NOTICE: This material may be protected by Copyright Law (Title 17 U.S. Code)
EFFECTIVE PROCESS IMPROVEMENT
DEVELOPING POKA-YOKE PROCESSES

DOUGLAS M. STEWART
STEVEN A. MELNYK
Department of Marketing and Supply Chain Management, The Eli Broad Graduate School of Management, Michigan State University, East Lansing, MI 48824-1122

The modern production and inventory control (PIC) manager is facing new and more demanding challenges. One of the more persistent is that of simultaneously reducing costs, improving quality, reducing lead times, and enhancing flexibility. This challenge is not new—it has been the target of developments such as total quality management (TQM), mass customization, time-based competition (TBC), Just-in-Time systems (JIT), and kaizen events. But despite the availability of these procedures and their well-documented success, the overall rate of success has been somewhat uneven. This leads to an interesting but unresolved managerial paradox: If we understand the overall objectives the PIC manager must achieve and if we have access to a well-established, validated, and well-documented set of procedures and developments to achieve those objectives, why aren’t PIC managers more successful in doing so? As we will show in this article, resolving this paradox involves examining the various developments, identifying certain critical elements, and bringing them together into a well-structured improvement method.

The critical elements consist of four building blocks: (1) clear identification of the critical customers, as well as an understanding of their needs; (2) a process orientation; (3) consistent and integrated metrics, with an emphasis on process as compared to outcome metrics; and (4) focus, urgency, and time compression (FUT). We show how these elements are integrated through an iterative multistep procedure.

The improvement method is essentially evolutionary in nature as none of the elements are new, rather they are drawn from procedures such as JIT, TQM, kaizen events [5, 6], and business process reengineering (BPR) [2]. What makes the method worthy of investigation is the way the elements are integrated, combined with evidence that the method works.

In this article we introduce the method through a discussion of the four building blocks and the multistep procedure that integrates them. We show why we view the method as an approach for developing poka-yoke processes. The term poka-yoke is defined in the APICS body of knowledge [9, 10] as "tail-safing." Within the context of process improvement, we use the term poka-yoke process to denote any process for which the desired outcome, as defined by the critical customer, is inevitable. That is, by following the process, as it is designed, the people involved in it should be able to achieve the desired results. We validate the method by illustrating its effectiveness through a case study that focuses on its implementation.

This article is organized into four major sections. In the first we examine the challenge of achieving poka-yoke processes. Next, we examine the four critical building blocks of the poka-yoke process. In the third section, we present a multistep procedure for ensuring poka-yoke processes. In the final section we assess the effectiveness of the method by investigating its application within a manufacturing system.

THE CHALLENGE OF POKA-YOKE PROCESSES

As a result of developments such as JIT, theory of constraints (TOC), and TQM, we now recognize that processes are the fundamental building blocks of any production and inventory control system as well as the focal point for most activities aimed at improving overall system effectiveness and efficiency. However, despite this awareness, the process orientation has suffered from several problems.

First, as embodied in BPR, few projects have realized the potential benefits offered by this approach. In part, this problem results from the fact that many projects, because they are large, often require many months to complete. Although the bulk of the resources must be invested at the outset of the redesign project, the project must be completed before the benefits can be realized. In this situation, realization of the payoffs becomes a matter of faith. A further complication is the problem of maintaining interest, focus, and group membership for the time period a BPR project requires. With many projects taking more than one year for completion, the problems created by attrition and re-
cruiitment within the teams responsible for the process redesign must be addressed.

Second, in many instances, the focus shifted from efforts to change the process to better enable it to serve customers, to an obsession with the process itself and the analysis of the process. This is the lesson that Florida Power & Light learned [1]. During the late 1980s it had an 85-person-strong quality department and 1,500 quality teams—all concerned with processes and the analysis of processes. In the midst of this program, the customer was lost. The result was that in spite of the great investment in quality management and process improvement, the resulting service—something of great concern to the customer—was not significantly influenced.

Third, there is the issue of metrics, which are used to establish the measures that describe how the process is operating and to flag potential problems in the process. In many cases the metrics in place are flawed. Often, they are cost driven, rather than being considerations of value, where value is based on factors such as lead time, quality, and flexibility. In addition, they report performance "after the fact." Costs are reported after the completion of an order; lead times are reported after the order has been completed and shipped. The problem with this approach is that the information is provided too late. The activity has been completed and there is no opportunity for preventing the problem from occurring.

As a result of these and other factors, users often find themselves faced by processes that are not in sync with the customer's needs. To meet those needs, they frequently have to circumvent the process in place by, for example, expediting or by allowing an informal system to emerge. The result is a process that is not poka-yoke. Developing the poka-yoke processes requires a rethinking of our process improvement methods.

Strategy for Developing Poka-Yoke Processes

Ultimately, every firm can be envisioned as being engaged in a delicate and dynamic matching process—matching the capabilities of the firm with the needs and demands of its customers. The firm's capabilities describe what it can do well and, more important, what it cannot do well. Shaping corporate capabilities are factors such as the capacity (amount, form, timing of changes to), facilities (size, location, specialization), technology, supply chain, corporate workforce (numbers, skill, wage policies), production planning and control system, performance measurement system, and organizational structure [3]. Capabilities also reflect the firm's critical processes, which in many cases fall under the PIC manager's control. The capabilities are used to meet the demands of the customers. A firm can be said to have a competitive advantage in the marketplace when its capabilities are in sync with its customers' demands.

DEVELOPING POKA-YOKE PROCESSES—THE BUILDING BLOCKS

Maintaining that alignment is difficult because both the customers' demands and the firm's capabilities are continuously changing. These changes reflect the influence of factors such as technology, governmental intervention, competitive actions, and even changes in customer tasks and expectations. When capabilities are no longer aligned with demands, several problems are created for the firm. These include frustration, internal and external, and increased costs as personnel fight the system and the various processes to get the desired results. Reducing this gap between what the firm can do and what the customer wants requires that the firm, in general, and the PIC manager, specifically, focus on the building blocks of customer, process, metrics, and EUT within the context of a structured and well-understood method.

Customer

The starting point for any project designed to improve the effectiveness and efficiency of a process is, and should be, the customer. After all, customers ultimately evaluate whether the process is meeting or exceeding their desires and expectations. It is important to recognize that every firm and every process deals with numerous customers. Some customers are internal. These are people within the firm who use, as inputs, the outputs of the process. Alternatively, there are external customers, that is, any customer positioned outside the firm. These external customers can be further classified as either intermediate customers or consumers. An intermediate customer is one who uses the output of the process, while not ultimately consuming the product or service. The consumer, in contrast, actually uses or consumes the product or service. In identifying these various categories, we recognize that each places its own demands on the firm and its processes. When taken in aggregate, these demands often conflict with each other. As a result, it is impossible to "delight" every customer. Rather, what must be done is to identify and agree on the critical customers. These are the important customers—the ones whose expectations we are interested in meeting or exceeding. Two points should be noted.
First, there must be agreement among the relevant people and groups about exactly who the critical customers are. Without that agreement, confusion that will only increase over time is created. In some cases, this confusion can be resolved by focusing on the needs of the internal customers and viewing the satisfaction of their needs as equivalent to meeting those of the critical customers. The second point is that critical customers can and do change over time.

Process

A process is defined as a "collection of activities that transforms inputs into an output that offers value to the customer" [2]. Four major traits should be emphasized: (1) a process is a collection of activities; (2) a process transforms inputs, typically resources and information, into outputs—goods, services, information, knowledge; (3) structure and capacity determine the resources that the process requires to accomplish its transformation, making issues such as bottlenecks important; and (4) processes are linked to other processes both vertically and horizontally, making them interdependent.

Processes are critical to every firm. They define the products and services the firm produces; they determine what the firm can do, and more important, what it cannot do. In many ways, the processes define the firm itself. To change the product and its traits requires that management change the processes responsible for those products.

The process perspective is important because it argues that to improve the effectiveness and efficiency of a system, managers must identify the critical processes and work on them. A process can be critical because of its position in the system (e.g., it could be a gateway process or an exit process), because of its visibility to the customer, or because it is a bottleneck (constraint).

Participants cannot study processes effectively by simply discussing what they think is taking place. Rather, as Shapiro, Kangan, and Sviokla [8] have said, to really understand a process, they must be willing to "be an order." That means starting at the point the order enters the system and physically following the process as the order would. Data and direct observation should replace perception and opinion. Furthermore, when the process is directly studied, hidden problems such as delays, which are often overlooked when processes are laid out, become glaringly obvious. Delays are critical because they tend to be random (i.e., difficult to predict) and to be created by other conditions. For example, a hidden delay is one in which an order waits because of batching rules (e.g., all orders are picked up once a day) or dispatching/scheduling rules or because of problems elsewhere in the system (part of the order has to wait while the other components need to be completed if it is processed).

Metrics

Metrics play a critical but often overlooked role in every process. They are critical because they help measure progress, flag problems, communicate expectations, and define operational value for the customer. Simply stated, a metric is a "verifiable measure stated in either quantitative terms (e.g., 95% inventory accuracy) or qualitative terms (e.g., as evaluated by its customers, the firm is providing above average service)." Metrics should be consistent with the way the firm delivers value to its customers, and they should be stated in meaningful terms.

Several features of this definition are critical. First, metrics must be verifiable. That is, you should be able to calculate the measure and arrive at the same result, if you were given the information used by the metric and the procedure for calculating the metric. Second, metrics are measures; they capture performance in terms of how something is being done relative to a standard. For metrics to make sense, there has to be a standard of comparison. The standard can be based on past corporate experience or on some external standard. For example, performance can be related to the best in the corporation or the best in the industry or the best in class (the world class benchmark). Metrics allow and encourage comparison, which can be between various people or groups or between our performance and the standard.

Before we conclude this discussion of metrics, it is important to point out that metrics can be predictive or they can be outcome-based. An outcome-oriented metric is one that is generated only after the fact. In contrast, a predictive measure is one that can be used to help predict the chances of achieving a certain objective or goal. Predictive metrics, although relatively new, are beginning to be recognized as far more powerful in that they help managers identify potential problems before they occur, thus permitting corrective actions to be taken. In essence, predictive metrics can serve as warning indicators [9], highlighting when failures have occurred, so they may be immediately corrected before they adversely affect the system. In general, predictive metrics are process-related. For example, if the goal is to reduce lead times, then appropriate metrics, as based on the processes, are distance, number of steps in the process, setup times, and number of people involved.
### TABLE 1: Relation of Building Blocks to Procedure Steps

<table>
<thead>
<tr>
<th>Building blocks</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
<th>7</th>
<th>8</th>
<th>9</th>
<th>10</th>
</tr>
</thead>
<tbody>
<tr>
<td>Customer</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Metrics</td>
<td></td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process</td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td>*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FUT</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>*</td>
<td>*</td>
<td>*</td>
</tr>
</tbody>
</table>

* Building block critical to step  □ Step important to forming building block

---

**Focus, Urgency, Time Compression**

As noted by Melnyk, Calantone, Montabon, and Smith [6], most improvement projects are doomed to failure because they lack three critical traits: focus, urgency, and time-compression. Focus means that from the outset the task to be studied is clearly delineated. The problem area has been bounded in terms of span (how much of the system will be studied) and conditions (under what specific conditions is the problem to be studied). Once the boundaries of the problem have been established, we do not go beyond them. Problems or causes that lie outside the boundaries are not ignored. Rather, we record the problem on an “action list.” That is, we write down the problem, the reason it is important, the implications of not dealing with it, and the type of actions we must consider to deal with it. We leave the items on this action list for others to focus on. For ourselves, we deal only with those items within the boundaries previously established. Focus is necessary to ensure that people have well-defined, specific problems that they can realistically be expected to address.

Urgency is the notion that people feel the problem they are dealing with is important and must be addressed immediately. In practice, urgency demands that people be assigned to a project full time over the “life” of the project—in effect the project becomes their life.

Finally, there is time compression. Most projects require that specific deadlines be set if the project is to succeed. Two aspects need to be considered. The first is that the deadline should not be too far into the future. For most projects, tasks can be successfully completed within two to five days if people are assigned to them full time. Second, the deadline should be a “drop dead” one. That is, management should be prepared to refuse any requests for extensions. Such an approach captures people’s attention because it conveys the seriousness with which on-time results are viewed.

**DEVELOPING POKA-YOKE PROCESSES—THE PROCESS DESCRIBED**

In the preceding discussion we identified the four building blocks of the poka-yoke method of process improvement. To develop processes in which the desired outcome is inevitable requires a structured approach that integrates and builds on those building blocks. The approach consists of the following 11 steps:

1. Identify the customers and determine the critical customers—those that we must delight.
2. For those customers, describe what constitutes value, with attention to prioritizing the various attributes by means of three categories—order winners, order qualifiers, and order losers.
3. Convert those attributes into appropriate metrics.
4. Identify and capture important/critical traits of the product.
5. Identify critical processes.
6. Document the process “as is.”
7. Evaluate the process using the set of metrics previously developed.
8. Determine how to improve the process—either refinement or redefinition.
9. Implement changes.
10. Generate an action list for future actions.
11. Repeat the process.

This procedure is essentially a cycle in that it begins with the customers and its goal is to keep refining the process continuously so that it better fills the needs of the targeted customers.

At first glance, it is not clear how the four building blocks are incorporated into the 11-step procedure. They are, however, as seen in table 1. The first step, identifying customers and determining the critical customers, is the point at which the customer building block begins. Step 2, describing what constitutes value for these customers, is the transition between the customer building block and that of metrics. Step 2 handles this transition through the identification of order winners, order qualifiers, and order losers. The act of identifying and classifying these aspects of the process that are important to the customer focuses us on what must be measured. Step 3, converting attributes into appropriate metrics, is the heart of the metrics building block. Step 4, identifying and capturing important traits of the product, helps form the transition between the metric and process building blocks. Some of the critical metrics will be directly process related; however, many of them are reflected in the product attributes and, by clearly identifying these attributes, we are able to identify the associated processes. Step 5 continues this transition by combining the product and process metrics in order to focus attention on a more limited subset of critical processes. This identification of critical processes places boundaries on our analysis. Steps 6 and 7 form the core of the process knowledge building block. The act of documenting the process "as is" and evaluating it using the metrics provides the necessary process knowledge.

In step 8 we see the transition from the process building block to the FUT building block. The previous seven steps have helped develop the required understanding of the process, goals, and direction of change. This mix we add in a necessary dose of impetus to drive the process improvement. In reality, we have been generating necessary focus and urgency during the first seven steps. During steps 1 through 3 we've developed a means of quantifying the degree of the problem through metrics, and ensure that the metrics we've developed are linked to what is important to the customer. By doing this we have highlighted the urgency of the problem. In steps 4 and 5 we have limited the scope of our analysis to the critical processes, and hence provided a necessary level of focus. However, it is in step 8 that we introduce this focus and urgency to the improvement team. The necessary time compression is provided in step 9, in the form of appropriate deadlines for implementing the changes. Step 10, generating the future action list, is both a byproduct of and a means of obtaining the requisite focus for the improvement effort. If the team stays truly focused it will necessarily encounter opportunities and constraints that are beyond the bounds of the current project. Providing a future action list allows the team to, in essence, put off for later enticing avenues of investigation that might otherwise lead it astray. The future action list provides a means for identifying new critical processes and leads directly to step 11, repeating the procedure.

Before we explore the application of this structured method for developing poka-yoke processes, several observations should be made. First, the method is strongly "managed with data"—an approach first proposed by Imai [5]. That is, data are collected, summarized, and evaluated to ensure that the "right" processes have been identified and that "real" improvements have actually been generated. Second, it is important that appropriate metrics be generated early in the procedural steps, before the process is actually studied. Otherwise, there is the real chance that users will focus on evaluating the efficiency (cost) of the current process, rather than its effectiveness (how well it satisfies customers' demands). There is also the chance that they will be influenced by the metrics that are then in use, rather than developing new and potentially more appropriate metrics. Third, this method is not new; rather it draws on and integrates procedures drawn from developments such as JIT, kaizen events, process analysis, and TQM. One way of appreciating the power of the method is to examine a case study describing its application in an actual corporate setting.

**AMERICAN VINYL PRODUCTS—A CASE STUDY**

The effectiveness and efficiency of the poka-yoke process method will be illustrated using the experiences of a company we will call American Vinyl Products (AVP) (for reasons of confidentiality, the firm's management has asked that the actual name not be used). This company is a manufacturer of vinyl after-market products (e.g., pin striping, decals, and such) for cars, boats, trucks, and airplanes. Employing about 160 people, the firm deals with four major customer groups: (1) original equipment manufacturers (OEMs); (2) large retail accounts such as Pep Boys;
(3) professional after-market services, such as people who apply pinstripes for customizing cars; and (4) “do-it-yourself” customers, a group that has been shrinking in importance to the firm. Although customers for the products supplied by companies such as AVP are varied, they fall into one of two distinct segments. The first is price/cost sensitive, with price being the major buying criterion—even at the expense of service or breadth of product offering. The second is service oriented. For this segment, the one in which AVP primarily competes, sales are won or lost mainly on the firm’s ability to provide quality products with appropriate variety and innovation, while being very responsive to customer requests, orders, and changes. This last dimension is critical because product demand is highly cyclical, with the major peak in demand occurring during the period from February through April. Customers in this market are very delivery sensitive. They expect orders to be delivered by the due dates, irrespective of the loads being experienced by the firm. In most cases, customers are promised that orders will be shipped 24 to 48 hours after they have been placed. As can be expected, meeting those promises is most difficult during the peak demand periods, with initial order fill rate percentages in the high 40s to low 50s. However, fill rates in the 20s have also been recorded (with management feels, a bit too much frequency). Fill rates were not something that management measured in great detail; processing was often driven by expediting and the “squeaky wheel” principle—whoever screamed the loudest received the most attention. As a result, shop personnel would wait for the expediters to tell them what to make, rather than being driven by the schedule.

By December 1998 management at AVP became aware that the system in place was inadequate. With increasing consolidation in the marketplace, along with a more competitive market (due in part to the advent of new and faster technology in the form of better inkjet printers), managers decided they had to do something to avoid a February crisis. On the basis of comments received from certain critical customers, management was left with the feeling that they would not tolerate any delayed shipments and that the firm would lose them unless something was done to improve performance.

The first step in the process was to identify the customers and flag critical customers. Top management performed this step, deciding that the critical customers were going to be the OEMs and the large retail accounts. These two groups were selected on the basis of a detailed Pareto analysis, which showed that the two groups, though all together relatively few in number, accounted for a very large, and growing, percentage of the sales, revenues and, more important, the profits. They were also the most demanding customers. Management felt that AVP’s ability to survive and grow was dependent on its ability to satisfy and, it is hoped, profitably please those two groups.

After the critical customers were identified, the next step was to determine what constituted “value.” Based on feedback received from critical customers in response to telephone and mail surveys, AVP learned that these customers prized three major product attributes: (1) speed, how fast orders were filled; (2) predictability, a lack of variance in delivery times; and (3) responsiveness, AVP’s ability to assess requested changes and respond to those requests quickly and confidentially. Other traits such as quality and product variety were viewed as order qualifiers (using the order winner/order qualifier/order loser taxonomy developed by Hill [41]). Failure to be predictable and fast was seen as an order loser. With that information, management decided that it would have to measure and report performance pertaining to those two dimensions, predictability and speed. The challenge was to develop predictive as compared to outcome metrics. It was fairly easy to develop a set of outcome metrics. All that had to be done was to measure—after the order had been completed—how long it had taken to fill the order. That measure, however, did not give management any time to correct the problem nor did it provide a warning of impending problems. To help remedy this situation, AVP developed and implemented four new metrics: (1) number of steps in the process; (2) distance covered by the orders; (3) number of people involved at each step in the process; and (4) number of delays. The view was that each of these metrics was negatively correlated with speed and predictability. For example, as the number of steps in the process increased, speed would fall and predictability would decrease.

The team next proceeded to step 4—identifying and capturing the product’s critical traits. In studying the product, the team quickly found that assessing material availability was very difficult. The inventory record noted the amount of square feet of vinyl material (the basic raw material) that was available in inventory. The problem was that this measure was an aggregate and did not deal with the fact that vinyl material was stored on rolls and that each roll had different amounts of material. A roll, when it was withdrawn from inventory, could be cut in two basic ways. The first was lengthwise. That is, a roll of three inches could be cut from the end of the roll. The result was that the roll had a reduced width. Alternatively, a roll could be cut widthwise. That is, an order might be for 20 feet of a roll—this amount would be sliced off the length (across the width). The problem was that the inventory num-

**EFFECTIVE PROCESS IMPROVEMENT: DEVELOPING POKE-YOKE PROCESSES**

Reproduced with permission of the copyright owner. Further reproduction prohibited without permission.
bers could only be used as a very rough indicator of availability. That is, an order needing 24,000 square inches of material could possibly be infeasible, even though the inventory records might indicate that there are more than 36,000 square inches of material. The reason is that the order might require a roll of material equal to 18 inches in width and 2,000 inches in length. Yet, there might not be enough rolls of vinyl 18 inches or greater in width with sufficient material to meet the order. In other cases, even when there was apparently enough material of sufficient width, the length of the order might require splicing together two or more rolls, resulting in a reduction in quality and an increase in processing time. Management found that assessing inventory accuracy was very time consuming and a major source of variance in lead times.

At this point the management team was ready to identify the critical processes. The first step in this stage was to lay out the overall process. In general, it was straightforward, consisting of six major steps: (1) receipt of the order from the customer; (2) evaluation of the order, typically involving assessing the customer’s credit history; (3) scheduling of the order; (4) release of the order to the shop floor; (5) processing of the order on the shop floor; and (6) packaging of the order. Of these six steps, the fifth one, processing of the order on the shop floor, seemed to be the most critical, for several reasons. It had the greatest variance in lead time and the most internal complaints and conflicts focused on shop floor performance, and most of the personnel the management team interviewed seemed to feel that the shop floor was simply “not working hard enough” to get orders out on time. Even though this was not sufficient evidence to conclusively indicate that the shop floor was the root cause of the problems, management decided that it would be a good starting point.

The process was documented “as is” by using guidelines for process flow analysis, as described by Melnyk and Denzler [7]. Everything that happened from the time the order was released to the shop floor for filling until it was completed, packed, and ready for shipment was to be studied. The process followed for a typical 3-color job consisting of 100 pieces was chosen. After the process was evaluated according to the metrics developed, it was found that it involved 15 people and 16 steps—nine operations, two inventories, and five delays—and covered 1,786 feet. Additionally, although the standard time was 33 hours, extensive variance was found in two specific steps. The first source of variance involved step 1, staging. It was here that material availability was finally assessed. This step, whose standard time was 4 hours, could take as little as 2 hours to complete, or as much as 336 hours if the material was not available. The second major source of variance was a delay encountered between sheeting and staging of the presses. This delay, not accounted for in the time standards, could take as little as 12 hours or as much as 720 hours, with the average delay being 360 hours.

With this information, the management team selected two areas on which to focus. The first, reducing the total distance covered by the process, was chosen because it was evident that the orders spent too much time traveling, which created excessive inventory. The second area, the delay encountered before staging for the presses, was chosen because of the size of the delay and because the reason for the delay was unknown.

Reducing the distance was straightforward and involved relocating equipment. The second area, the delay before the press stage, was more challenging. First, the reasons for the delay had to be better understood. Given the emphasis on “managing with data,” the management team, in close cooperation with shop floor employees, designed a form to be filled in for every order. The form listed eight possible causes for the order delays, as identified by shop personnel: (1) out of stock; (2) rewind capacity; (3) slit capacity; (4) sheet capacity; (5) hard work (employees were not working hard enough); (6) multisize operation late; (7) training; and (8) oddball (a reason not captured elsewhere). Data generated from this form were collected for about a month. On the basis of the data, the management team noted that in more than 60% of the late orders, the primary cause was the lack of rewind capacity. The rewinder machine was then identified as a bottleneck. Before we describe how the rewinder bottleneck was attacked, it is important to note that in the poka-yoke method, there is iteration between steps 5 through 9. The iteration is critical to the issue of focus, as it serves to identify a single process, or process stage, where effort is best utilized. In this instance, as the problem of the delay between sheeting and staging lacked focus, we returned to step 5 to identify the critical subprocesses.

As noted, the rewinder had been identified as the bottleneck. To attack this bottleneck, the management team used the kaizen event methodology, as described by Melnyk, Calantone, Montabon, and Smith [6]. A one-day event was scheduled. From this event, it was learned that employees who worked with the rewinder were not aware of its importance or that it was a bottleneck. New scheduling rules and procedures were developed and implemented as a result of the event. In addition, a new metric was identified—rewinder utilization, the percentage of time the rewinder was operating, after adjusting the time for all breaks and meal times. The goal driving the people manning the
Rewinder was to keep rewinder utilization at over 80% and ideally toward 100%.

By this point, management had gone through the first nine steps of the poka-yoke method. The next step was to identify the action list. Based on experiences with the critical processes, the team had identified a series of other areas to look at. These included production scheduling, inventory ordering, and credit-checking procedures. These areas are now being actively explored.

What has been the impact on the process? Consider the following results: The total distance traveled by an order has dropped from 1,786 feet to less than 400 feet; the number of steps have fallen by two; the times required for checking inventory and for staging have fallen; and on-time deliveries have increased to in excess of 70%. More important, the usual spike in orders during the February-March "crush" did not create the same problems as it did in the past. Management did not have to modify the amount of overtime—a tactic that had been frequently used. Finally, shop floor employees noted that the work seemed to be going better and that they felt as if they really knew what was taking place during the process. AVPs' customers have also noted the firm's improved performance.

CONCLUDING COMMENTS

The production and inventory control manager is increasingly under pressure to simultaneously reduce costs, improve quality, reduce lead time, and improve flexibility. This article has presented a method for simultaneously achieving those objectives. The method is poka-yoke in that it seeks to develop processes in which the desired results (outcomes) are inevitable. More important, the method integrates themes of process analysis, customer awareness, metrics, and continuous improvement into a system that emphasizes focus and rapid achievement of results. This method succeeds, as shown by the experiences of American Vinyl Products, and it can be applied to a wide range of firms and settings.

REFERENCES


About the Authors—

DOUGLAS M. STEWART is an assistant professor in the Department of Marketing and Supply Chain Management and has been at Michigan State since 1997. He received his Ph.D. from The University of Southern California where he also worked with the USC Center for Service Excellence. Professor Stewart's current research interests include metrics, the application of human error psychology to service quality improvement efforts as well as service design, service operations management, and TQM. He has published papers in the Sloan Management Review, Harvard Business Manager, USC Business, and The Service Quality Handbook on the topic of mistake-proofing services. In addition, he has co-authored a book titled Mistake-Proofing and lectured on the subject to both academics and business professionals.

STEVEN A. MELNYK is a professor of operations management at Michigan State University. He is the co-author of 10 books and major research monographs and has published extensively in journals such as the International Journal of Production Research, Journal of Operations Management, Production and Inventory Management, and the International Journal of Production and Operations Management. In addition, he has just completed a major research project into environmentally responsible manufacturing that was funded by the National Science Foundation. His current research interests include environmentally responsible management, metrics and system measurement, and time-based competition. Since 1996 Dr. Melnyk has been recognized by Business Week as one of the 10 best MBA instructors at Michigan State University.