew a diagram illustrating the current specimen labeling and transporting process. She then walked the other participating members through the drawing. As she described the current process, members from the group provided additional information, which made the current process look even more

> cumbersome. The group saw the problems associated with specimen labeling and transport, and identified lack of clear specification of the specimen labeling and transporting process as the root causes. The team met several times to discuss these issues. Based on consensus, the problem solving team devised a new labeling system (called a "secondary label") as a countermeasure that captured the neccesary information in the OR prior to transporting the specimens to the laboratory. Consequently, they developed a new process targeted at meeting this goal and drew it on the A3 Report.
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> As part of the implementation plan, the team planned on printing the secondary label and implementing it immediately. One of the participating members, a physician, became responsible for coordinating with physicians in the OR. The other participating members from OR and Lab discussed the problems and the new labeling system with their colleagues in their respective departments.
>
> The new process was implemented and follow-up data was collected to ascertain its efficacy. Initially, the team was able to achieve significant success with the new process, as there was a marked reduction of missing information on specimen labels. But a month later, a similar experiment discovered some slippages with the new processes, which caused concern among the team members. The initiator of the problem solving effort found that though the new process was operationally feasible, more control and training was needed at the operational level to make it routine for its ultimate success. She shared the data with the team members and all other staff in the OR and the laboratory using email and warned about the consequences of not complying with the new process, and suggested stricter control before sending specimens to the laboratory. In fact, she proposed halting transport of specimens to the laboratory until the secondary label was completed and placed on the specimens in the OR. Six months later another set of follow-up data was collected to measure the success of the new process and the results were astonishing. The success rate was close to 90% in most of the parameters studied. Observing the latest results, the team was certain that the new process was capable of providing accurate, timely, cost-effective, and safe medical care and so they developed new policies and procedures for labeling laboratory specimens and added them to the Administrative Policy and Procedure Manual.
>
> In order to address the transportation problem, the problem solving team as a countermeasure agreed upon stopping any transport of specimens by elevator. The laboratory personnel carried out an informal experiment to check whether sending specimens by elevator was discontinued or not. They kept observing the OR personnel on how they transported specimens over an extended period of time. The results were very satisfactory because sending specimens by elevator was completely discontinued. The new policies on how to transport specimens during routine operation hours and after hours were also developed.

Though all the steps of the A3 Process were followed to successfully accomplish the problem-solving effort, we observed four elements in particular that appeared play a strong role in switching the organizational members from a first-order to a second-order problem solving mindset. These steps were: observing the current process, hand sketching the current state on the A3 Report, discussing with other stakeholders, and conducting follow-up studies.

Direct observation of the specimen labeling and its disposition in the OR seems to be central to attaining a detailed understanding of the problem and its root causes. In this case, the observer talked to the OR staff prior to observing, and therefore, observation was a mechanism to validate against their statements. The observer's prior understanding of the process was not necessarily the reality. Therefore, observation provided a validation against her current understanding of how the specimen labeling and transporting actually worked, and how it impacted the working of the laboratory. In addition, observation provided some additional new knowledge to the observer about the work practices within the OR that contributed to wrong labeling. For example, the specimen labels of the previous patient were not always removed from the OR which contributed to errors in labeling for the following patient. Similarly, multiple specimens were sometimes not clearly differentiated. The pathology form listed specimens as A, B, C, while the physician identified specimens as 1, 2, 3, for example. Furthermore, collection of objective facts through direct observation motivated the behavioral change process at the individual level. In a number of cases, the findings were so compelling that they motivated the observer to be proactive in seeking a solution collaboratively rather than being passive. The observer remarked on her observational experience:

> It [observation] was very educational. I learned a whole lot. I went up to OR and watched several surgeries and just made sure what they [circulators] told me matched with what they were doing. I even questioned people from Pre-op to find what they really did. I talked to Pathology to get their experience. It was very interesting and was a major learning experience. It is so hard to make anything better without other's cooperation.

In an effort to seek a collaborative solution to the problem, the observer decided to explicate her tacit understanding to the other participating members. By getting the other stakeholders involved, the observer not only mitigated their possible resistance to change, but also stimulated them to contribute to a more effective change process. When the observer discussed the observations she made in the OR with the other stakeholders and walked them through the iconic representation of the current state on the A3 Report, they, too, contrasted their conceptions with the observed data and/or confronted misconceptions. This exercise integrated knowledge from multiple sources. They realized that the existing work practices in OR and Lab were incapable of achieving the organizational goals and so they assumed active roles to collaboratively identify the sources of the problem and create new shared knowledge to address it. In fact, they created a new secondary labeling system, which captured all the relevant information on specimens prior to transporting. They also decided to discontinue elevator transport because it was not a desirable mode and delayed the testing and reporting process.

This joint validation and collaborative act of individuals during the A3 Process was a common trend that we observed. One informant who studied the problem of wrong transcribing of stress tests in the Hospital Information Management department summed up a similar reaction when she drew the current state diagram.

> The drawing of the current state of affairs was the most impressive. I observed each step of how the current process was being done. I knew it was a mess. Drawing out the current state on paper was an eye opener. Not just for me, but for all departments involved. We were all shocked at how bad our process was and how it screwed everything up. Once it was drawn out, it was easy to see where things could be changed.

The collaborative understanding appears to have provided the necessary groundwork for the members to verify their newly developed process objectively and jointly using a small-scale experiment to see whether this process worked or faltered. Indeed, the team observed some glitches in the initial stages of the implementation in the secondary labeling system and had to make minor adjustments in the new process to make it fully functional. The lesson learned seemed to be that real learning occurs only when new knowledge is put to practice.

An informant from a different case who studied the issue of missing orders for the diagnostic tests required on specimens (a project which failed to achieve positive results) recounted his experience on how such real learning was missed when experimentation was skipped in their A3 problem solving effort.

> I think experimentation is critical, so that a bad process is not implemented and the whole process is thrown out of whack. That happened in our work with one of the clinical departments, who seemed to develop every idea without carefully looking at the ramifications or experimenting to see what the results might be.

In summary, the generalized conclusion we made from examining the successful cases was that observing, drawing an iconic sketch, discussing with other stakeholders, and experimenting appeared instrumental in transforming the behavior of individuals from an individualistic and passive to a collaborative and active mindset. These activities in turn influenced either knowledge validation or knowledge creation or both, leading to a deeper contextualized understanding of work. Observation and iconic representation caused individuals to validate their current understanding of work processes and also helped to gain new knowledge. Discussions also aided knowledge validation through shared understanding with others involved in the process, and subsequently fostered new knowledge creation in many cases. Experimentation validated the new knowledge just created. Challenging assumptions, preconceptions, and misconceptions seemed central to the deep understanding of work, and resultantly in stimulating second-order problem solving, because preconceptions and misconceptions hid the root causes. Observation, iconic representation, and discussions actually peeled the surface to uncover the underlying causes. In short, adopting the A3 Process as a metaroutine changed the behavior and the cognitive abilities of individuals as shown in Figure 2. These two cycles interacted together to promote second-order problem solving.

Insert Figure 2 about here

Characteristics of an Effective Metaroutine

From the analysis of the 18 cases of organizational problem solving, three characteristics emerged as essential elements of an effective metaroutine. The first characteristic is, does the metaroutine prompt the individual to validate his/her current contextual knowledge in a tangible way (i.e., crosschecking the existing understanding against reality and altering the former, if necessary)? Without such accurate understanding, problem resolution becomes biased, opinionated, and suboptimal. The second characteristic is, does the metaroutine bring individuals affected by the problem or proposed change together to validate their collective knowledge? These discussions not only give individuals increased confidence that their understanding of the current process is sound, it also aids in the creation of new common knowledge and consensus on a course of action. The new knowledge, having become explicit, is readily deployable. The third characteristic of an effective metaroutine is, does the metaroutine encourage joint validation of new knowledge? If the consequences are positive, they confirm the individuals' understanding. If they are negative, the individuals have the opportunity to revise their understanding.

The above three characteristics seem to be in agreement with the prescription of some scholars who posit that communication, shared investigation, and experimentation are key ingredients to promote second-order problem solving (Tucker and Edmondson 2003). These scholars imply that second-order problem solving necessitates conscious and explicit inquiry in addressing a problem. We offer something deeper that supplements their work. At the heart of second-order problem solving is constant knowledge validation, which provides the necessary fluidity to knowledge absorption and its dissemination at the individual and collective levels. An effective metaroutine is one conduit to achieve that validation systematically.

TQM in Practice

The model depicted in Figure 2 may also help explain why TQM programs often fail to produce second-order problem solving and deliver satisfactory results. In most of the cases reported in the literature, the managers or the senior staff handled problem-solving efforts, and hence, problem solving seemed divorced from the actual problem site and became de-contextualized. Objectively validating existing knowledge was not apparent in those efforts even though the effectiveness of all subsequent steps depended on that understanding. In fact, researchers in a recent empirical study note that the problem solvers often assumed the source of the problem without any prior research (Walley and Gowland 2004). Therefore, there was no individual validation of the current process by the problem solver(s) before embarking on the subsequent steps.

Second-order problem solving requires collective validation of existing knowledge, and a boundary object seems to facilitate such validation process. Boundary objects are tangible artifacts used by organizational members to facilitate communication among organizational members from different functional expertise to solve problems (Star and Griesemer 1989, Brown and Duguid 1998, Carlile 2002). A typical example of a boundary object in a healthcare setting is a medical chart used by physicians and other caregivers to treat a patient. Using the information provided in the chart, different caregivers can validate their tacit understanding about the health condition of the patient, discuss, and plan on their subsequent interventions to achieve patient care goals.

In the case of TQM programs, many researchers document limited use of tools (Kano 1993, Hackman and Wageman 1995, Zbaracki 1998, Rigby 2001). Zbaracki observes from his field study that one of the primary reasons members were reluctant to use the tools was because the members found the tools cognitively difficult to understand, and the frequency of the usage declined as the tools became more technical. The problem was more acute with employees from service sectors such as hospitals and hotels. Similarly, Kano finds from his field study that members did not take any action even when the control charts showed out of control situations. These findings seem to suggest that the tools were not very effective as boundary objects, as the organizational members faced roadblocks in validating their tacit understanding using them, discussing with others, and taking appropriate actions in their respective departments to resolve the problem.

Experimentation enhances second-order problem solving by validating newly created shared knowledge. Though experimentation is advocated in TQM, scholars report that users often abandon it (Hackman and Wageman 1995, Ovretveit 1997) or do not use it rigorously (Walley and Gowland 2004). One explanation for the disregard for experimentation is the superficial understanding of the problem solvers – the managers. Because they did not always validate their current understanding by objective means upfront, they lacked deep contextualized understanding of work and how it impacted performance. Therefore, there was no individual-felt compulsion to test whether the new knowledge faltered or not.

Thus, it appears that in most failed cases in TQM, the problem solvers did not address the problem with objective approaches such as observing the current process and mapping it, discussing with others using boundary objects, and experimenting. As a result, the members failed to validate their existing knowledge and create new knowledge for an enduring change.

Conclusion

Even though the topic of how to achieve lasting change in an organization when confronted with process-related problems has received a great deal of attention in the literature, it remains largely inconclusive. Scholars observe that problem solvers resort to first-order problem solving and rarely undertake the next step, that is, second-order problem solving, to prevent recurrence. We argue that a properly designed and deployed metaroutine may be an effective mechanism to foster second-order problem solving. But the effectiveness of metaroutines in improving work processes is not well understood.

Our empirical research attempts to make several contributions to the existing body of knowledge on second-order problem solving. We present our empirical findings and a model to explain why in the absence of a metaroutine first-order problem solving was much more common than second-order problem solving. Subsequently, we find that second-order problem solving is indeed possible, and demonstrate how the A3 Process, when followed as prescribed, became instrumental in transforming the behavior and cognitive processes of individuals jointly. We then present a model that characterizes the metaroutine and highlight three characteristics that are indispensable to achieving second-order problem solving and sustainable change. The model suggests a theoretical basis for the ineffectiveness of many TQM programs reported in the literature.

Although additional work should be conducted to confirm these findings in other contexts, we argue that our findings still remain significant. The empirical data suggests that problem solvers rarely get to the root cause of the problem due to inadequate shared understanding of the work, coupled with individualistic behavior. Hence, they did not expend sufficient effort to engage in second-order problem solving. Our research data shows that a metaroutine such as the A3 process can be very effective for organizational members to collectively validate existing knowledge through shared understanding, identify and deal with the problems at their sources, and create new knowledge to address them for a sustainable change.

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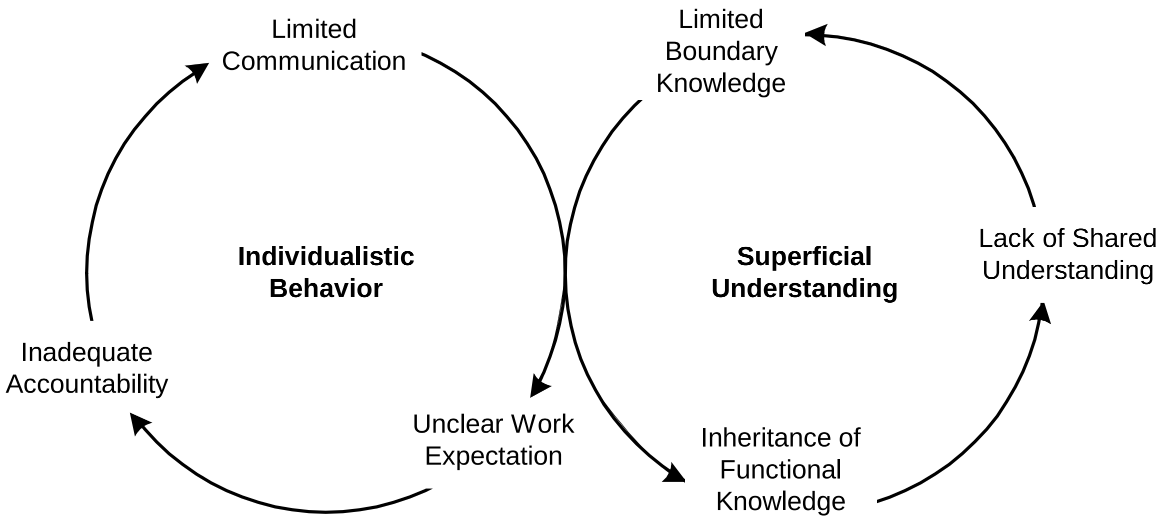

Figure 1. Model of Problem-Solving Behavior Without a Metaroutine

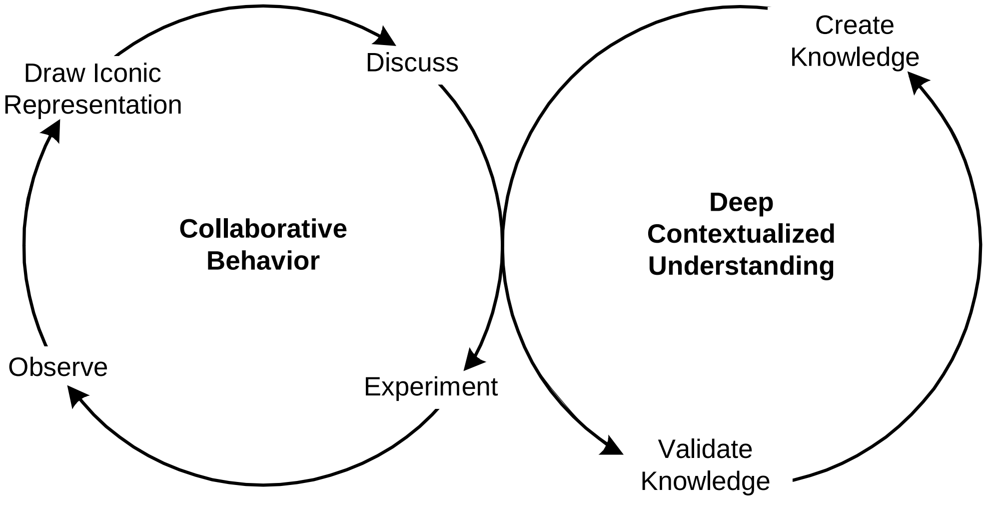

Figure 2. Model of Second-Order Problem Solving Using the A3 Process

Table 1. Summary of the Metaroutine Steps Followed by the Participants

	Observe	Draw current process	Analyze root cause	Develop c/measures	Draw target process	Plan implementation	Discuss	Execute	Follow-up	The A3 Process followed	% Improvement
Case 2	●	●	●	●	●	●	●	●	●	Y	100%
Case 5	●	●	●	●	●	●	●	●	●	Y	100%
Case 6	●	●	●	●	●	●	●	●	●	Y	100%
Case 7	●	●	●	●	●	●	●	●	●	Y	100%
Case 10	●	●	●	●	●	●	●	●	●	Y	100%
Case 16	●	●	●	●	●	●	●	●	●	Y	100%
Case 18	●	●	●	●	●	●	●	●	●	Y	100%
Case 17	●	●	●	●	●	●	●	●	●	Y	92%
Case 3	●	●	●	●	●	●	●	●	●	Y	80%
Case 12	●	●	●	●	●	●	●	●	●	Y	77%
Case 8	●	◉	●	●	◉	●	●	●	●	N	60%
Case 4	●	●	◉	●	●	●	●	●	●	N	50%
Case 13	●	●	●	●	●	●	●	◉	●	N	50%
Case 9	●	●	●	●	●	●	◉	◉	●	N	26%
Case 11	●	●	●	●	●	●	◉	●	●	N	25%
Case 1	●	●	●	●	●	●	◉	●	●	N	17%
Case 14	●	●	●	●	●	●	●	○	○	N	0
Case 15	○	◉	◉	●	◉	●	◉	○	○	N	0

Legend: ● Step completed, ◉ Step partially completed, ○ Step not completed