Transforming to a Quality Culture

The Henry Ford Production System

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Abstract

We describe the cultural transformation of the surgical pathology laboratory at Henry Ford Hospital, Detroit, MI, to one that has adopted an expectation for empowered workers to see their daily work in the context of continually learning and making effective process improvements that are designed and tested by the scientific method. This transformation has been achieved by creating an organizational and educational framework for implementing guiding principles originally systematized as the basis of lean manufacturing by our founder, Henry Ford, at the turn of the century, and incorporating the innovations of the Toyota Production System. We present novel data collection techniques to establish baseline states by which to gauge the success of changes and lessons from rapid process improvement studies. Herein, we share our experiences, lessons learned, and successes to date in the pathology-based Henry Ford Production System.

We do not make changes for the sake of making them, but we never fail to make a change once it is demonstrated that the new way is better than the old way. We hold it our duty to permit nothing to stand in the way of progress.

—Henry Ford[1]

The Laboratory as Production Line

In a sense, the pathology laboratory is a production line dedicated as much to reverse manufacturing, that is, reducing human parts into their basic components for analysis, as to then manufacturing or synthesizing those pieces of data back into an informational product for subsequent therapeutic decision making. Yet, surgical pathology laboratories struggle to consistently meet 2-day turnaround times for this only product. Not even 80% of the simplest of routine biopsy specimens were completed in 1 working day in the 1993 College of American Pathologists Q-Probes study performed by 525 surgical pathology laboratories.[2] Despite the throughput and efficiency pressures of modern health care delivery, that performance level in biopsy turnaround time in our own laboratory has remained largely unchanged in the subsequent 13 years.

The focus on quality improvement in anatomic pathology during the last 17 years has been on the identification of benchmarks of performance that describe current practice and has attempted to satisfy accreditation requirements for continuous quality improvement.[3] This often has meant striving to perform at median or mean benchmark performance levels. Multi-institutional, peer-derived goals, like Q-Probes or Q-Tracks, often set the bar too low, aiming to match mediocre performance, and are without granular data allowing insight for laboratory leaders to recognize and adopt best practices.[4]

It is our belief that this approach to quality has resulted in no significant performance improvements in surgical pathology. Clearly, there must be a better way.

Henry Ford: Nothing New Under the Sun

The current popularity of the improvement techniques and tools known as "lean management," sometimes melded with Six Sigma methods, dedicated to the elimination of waste in all its forms, would have one believe that there is a new boy on the block just arrived from the Far East. In reality, lean manufacturing and the incessant attention to reduction of waste is an American invention conceived early during the last century. Henry Ford is credited with creating the first comprehensive lean manufacturing system and, more broadly, a lean enterprise encompassing not only his factories, but also their supply chains.[5] However, Ford was keenly aware that at the core of his business success was the fact that "Our system of management is not a system at all; it consists of planning the methods of doing the work as well as the work."[1]

Ford's major insight was that increases in efficiency and productivity are derived readily from savings derived from waste in all its forms. This is best summarized in his reflections that "It is not possible to repeat too often that waste is not something which comes after the fact." and "It is not possible long to continue to get something for nothing, but it is possible to get something from what was once considered nothing."[1] His constant perspective on identifying and eliminating wasteful aspects of manufacturing are likely derived from his roots as a farmer's son. This parsimonious perspective of the leader became the culture of the early Ford Motor Company down to the level of the factory line worker. Eventually, Ford's many industries became world-famous for mass production with implementation of many work innovations such as the following:

- Respect for workers: "One's own workers ought to be one's own best customers."[1]
- Standardization of process, machine tools, and equipment: "90% of our equipment is standard" and "Today's standardization, instead of being a barricade against improvement, is the necessary foundation on which tomorrow's improvement will be based."[1]
- Just-in-time manufacturing to reduce work-in-process inventory: "Having a stock of raw material or finished goods in excess of requirements is waste…." and "The traffic and production departments must work closely together to see that the proper parts reach the branches at the same time—the shortage of a single kind of bolt would hold up the whole assembly at a branch."[1]
- Facilities and processes designed to reduce transport, motion, and steps: "The whole plant has been built with the single thought of simplifying the handling of material" and "Recently, a new type of assembly plant has been worked out…. Production may be greatly increased without additional labour…. The greatest distance any material has to be trucked is twenty feet."[1]
- Products designed to reduce waste: "economy of design," "if a design proves unsatisfactory, its major parts may be salvaged."[1]
- The moving assembly line: "The thing is to keep everything in motion and take the work to the man and not the man to the work."[1]
- Continuous flow production: "Every department is coordinated into a continuous system of manufacture by the use of conveyors." and "Whenever one can line up machinery for the making of exactly one thing and study everything to the end of making only that thing, then the savings which come about are startling."[1]
- Focus on reducing cycle time: "Time waste differs from material waste in that there can be no salvage. The easiest of all wastes, and the hardest to correct, is the waste of time, because wasted time does not litter the floor like wasted material."[1]
- Continuous improvement: "Today's best, which superseded yesterday's, will be superseded by tomorrow's best."[1]

The old saw about the Model T car was that "you can have it any color you want as long as its black." Although amusing, it reflects Ford's keen business insight that black paint dried much quicker than other colors and, therefore, contributed to a reduction in the production time of the final product. The 1926 publication of *The Ford Industries* illustrated Ford's incessant focus on improving efficiency of production, described as shortening the cycle time, which in turn kept his prices low.[6]

The pace of production in 1925, measured from the point of iron ore delivered from the Upper Peninsula of Michigan to the River Rouge plant and made into foundry iron and engine blocks for newly manufactured cars that then were delivered to the dealer in just 3 days and 9 hours, was astounding. By focusing on elimination of wasted time and optimizing efficiency for conversion of raw materials to final product, Ford was able to reduce cycle time from 21 to 14 days during the business depression of 1920. That efficiency of mass production enabled him to reduce the cost of the Model T Touring car from $950 in 1908 to just $290 in 1925 while increasing production during that time from just more than 10,000 to nearly 2 million cars per year.[6] Considering that today's production of final surgical pathology reports does not even approach the complexity of automobile production of that era, the lack of timeliness in which we deliver our product that greatly impacts human lives is surprising.

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The Toyota Production System

The Toyota Production System (TPS) is based on the historic Ford System with a relentless goal of eliminating waste. But, because of the economic business environment after World War II and the Japanese home market for many types of cars in small quantities, it was developed along a different path. Its management principles have been well summarized by Liker in *The Toyota Way*.[7] Taiichi Ohno, who updated Ford's system, focused on waste reduction to create Toyota's so-called Just-in-Time production system, has described its real strength as a "management system adapted to global markets and high-level computerized information systems."[8]

There are 2 main departures from Ford's lean manufacturing approach. The first is a focus on small lot sizes to approach an ideal of outputs produced one-at-a-time rather than a forced mass production of one product in large lots. The second is rapid tooling changeovers or setups that enable this continuous production flow to be based on product demand for immediate delivery rather than production to market forecast. The kanban system was devised to allow "pull" production, whereby "a later process goes to an earlier process to withdraw parts needed just in time."[8] This, in turn, allowed Toyota to drastically reduce waste associated with excess inventory that leads to overproduction and costs of storage and management. Other innovations of TPS include autonomation (machines with error-proof smart logic) and an empowered workforce incrementally and continuously innovating by scientific testing of changes to move toward the ideal condition. Like Ford, the Toyota manufacturing system preaches standardized tasks and workstations, workload leveling, visual controls, and just-in-time inventory. However, we believe that the most distinct advantage of TPS is the cultural expectation of change and decision making from an empowered workforce based on careful, scientific study to prove the effectiveness of any adopted process improvements.

There are 2 key tenets to the success of the TPS. To those of us in laboratory medicine, the testing of hypotheses as the underlying basis of the TPS should be a comfortable notion as innovations and improvements are based on scientific data and evidence rather than pure trial and error. The other key aspect of TPS is the rigid scripting or high specification of work processes, connections, and pathways that minimize variation and allow for hypothesis-driven tests of improvements from a standardized baseline state.

This scientific method for continuous change and improvement is guided by 4 rules or principles that define how these "experiments" can be carried out by those doing the work at the lowest level without destabilizing the organization.[9] These rules, as deduced and described by Spear and Bowen,[9] are:

"Rule 1: All work shall be highly specified as to content, sequence, timing, and outcome. Rule 2: Every customer-supplier connection must be direct, and there must be an unambiguous yes-or-no way to send requests and receive responses. Rule 3: The pathway for every product and service must be simple and direct. Rule 4: Any improvement must be made in accordance with the scientific method, under the guidance of a teacher, at the lowest possible level in the organization."

These rules sound simple and define the functioning TPS culture, but their consistent adoption outside of Toyota is not. We believe that successful implementation of TPS style quality improvement goes far beyond lean manufacturing methods that focus on elimination of waste because TPS requires a major change in organizational culture.

Other elements contribute to the success of the TPS. One important factor is the focus on a long-term philosophy rather than the short-term fix as in the common American business tactic for success. In effect, it's all about creating trusted relationships and building long-term thinking into decision making. This, in turn, influences actions that enhance quality and thereby define long-term success, not necessarily the immediate financial bottom line.

Another top Toyota goal is valuing the people in the organization who are expected to drive continuous improvements. Probably the most significant attribute of the Toyota approach is the establishment of a system culture composed of an empowered workforce. This results in a basic expectation of continuous attention to opportunities for improvement by all staff. This also defines the foundation of work. The need to continually improve is woven into the fabric of the people and not viewed as a time-consuming inconvenience, option, potential reward, or incentive, as often is the perception in the usual American workforce.

In the TPS, building a functional team may take up to 2 years before team members are ready to contribute on work teams. This level of investment in employee training is significant and would be unusual in the American culture, but it yields large dividends—the Toyota belief is that there is but one chance to train an effective and successful team. In other words, do it the right way, the first time. Teamwork is the foundation of process improvement, and it has been proven that individual performers will extend themselves to make the company successful if they are included early on in the decision-making process. In the TPS, learning often is by experience in which an early ongoing effort is demonstrated to teach teams how to work together to reach common goals. The problem-solving approach is "Go and See" in which subject matter experts observe the problem to deeply understand the current condition before suggesting process improvements. This includes analysis of workflow, standardized work procedures, and further evaluation to analyze and detect the root cause of defects. In comparison, other quality

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improvement methods often are limited to the review of data from reports created by individuals external to the work itself.

Toyota's success is the result of leadership and employee involvement. To be functional leaders, senior staff at Toyota must believe, drive, understand, and live the same training philosophy and employee empowerment that in turn reinforces the culture established by the original company founders. Unlike many businesses, on-the-job employee training is built into the system in which the expectation embraced by all is that of "learning by doing" first, with more formal training second. In this approach, staff are placed in an everyday difficult circumstance and then allowed to problem solve by doing. The TPS processes are designed to highlight problems in real time where the work is performed by getting to the root cause and by the person doing the job at the time the problem occurs.[10] In comparison, the usual American approach to training is that of an undertaking that must be scheduled, presented by formal instruction, with a minimum of hands-on instruction. In this latter view, training time is viewed as a detractor of valuable production time.

One of the keys that most impressed us as a means of moving toward the ideal condition is Toyota's Rule 4, which states that any improvement must be made in accordance with the scientific method, under the guidance of a teacher, at the lowest possible level in the organization. The teacher is defined as an internal expert, knowledgeable and experienced in the area taught. In comparison, the American business culture often employs consultants to analyze and suggest change, yet many times these "experts" have only minimal knowledge of process and output. Conversely, in the Toyota approach, empowered workers see their daily work in the context of continually making effective process improvements that are designed and tested by the scientific method. The importance of data collection to establish a baseline state by which to gauge the success of changes made by the person performing the task cannot be overstated.

Through this cultural change in management and the resulting continuous quality improvements made at all levels of the workforce, the pace of improvement is often rapid and the processes of work are ever-evolving and optimizing toward a more perfect state.

The Six Sigma System

Another popular manufacturing business–based quality improvement method developed by Motorola, effectively used by General Electric to achieve customer satisfaction, and now applied in health care, is known as Six Sigma. This method relies on the basic quality tools of total quality management to focus on the identification and elimination of sources of process variation based on data collection from actual conditions. Sigma is a performance metric referring to the variability defined by statistical deviations from the performance goal at the opportunity level. For example, six-sigma (99.99966% yield) reflects 3.4 defects per million opportunities and commonly is accepted as a manufacturing goal.[10] Through the Federal Aviation Administration's Aviation Safety Reporting System, the US airline industry has been able to sustain a safety record in excess of 7 sigma for fatalities per million flights. Most endeavors in health care function in the range of 3 sigma (93.32% yield) to 4 sigma (99.38% yield) or 66,800 to 308,000 defects per million opportunities.[11]

Transformation of Laboratory Culture

"Your methods are formed by what you are trying to do; they do not determine your purpose. To my mind it is starting wrong to put methods ahead of purpose."

—Henry Ford[1]

No matter the method used, the new paradigm in pathology quality improvement is that of applying techniques highly effective in manufacturing production to the laboratory. Most adopters of so-called lean management focus solely on rapid but limited improvements in facility design, inventory control and placement, and workplace standardization, whereas the Six Sigma adopters attempt to limit process variation in order to excel in satisfying the customer.[10,12] More recently, management techniques have been proposed that meld or fuse the management tools associated with Six Sigma and lean methods.[13]

However, applications like the TPS, a refreshed and innovated version of Ford's original production system, go even further to change the underlying management culture of the laboratory to create a continuously learning, empowered workforce, making scientifically based rapid process improvements as a means of continually striving toward higher performance. Whereas in the old paradigm, decision making about improvements is top-down from management, in the TPS paradigm for improvement, ideas and decision making would be derived from the bench level up. Rather than offering the laboratory service or product "when we get to it," the product would be produced when and how the customer wants it. In the old system, we would gear up for increased production with more staff, but in the new model, we would often find that fewer staff members are needed to do more. Is transformation of laboratory management and laboratory culture necessary to improve? That would depend on your purpose.

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Henry Ford Production System

"Our first motive…was to improve the manufacturing processes to increase the output and decrease the prices.… There is nothing incompatible between quality and mass production."

—Henry Ford[1]

At Henry Ford Hospital, with the 15th largest hospital-based laboratory in the United States, we have proudly built on our founder's approach to mass production to include the Toyota-derived concepts that go "beyond mass production"[8] and have melded this with currently available laboratory automation and new technology to create a culture continuously perfecting pathology laboratory processes and improving quality. Our laboratory-wide effort to implement the original Ford Motor and TPS principles eliminating waste in all its forms while perfecting processes and advancing patient safety is known as the Henry Ford Production System (HFPS). With a goal to become "best in class" for defect reduction and elimination of waste, we seek a global increase in the quality of our services. Core to this, we have adopted a mission to change our culture to one that continually improves quality by relying on employees empowered to implement change in a self-directed manner on a daily basis.

In the HFPS, we have thought about the elements of philosophy, leadership and management structure, and employee foundation that would be prerequisites for success. We began by creating and articulating to the staff statements of the HFPS mission, vision, values, and objectives. The HFPS culture began with management commitment to change and a long-term vision to be the best in class, that is, to achieve performance at the level of zero defects. The mission is simply that of employee commitment to continually learn and strive for process and outcome perfection while assuring patient safety. This is achieved by many empowered individuals, linked by an understanding of their customer supplier relationships, making ongoing small improvements in segments of the process under their control that can incrementally move the end results of the entire process toward perfection.

The main driver to the department moving continuously toward the ideal condition is our focus on process standardization and elimination of non–value added waste of all types. The definition of success in adopting the Toyota Way is said to be whether top management can walk away and the employee culture can sustain itself in the implementation of continual process improvements. Successes of this type have yet to be demonstrated in any significant numbers outside the Toyota culture in other manufacturing industries, let alone health care delivery. Our initial successes in the HFPS lead us to believe that we are on the right path to achieving that goal in these laboratories.

Given the current hospital-based business management, human resources structure, and malaligned employee incentives, these will be our greatest challenges in making and holding this cultural change. Our early experience informs us that these management concerns can be dealt with effectively by strong leadership and the demonstration of successes. Moreover, by focusing employees on the details of how work is done and enabling an educated and empowered workforce to continually adapt and change that work for the better, we believe that this approach will be superior in striving toward a goal of excellence. That is often reward in itself. These sentiments regarding work and management are not new and were reflected in the words of Henry Ford 80 years ago—"It is the work, not the man, that manages" and "Our system of management is not a system at all; it consists of planning the methods of doing the work as well as the work."[1]

Herein we share our early successes in implementing the production redesign principles, goals, and quality organizational structure of the HFPS and the lessons learned from people, leadership, and operational challenges.

Operational Beginnings

"We do nothing at all in what is sometimes ambitiously called research, excepting as it relates to our single objective."

—Henry Ford[1]

We began by selecting team leaders who were competent, effective, and communicative subject matter experts in their field of expertise. These leaders, who had been comfortable making operational improvements in the past, were charged with responsibility to drive the transformation, facilitate change, and operate as teachers for the "student" workers in their respective work cells. We defined sequential work cell teams for the following: (1) accession and transcription, (2) gross room, (3) pathologists, (4) residents, and (5) secretaries. These teams were supported by additional staff composed of 2 group leaders (quality improvement project coordinator and chairman), data analysis coordinator, quality education coordinator, and pathology informatics (fellow and division head).

The group and team leaders initially were educated in the TPS through a grant from the Pittsburgh Regional Health Initiative (Pittsburgh, PA), a national leader demonstrating TPS as a foundation for change in health care. Team leaders subsequently began recruiting staff members in their sections who not only had an interest in process improvement, but also were often the most vocal in their frustration with work defects encountered daily. These individuals subsequently volunteered for a Saturday group 5S exercise to reorganize the physical aspects of the laboratory workspace and supplies to gain efficiencies. This consisted of applying the

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5S precepts of Sort, Stabilize, Shine, Standardize, and Sustain to clean, eliminate non–value added equipment and supplies, and organize and label what remained so that the changes could be sustained.

Team leaders then proceeded to train all team members in the TPS principles. In the surgical pathology division, this amounted to 77 people, including the house staff and professional staff. Each team experienced an enjoyable, team-bonding training exercise using the assembly of Lego blocks to simulate inventory and product "manufactured" according to the pull system popularized in the TPS. This departure from the usual "push" of surgical pathology case material through the laboratory illustrated the advantage of leveling the workflow to increase efficiency and eliminating throughput bottlenecks to create a just-in-time ideal of inventory and production. The exercise also fostered an understanding of customer-supplier relationships and making ongoing small improvements in segments of the process under their control that would incrementally move the end results of the entire process toward perfection. Additional insights focused on process standardization and elimination of non–value added waste in its many forms as keys to moving continuously toward the ideal condition.

Customer-Supplier Meetings

"Our invariable reply to 'It can't be done' is, 'Go do it.'"
—Henry Ford[1]

Many of the early successes achieved in the HFPS were the result of actively increasing communication among employees. Because of the complicated nature of the sequential and sometimes parallel surgical pathology laboratory processes, it often was difficult for employees to comprehend the magnitude and the downstream effects of their work. To compound this problem, the inherited culture of change was that of top-down directives that addressed crisis issues. To gain a sense of requirement of each section's requirements to function more efficiently, we next scheduled weekly customer-supplier meetings to bring workers together to discuss their expectations and customer requirements as product was produced and passed from one work cell to another. In the meetings, we discussed highly specified requirements to aid in the direct hand-offs between customers and suppliers so that the main types of waste in processes could be eliminated. The meetings, composed of small groups for 30 minutes or less, were focused to include suppliers who interacted directly with the customer with discussion limited to one requirement per meeting.

Initially, we held these meetings weekly and forced connections despite the early discomfort resulting from emotionally charged discussions. Barriers between work cells were eliminated readily when people recognized that the issues between work cells were universal and fixable so that the typical "blame game" could essentially be stopped. It was freeing to allow employees who hadn't spoken in years to articulate their longtime frustrations about staffing levels, budget constraints, and process variation that they were now empowered to address through the HFPS. Eventually, our suppliers understood and accepted the demands of their internal customers and began responding by changing processes to meet customer requirements. With this new understanding of team, eventually our culture began to change—for example, in November 2004, no meetings existed to discuss work requirements, but in May 2006, up to 20 meetings a month and more than 100 employee interactions took place. The direct outcome of these customer-supplier interactions is the continued and rapid pace at which these improvements, which we designate rapid process improvements, have taken place. In the first 4 months of the HFPS, these teams have accomplished an astonishing 88 rapid process improvements.

Team Recognition

"It is not easy to get away from tradition. That is why all our new operations are always directed by men who have had no previous knowledge of the subject and therefore have not had a chance to get on really familiar terms with the impossible."
—Henry Ford[1]

Team recognition and group learning from the numerous process improvements—failed and successful—are highlighted in a monthly "Sharing the Gain" meeting of all team members. At these meetings, team members, rather than leaders, are encouraged to present the most significant monthly improvement and reflect on lessons learned. We also have recently created a "Spotlight Team of the Month" poster that recognizes a productive team and its process improvements. The first team featured was composed of 3 self-driven pathologist's assistants who accomplished 17 process improvements in a 3-month period. These initiatives are designed to solidify the workers' senses of self-confidence and empowerment and an appreciation of the interdependence of the work.

Scientific Basis of Change

"The old way was to guess. We cannot afford to guess. We cannot afford to leave any process to human judgment."
—Henry Ford[1]

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Unlike our historic "sounds like a good idea" approach to improvement, the HFPS relies heavily on proof of effectiveness of each change, which requires each team to be knowledgeable in using the scientific method of data collection and analysis to determine the significance of process improvements as a basis for continuous learning, improvement, and better communication. The project coordinator and support staff are keys to this discipline. They are included in team meetings to ensure that the "change experiments" are designed properly with appropriate indicators that allow collection of baseline data reflecting the current condition before the proposed change is implemented. They also assist in data collection, analysis, and presentation. We have capitalized on these human resources to better understand our own processes through data massaged and converted by our expert teams into information that reflects the pulse of our business.

Identification of Defects in Surgical Pathology

We know from the changes that have already been brought about that far greater changes are to come, and that therefore we are not performing a single operation as well as it ought to be performed."

—Henry Ford[1]

From our experience with more than 16 years of studying quality improvement opportunities by defining benchmarks of performance and errors in anatomic pathology processes through the College of American Pathology's Q-Probes and Q-Tracks programs, we had thought that the majority of defects occurred in the preanalytic and postanalytic phases of testing, rather than within the laboratory (the analytic aspect of testing).[2,4,14-17] This impression, we now recognize, was an artifact of the tools and measures used in those multi-institutional studies.

In the HFPS, we began by defining the true magnitude of defects that arise within the surgical pathology process from the preanalytic through the postanalytic phase. We initially polled all anatomic pathology professional, technical, and secretarial staff, asking them to list the top 10 defects they commonly encounter that required them to accept less than standard work, to stop work, to fix an error, or to return work to the sender. From this information, we created 100 indicators of potential defects in surgical pathology. Nine data collection posters were created and posted in each work unit, such that 57 personnel in anatomic pathology could identify defective cases in real-time in a public display. By using this method, we found that the majority of defects arise within the analytic phase of testing rather than the preanalytic and postanalytic phases, as previously thought. The top 4 analytic defects related to histology slides, defects at accessioning, defects in the gross examination of tissues, and in recuts.

During a span of 2 weeks, comprising 1,690 surgical pathology cases, we determined from this collection of data that 28% (or nearly 1 of 3) of cases moving through the surgical pathology division were defective in some way. Although alarming, this is not to be misconstrued as a tabulation of "errors" or defects of a diagnostic nature, but from the point of specimen receipt to case sign-out, some defect was associated with a case that was corrected before the process could continue. This data collection exercise was helpful in quantifying the amount of waste commonly encountered and quietly accepted in the complicated sequence of mostly manual laboratory processes in surgical pathology. Only through identification of the numerous sources of waste, in its many forms as described by Ford[1] and Ohno,[8] can a target goal of achieving zero defects in the laboratory environment be achieved. Group involvement in data collection served to solidify a sense of teamwork and educated and stimulated the staff to make directed changes.

Rapid Process Improvements

"Our own attitude is that we are charged with discovering the best way of doing everything, and that we must regard every process employed in manufacturing as purely experimental. If we reach a stage in production which seems remarkable as compared with what has gone before, then that is just a stage of production and nothing more."

—Henry Ford[1]

In the following segment, we illustrate the implementation of 2 improvement principles of process simplification as described by Ford[1] and pull production innovated by Ohno,[8] demonstrating the potentially large impact of small changes.

Process Simplification: Reduction of Handling and Time Savings

"Every well thought-out process is simple. And with the simplicity and the absence of hand labour has come a greater safety. We can at least save the waste of human labour in handling and transportation."

—Henry Ford[1]

When a specimen is received in the surgical pathology laboratory, a number of early process actions must be taken, including accepting, sorting, classifying, assigning, preparing, numbering, batching, transporting, and entering data with identification verification. There often is no standard or

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scripted sequence, and, often, the processes are not highly defined but left to the individual(s) tasked with them to perform as they see best. This was our scenario. We hypothesized that the lack of early work standardization by less skilled workers over time resulted in unnecessary task complexity and inefficient subsequent downstream work by workers with specialized skill sets who could have been redeployed to other areas.

When first evaluated, the early work was performed by numerous workers who handled the specimens up to 5 times to achieve the actions required before the specimen could be passed to the next work station. With all the handling steps, the amount of time taken to fill 1 batch bucket for the next station was 20 minutes. The early work was redesigned for 1 worker to handle the specimen only twice, but the work was now written to include more complete early work that ordinarily was passed on to the more skilled workers at the next station. In this redesign, there was no difference in time to create the batch by the early worker. We collected data on the individual task time of both processes and concluded that the downstream workers were now able to complete their assigned work on the batch of specimens in 12 minutes, an 8-minute savings compared with the original process performed by the early worker. This represents a 40% labor time savings in the accession process by fine-tuning the very early steps that prepare the specimens for later workers. Something new? Not really—"*My theory of waste goes back of the thing itself into the labour of producing it.*"[1]

Pull Production: Continuous Flow

"Manufacturers and workplaces can no longer base production on desk-top planning alone and then distribute, or push, their products onto the market. It has become a matter of course for customers, or users, each with a different value system, to stand in the frontline of the marketplace and, so to speak, pull the goods they need, in the amount and at the time they need them."

—Taiichi Ohno[8]

To enhance workload leveling and improve turnaround time of case sign-out, we began focusing on customer-supplier hand-offs of the slide delivery pathway from the histology stations to the pathologists. It was determined that no standard practice or schedule existed for slide delivery to pathologists, and, many times, delivery of the slides for first-morning cases was well after 8:00 AM.

By working backward, we reviewed the tasks leading to slide delivery and began focusing on the slide pathway in histology from the microtomy cutter station to the stainer station. From observation, it was noted that the basket that contained the cut slides from the microtomy stations would remain on the counter and was filled 1 case at a time until the maximum of 60 cut slides comprising a full basket was attained. It was at that time that the basket was loaded onto the automated staining instrument to begin the 20-minute run. We hypothesized that "pulling" cut slides to the staining instrument every 20 minutes by use of an auditory timer, rather than waiting for a full batch of 60 slides to accumulate, would match the staining instrument cycle and thereby enhance throughput.

We collected data on the time and numbers of slides loaded onto the stainer in the current condition of a full-batch size and compared the data with data obtained after the timer-instituted change of slides pulled every 20 minutes regardless of batch size. We also sought the effect of this change on the far downstream result of timeliness of report sign-out by pathologists. Because of the minute changes made in the process, data had to be collected manually on each case because the information in the computer system was not sensitive to measure small intraday changes. For same-day biopsy specimens, the small change of instituting a pull process between 2 histology stations resulted in an end result of 93% of biopsy cases signed out in 9 hours compared with the previous state of 81% biopsy report completion. This represented a 12% improvement in turnaround time of same-day biopsy case sign-out. This global decrease in report turnaround time can be attributed to a combination of pull production and workload leveling in continuous flow production.

Conclusion

"The best way to predict the future is to invent it."

—Alan Kay

True to those words, Henry Ford proceeded to revolutionize American manufacturing and eventually define the future global economy with his efficient and continually improving approach to mass production of the automobile, providing a reliable and affordable means of transportation to the common people. It has been more than 90 years since this leader with so many diverse interests founded this hospital in Detroit. As with his industries, he incorporated the management principles that worked so well in his factories to infuse his hospital services with quality assurance and economic discipline.[18] Pathology at Henry Ford has a rich history since being established as the third department in 1917.[18] It is our goal, as the health care scions of this visionary man, to revolutionize the culture, practice, and quality of current laboratory services by adopting his continual attentiveness to wasteful practices in our environment and innovating more efficient processes that focus on the needs of the patient. And as he said so genuinely, "If we

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do that which is before us to do in the best way that we know, that is, if we faithfully try to serve, we do not have to worry much about anything else. The future has a way of taking care of itself."[1] With that guidance, how can we fail?

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