**"FROM IE TO JIT TO TIME-BASED COMPETITION"**

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## Abstract

Recent developments in global manufacturing suggest that the traditional industrial engineering approach for work improvement is off-target and ineffective. The experiences of many leading firms show that the task-oriented approach of Industrial Engineering (IE) misses major opportunities for process improvement. We maintain that the problem stems not from IE's original principles but from how it has evolved (or deviated) from them: the evolution of IE in support of mass production created a myopic, task focus that is inappropriate for the time-based, flexible operating environments of today.

Just-In-Time (JIT) represents a radical departure from traditional IE practices and Time-Based Competition represents further development along that path. Remarkable changes are occurring on the factory floor and even more striking changes are affecting processes off the factory floor -- in the white-collar areas of the firm.

We argue in this paper that these changes represent a departure from what has become standard IE practices and that these practices are obstacles to the quantum leaps in response time and quality necessary to compete in today's global markets.


KEY WORDS: Just-in-Time, industrial engineering, time-based competition.

## I. Introduction

Time-based competition (TBC)--the strategic concept in which firms use quick response to customer demands as a prime source of competitive advantage--has been widely adopted by leading firms as an integral part of their corporate strategy ([3],[11]). These firms carefully examine their customer service processes and seek ways to improve both lead time and quality.

In a related development, the "lean production system" or the Just-In-Time (JIT) production system as implemented by Toyota was dubbed "the machine that changed the world" by the researchers of MIT's International Motor Vehicle Program [14]. Successful JIT implementations have produced dramatic lead time reductions on the factory floor and have been the catalyst for a new form of cooperative buyer-supplier relationships. Increasingly, firms are combining information technology (IT) with JIT to create new opportunities in Computer Integrated Manufacturing (CIM). The CIM combination of JIT and IT brings new capabilities of speed and quality to managerial decision making: moving beyond the simple management of operations to management of opportunities.

However, some cynical managers react to the success stories associated with JIT and time-based competition by asking "Aren't these just new labels and packaging by the old efficiency experts for the time-and-motion studies that we have been hearing from the Industrial Engineers for years?" The question is important but for an entirely different reason. As we explain below, there are large and significant differences between traditional IE and JIT, as well as TBC. Although IE has played an important role in what has been a persistent pattern of productivity increases in manufacturing over the past century [5, Ch. 13], the discipline has fallen into disfavor, and this paper explores why this has occurred.

Although industrial engineers are frequently called "efficiency experts" and "time management experts," we contend that, to the contrary, IE has evolved in ways that are inimical to total process efficiency or lead time reduction. As we demonstrate in this paper, there are strong similarities between TBC, JIT and the *original principles* of IE. However, IE, as popularized by Frederick Taylor and his disciples as "scientific management," developed in certain specific directions that were diversions from the original principles. Instead of separate developments, JIT and TBC may, in fact, represent a renewed emphasis, or rediscovery, of the principles upon which IE was founded.

In the sections that follow, we will examine a typical manufacturing process from all three perspectives-- IE, JIT and TBC.

## II. The "Traditional IE" Approach

There are significant differences between the original concepts on which IE was founded and the "traditional IE" approach that has evolved through the practice and writings of Taylor, Gilbreth, and their followers.

When Industrial Engineering was developing as a discipline in the early part of this century, it took a very broad view of the manufacturing process. In his book, *Principles of Industrial Engineering*, published in 1911 [6], Charles Going called IE "the formulated science of manufacturing. It directs the efficient conduct of... any undertaking in which human labor is directed to accomplishing any kind of work. It is of very recent origin." Early IE doctrine emphasized efficiency, but with a view of the entire manufacturing system, not simply at the task level. Going explained:

> "This new and ethically fine ideal, therefore, is efficiency-- the reduction of costs and the elimination of waste for the primary purpose of doing the thing as well as it can be done... the great purpose and value of these analytical functions of industrial engineering is that they visualize the operations of the business and enable us to pick out the weak spots and the bad spots so that we can apply the right remedies and apply them where they are needed... the second phase of industrial engineering-- the active, creative and synthetic phase-- goes on from this point and effects improvements, devises new methods and processes, introduces economics, develops new ideas. To this part of work management belongs, for example, the rearrangement of manufacturing plants, of departments, or of operations so as to simplify the process of manufacture."

The systems view of manufacturing processes was central to the principles of IE in its early years.

Over the next few decades, however, the disciples of Frederick Taylor and the Gilbreths changed all that by narrowing the focus of their techniques to individual tasks.

Taylor, revered by his followers much as Deming is today, made efficiency a household word with his principles of Scientific Management. Taylor's principles were summarized by Going as follows:

> "It is the study of the plans for executing work by the highest expert skill obtainable: the reduction of these results to a set of standards for performing work and the provision of the best apparatus for doing the work; the careful training of the workmen by competent instructors to do the job in the best way with these best appliances in the minimum of time."

Although Taylor may have intended for these principles to be applied to entire processes, many of his famous experiments and his writings dealt with the efficiency of individual tasks ([2],[12],[13]). Drucker [5, Ch. 13] states that Taylor preferred the term "task study" to describe his methods and that the question he asked was "How is it done?" not "What is the task?" or "Why do it?" Significantly, the *interpretation* of his principles by legions of budding IEs emphasized the application to the task of an individual worker and earned Taylor the nickname "Speedy Taylor." Frank and Lillian Gilbreth narrowed the focus further by developing a science of motion efficiency, complete with a set of tools and terminology to study and develop a most efficient method for performing a task. As the application of these principles met with opposition from a skeptical workforce, the IE practitioners earned the pejorative title "efficiency experts."

The followers of Taylor, Gilbreth and other early IE pioneers focused on time compression, but time compression in the small, or micro, level. The microscopic task-focused view of IE was supported by the dramatic changes in manufacturing caused by the wide-scale adoption of mass production in the 1920s. In order to have mass production, *interchangeable parts* were required for quick, easy assembly. To make assembly faster, repetitive and to achieve scale economies, the production process was subdivided into *small tasks* with short cycle times and *dedicated machines* were designed for specific tasks. Flexibility was unimportant. The systems were fast, efficient and rigid.

The demands of mass production also changed labor and management. Advances in metal-cutting technology required that production engineers set machine speeds, cutting conditions, tool changes. These changes increased centralized control over the process and reduced the worker's involvement to the point that worker skills were minimized: their responsibilities were reduced to loading/unloading, and touch-button operations; their work was governed by tightly-controlled operations procedures.

Reduced skills were important for another reason. The success of mass production created increasing demands that extended deeper into the pool of available labor. Rather than raise the language skills and educational level of the population, task requirements were simplified and lowered to match that of the available population. The discipline of IE evolved as a science of mass production to serve these new systems. In many ways Henry Ford's River Rouge plant was a shrine to industrial engineering principles.

The IE approach to mass production has had widespread ramifications for manufacturing management practices in inventory and materials control, factory layouts, supervision, quality control and even cost accounting.

Inventory and materials control--Under the task-focused, microscopic view of production, the objective is to maximize the efficiency of each individual task, so workers tend to be *isolated* on individual machines. This often creates a need for large inventory buffers between work stations. There must be a sufficient supply of components or raw materials to work on and a large bin in which to place the output, so neither the machine nor the worker need stray from their appointed task. Production output is stressed at the cost of long lead times.

Layouts-- Driven by goals of local efficiency, factory layouts evolved in which high-volume, inflexible machines are grouped together by function and in which parts travel long distances.

Supervision-- Accompanying this task-focused, microscopic view was a principle of external control. There was a scientific way to perform the task and this was the purview of the IE expert; the worker was informed and trained in proper operating procedures, but not consulted.

Quality control-- Quality was certainly not the concern of the individual worker; his job was to turn out parts as fast as possible. Therefore, quality became a separate, detached task, or activity. Inspectors were added, as a separate function, to examine the output and either pass it along or discard defectives. Implicit in this activity is the notion of external control, even in the term applied to it: *quality control*.. An entire discipline of quality control grew up around this external view. For decades quality was viewed as something to be *inspected in*, divorced from the actual process of work.

Cost accounting-- The isolated, task-oriented view of the manufacturing process was embraced by cost accounting: standard costs, labor efficiencies, machine loadings and controls based on variance from these standards are the principles that have guided generations of cost accountants and their numbers were used to measure and control the factory. With conventional cost accounting building inventories creates the illusion of building profits.

The consequences of the "traditional IE approach" to manufacturing are well-known by now:

1. High production efficiency;
2. High machine utilization;
3. Good accounting numbers;
4. Long lead times;
5. Large WIP inventories;
6. Persistent quality problems;
7. Scheduling nightmares;
8. Worker alienation;
9. Strong functional barriers;
10. Poor customer service.

How could a system devised by "efficiency experts" go so wrong? Does the problem lie with the principles of IE or in how they have been applied? In retrospect, the problem appears to have been a loss of a system perspective in pursuit of small, local efficiencies. Clearly, there has been movement away from some of the original principles of the industrial engineering discipline.

Over time, external forces revealed the flaws in the system. From a competitive standpoint, the task-focused, mass production system lacked the *flexibility* to respond to market forces and produce products in the variety that consumers demanded, the *quality* levels required for customer satisfaction and, in some cases, the *speed* to respond to customer needs. In fact, the JIT system that has supplanted the traditional approach to manufacturing in many firms drives improvements in flexibility, quality and speed.

## III. The JIT Approach

The JIT philosophy differs in significant ways from the traditional IE approach. IE seeks "efficiency" and JIT seeks to "eliminate all waste in the process." This blatant oversimplification is important because of its implications: the two objectives steer managers in different directions with sharply divergent results.

Following the JIT path illustrates the differences. Send two people into a plant and tell one to look for waste and tell the other to look for ways to increase efficiency, and they will view the process with different eyes. By looking for waste, one looks as closely at what is happening (or not happening) *between* activities as at the activities themselves.

Implementers of JIT, pursuing a goal of eliminating waste, are led to focus more on non-value-adding activities-- those activities that do not add value for the customer (such as inspections, setups, queuing time)-- than the value-adding (VA) activities. By targeting for elimination of all the time between VA activities, the focus is in some sense on the dual of the problem that the IE attacks.

JIT, therefore, takes a macroscopic view of the entire process. The emphasis is not on individual task cycle times, but rather the quality and response time of the entire process.

For example, setup times are clearly identified as waste: time when an entire work center must come to a stop to prepare to carry out another activity. If that work center is a bottleneck, then this is tantamount to shutting off the output of the entire process. From a drive to reduce setup times comes the economic capability to produce smaller lot sizes, dramatically increasing the flexibility of the process and achieving a result quite opposite from a "traditional IE study."

By viewing the approaches of JIT and IE from a process perspective, we note that significant differences emerge in the areas of employee involvement, layout, quality, inventory management, focus and flexibility.

<u>Employee Involvement</u>-- Under the JIT approach, ignoring the employee's input and knowledge is also a waste. JIT seeks to provide real, rather than symbolic, empowerment and make full use of the insights and creativity of the employees on the factory floor to make process improvements. Adler [1] suggests in a recent paper, based on a study of the GM-Toyota NUMMI joint venture in California, that the principal shortcoming of the traditional IE approach is not so much the attempt to standardize work, but that the standards are best determined by staff experts and imposed on the workers. In that context he argues that some of the "Taylor-bashing" may be undeserved and that many of Taylor's principles are imbedded in the Toyota approach; the difference at NUMMI is that the employees on the floor have local control over the development of work procedures. Traditionally, IE seeks local process efficiency and maintains global control. JIT, on the other hand, seeks global process efficiency and supports local control.

<u>Layout</u>-- Since JIT focuses on the flow of the entire process, the objective is a layout that eliminates waste in moving product and allows workers access to more than one machine. As a consequence, compact, flow-oriented, U-shaped layouts have been formed in many JIT facilities.

<u>Quality</u>-- Having a separate function for quality is wasteful; so is solving the same problems over again. JIT seeks to build upon local control and integrate quality into the

process. Bad product is something that should be driven out over time. Quality becomes the responsibility of the person or team that produces the part. Research on quality provides growing evidence that this integrated approach creates conditions under which quality tends to improve over time.

<u>Inventory</u>-- Maintain the minimum inventories to produce parts as needed to meet demand. It is wasteful to produce parts before they are needed. This also leads to dramatic space and time reductions as well as to simplified and decentralized material control systems (for example, Kanban-driven pull systems).

<u>Focus and flexibility</u>-- By reducing setup times and, hence, the basic cost of complexity, JIT results in a more flexible production process-- the "lean, flexible production system" that allows a firm to produce a variety of products on the same line, yet incur the costs that are associated with scale production. Successful JIT implementation leads to better flow patterns, smaller lot sizes, reduced need for complex scheduling algorithms and reduced need for centralized control systems.

The results of JIT's quest for waste removal are short lead time, small WIP inventories, better quality, scheduling simplicity and, in general, a continuous improvement environment through a motivated workforce empowered to "own" its processes. However, although global production efficiency may have increased substantially (for example, less rework), machine utilization may not have increased. In fact, less WIP and shorter lead times may induce more machine idle time; creating idle capacity instead of idle inventory.

For the organization JIT's efficiencies can be a two-edged sword. Lead time and quality may exhibit marked improvement but local production efficiencies as reflected in conventional accounting measures may deteriorate. Consequently, JIT change agents may clash with accounting managers over measures of performance. Resistance from other functions within the organization may also impede improvements in customer service. For example, marketing may prefer to have finished goods inventories and resist a leaner, JIT system. Purchasing my balk because their cost-based measures of performance will suffer under the new supply requirements of JIT which place a premium on shipment timeliness and frequency.

## IV. The TBC Approach

Time-based competition is a customer-driven strategy. The time-based competitor seeks, above all, closeness to the customer and total customer satisfaction, which means delivering high-valued products and services in the least amount of time at a competitive cost.

How does this differ from JIT? JIT focuses primarily on the manufacturing cycle, seeking to remove waste and increase speed on the factory floor and in the raw material supply chain. TBC takes a more holistic approach to the problem of quick response to customer needs, looking beyond the factory floor to the broader needs of the customer. TBC is a global, systems view of the firm.

In "How Northern Telecom Competes on Time," Roy Merrills explains the global approach of a time-based competitor. "Ultimately we didn't just change our existing processes. We looked at them in totally new ways and redesigned our entire organization so we could conduct business faster than ever before [8]." Northern Telecom's initial successes at time compression were achieved on the factory floor; one product's manufacturing lead time was cut from 9 to 2.4 weeks. However, despite these successes with JIT, customers were dissatisfied by delays in the other activities needed to fill orders--order entry, receiving and distribution. Recognizing a need to shrink the time in the entire value-delivery chain, the firm began identifying and eliminating waste in these activities. Several research assistants of one author worked to compress by half an order entry cycle that required up to six weeks to complete [10]. Building upon these efforts, Northern

Telecom has cut new product introduction times by 50 percent and receiving cycles by up to 97 percent. As a result, customer satisfaction surveys have shown steady improvement in a highly-competitive market characterized by rising customer expectations.

Toyota--whose Toyota Production System is considered by many to be the pioneering JIT process [9]--is another firm that has made the transition from JIT to TBC. By the late 1970s Toyota's JIT system could manufacture a car in under two days and this benchmark was the envy of the other global auto manufacturers. However, speed was lacking in the rest of the value-delivery chain. Toyota was dismayed to learn that the sales and distribution process consumed between 15 and 26 days. They were spending more money distributing cars than making them! By focusing on waste in sales and distribution with the same zeal exhibited on the factory floor, Toyota was able, by 1987, to cut time in sales and distribution by half and move the entire process closer to the customer [11].

TBC concentrates on value-delivery chains: the chain of activities that link customer need to customer satisfaction. The entire firm is viewed as a system of value adding and supporting process. For example, from the customer's perspective time in the order entry cycle is as important as manufacturing lead time because all the time spent filling the order, manufacturing the product and delivering it are of equal value to the customer. The new product development cycle is also an essential value delivery chain because of market pressures to deliver new technology and product enhancements to the customer as quickly as possible.

Viewed from a customer service perspective, knowledge of current customer preferences must penetrate on-line into the entire value-delivery chain. Information transfer between pairs of work stations, as is done in JIT with Kanban, is not enough. Using technology, such as electronic data interchange (EDI), to simultaneously transmit information among all members of the response team takes on paramount importance.

As stated by Roy Merrills of Northern Telecom, "We found that all the things that were vital to our long-term competitiveness had one thing in common: time . . .

emphasizing time instead of money means rethinking every aspect of the business [8]." For the time-based competitor time becomes the critical performance metric. Time reduction becomes the driver of continuous improvement for every process in the firm. In every process the goal is the elimination of non-value adding activities so as to respond faster to customer needs. In contrast, the traditional IE approach would strive to improve the efficiency of VA activities, and JIT would focus myopically on the chain of manufacturing activities.

V. TBC: a return to the original IE principles?

A summary of the points made in the preceding paragraphs is useful to clarify the historical perspective. Initially there was a discipline, called Industrial Engineering, that emphasized a scientific and macroscopic analysis of a system's effectiveness by taking a holistic view of its components. Unfortunately, in the slipstream of success of mass production, IE soon degenerated into Taylorism, a word associated with situations depicted in Chaplin's *Modern Times*: employees as robots and machines as subterranean monsters. IE's view narrowed to microscopic analysis with the sole purpose of local task efficiency through cycle time reduction. The extreme example of this development are Gilbreth's "Therbligs"-- motion study at the level of individual eye movements and hand motions in microseconds.

JIT reversed the trend by focusing on the efficiency of the entire process, linking again the various functions that had been partitioned off for analysis by the efficiency experts (material handling, setups, quality, production, etc.), transferring authority to the shop floor and decentralizing it there.

TBC took JIT one step further by recognizing that the customer is king and examined all processes within the customer service system. Since the key TBC concept is creating value for the customer, the goal is process effectiveness, rather than efficiency. Stated in the current fashion: do the right thing first and then do the thing right. Therefore our view is that we have returned to a discipline emphasizing a scientific and macroscopic perspective on system effectiveness, not unlike IE in its early days, but with the additional benefit of modern information technology such as barcoding, EDI and telecommunications.

Information technology offers new opportunities for more tightly-coupled processes, especially those that are cross-functional and those that include partners in a supply chain. The "Quick Response" movement in the apparel industry clearly demonstrates how the marriage of TBC and IT leverages the profit potential of a closely-coupled supply chain, linking textile producers, apparel manufacturers, retailers and the customer [4]. The Quick Response pioneers, such as Wal-Mart in discount retailing and Milliken in textile production, have shown that supply-chain partnerships can shrink time in two directions--in the time to manufacture and move product forward to the customer and to provide information feedback from point-of-sale. With scanners at point-of-sale and EDI, Wal-Mart can (and does) provide its suppliers with real-time data on the fashions, sizes and colors that its customers are buying. Instant customer information feedback supplants the conventional order chain that delays and distorts sales information. Using IT, the Quick Response partners have attacked the major profit killer in apparel--demand uncertainty--by eliminating the information time lag that makes demand forecasting difficult. By shortening the lead time for forecasting, forecast errors are reduced and the retailer is more likely to stock the items that consumers desire. Wal-Mart's surge to the front among America's discount retailers is due, in large part, to consumer approval of their information-driven pull system.

In France, the Minitel system has brought information sharing into the home and has made banking at home a reality. Consequently, some small, nimble banks such as CORTAL have quickly moved into the market and seized market share from larger, traditional banks that were slow to capture this opportunity. CORTAL, founded in 1984, has no branch offices and operates entirely by telecommunication with its customers [7]. According to CEO Bernard Auberger, " Physical proximity does not necessarily imply being close to a client. Just think of the poor face-to-face service that you might have experienced at a branch. Our strategy is to apply information technology to make CORTAL a bank of proximity."

## VI. Examples from field research

Some examples from our field research on time-based competition [4] illustrate the profound differences between the traditional IE approach to process improvement and the TBC approach. Most of these examples deal not with pure manufacturing, but white collar processes. Although most of the development of IE techniques and JIT have taken place on the factory floor, the greatest need for efficiency and time compression lies in administrative processes. For IE concepts to have the greatest impact, they must be applicable to all parts of the process that deliver value to customers.

Table 1 provides a summary of field studies of a number of customer service processes from a variety of industries. To estimate the potential for response time improvements, the processes were charted in detail and data on the average process lead times and times for the various activities were collected. Activities were then partitioned into two groups: value adding (VA) and non-value adding (NVA).

The startling statistic in Table 1 is the low percentage of VA activity in white-collar processes. In most of these processes, less than 15% of the lead time is consumed by VA activity (whereas with some processes on the manufacturing floor, particularly assembly, VA percentages above 60% can be achieved). From a process improvement viewpoint, however, it is more interesting to note the large percentage of NVA activity. Most of the time in the processes depicted in Table 1 is waste; very little is being accomplished that adds value for the customer. Therefore significant time compression can be achieved by attacking waste, without having to work faster or harder on the VA activities in the chain.

Prior to examining one of these processes in detail, it is important to note that when the percentage of lead time consumed by VA activities is so low, a task-oriented approach devoted to making VA activities faster and more efficient will have little effect on overall lead time and therefore will have minimal effect on customer satisfaction. Also, these examples show that although much of our efforts at time compression have been directed to the factory floor, a richer set of targets exists beyond the walls of the factory in the white collar and overhead areas. Are the traditional techniques of IE useful in this environment or are different tools required?

A closer look at one process-- the new life insurance policy application process-- highlights the differences between the IE and TBC approaches. The setting for this process was a large insurance company who recognized that increased customer satisfaction was linked closely to faster new policy approval-- that is, speeding up the chain of activities from the point of sale until the approved policy is delivered to the customer. As with many other administrative processes, most of the activities in the insurance policy approval chain involve information processing.

The process was analyzed in the same manner as one would reengineer a manufacturing process: a process flow diagram was developed to depict all activities involved in a new policy application. The flow diagram is displayed in Figure 1. As reported in Table 1, this process typically takes about seventy-two hours but the amount of actual VA activity consumes only a few minutes. On inspection, the process flow diagram appears very similar to the flow diagram of a conventional, batch manufacturing process. The process is sequential, WIP inventory builds up ahead of operations, and there is strong evidence of batch processing; many of the same things that slow a traditional manufacturing process are evident here. The research team found that batch processing of policies produced a severe capacity problem that began each Monday morning with the sorting process. The batch of policies then surged through the system, creating capacity problems at each operation in the sequence.

Additional problems were created by the layout. As with many offices, the building layout was departmental: a functional layout designed to fit a functional organization. The layout had not been constructed to mesh with the policy approval process; it was designed to serve a functional organization. When the layout was superimposed on the flowchart in Figure 1, the team observed that the paper flow crisscrossed two floors of a large office building; the surge of activity moved back and forth between departments on a path that bore closer resemblance to a random walk than a straight line.

The research team found that about 20% of the policy applications had erroneous or missing information and had to be reworked back through the process. When traced, most of the quality problems were occurring at the input interface between the salesman and the customer: not getting it right the first time. Until the study was carried out, the firm was unaware that the defect rate was so high. As is typical of white-collar processes, quality and lead times were not measured; incentives were based only on sales-- and the salesmen in their zeal to get policies sold and into the pipeline were creating quality and time problems. The firm was surprised and pleased to learn that they could achieve a 20% increase in productivity in the application process simply by getting the forms filled out carefully at the point of sale. Data from British insurance firms with input error rates up to 40% suggest that the 20% value may be below the industry average.

A recurring theme in our studies of administrative processes is that quality problems-- doing it wrong the first time (and subsequently) -- are as serious a problem in administrative processes as in manufacturing. In fact, examples such as this highlight the symbiotic relationship between lead time and quality.

What would be the traditional IE approach to this problem? An IE study would concentrate on the individual tasks and strive to improve their efficiency. This would accomplish little except to risk alienating employees who already see themselves as harried and overcome by a flood of paperwork. Suppose, for example, that the efficiency of the value-adding tasks could be improved by 100%. The improvement in lead time would be infinitesimal: under 1%. The value-adding tasks constitute 0.16% of the total process lead time, so eliminating these tasks would only decrease the time by 0.16%. More important, a customer would not notice the difference in response time if the value-added tasks were sped up to a cycle time of zero! By focusing on VA activities, the traditional IE approach misses the target; in fact, it is aimed at the wrong target. The real targets of opportunity are in the non-value-adding activities.

The process approach of JIT should be a more effective way to improve the situation. By examining the flow of activities within the building, JIT would improve quality and response time by attacking the waste in the process. Steps would be taken to reduce batch sizes and, consequently, the large WIP inventories. This creates the need for a new layout (for example, all personnel involved in new policy approval would be moved close together and their work flows physically linked), shaped to serve the needs of a small-batch process and to keep work flowing smoothly.

However, a global systems approach can be even more powerful here in improving quality and response time. Most of the quality problems-- the ones that require multiple rework cycles through the process-- occur at the customer/agent interface. A key step in faster response time is simply to get information right the first time; accomplishing this step alone eliminates several subsequent activities in the chain by making them superfluous. For example, close observation combined with a global view of the activities led to the discovery that sorting policy applications into color-coded envelopes in the field eliminates a half-day of sorting and filing activities back at the home office.

The application of IT at the customer/agent interface provides an opportunity to add more value in this transaction. Some firms have given their agents software that allows them to simulate a number of policy risk/price alternatives while interacting with the client. Once the client has selected from among alternatives and the information has been captured electronically in the field, many subsequent activities can be done in parallel; the process is less sequential and more time-responsive.Extra value is added by "fail-safing" the software to eliminate the need for rework; that is, the transaction can proceed only if all the client data necessary for further processing are entered correctly (Japanese manufacturers refer to this as "Poka-Yoking" the process). Sequencing the flow of information from the field also trims batch sizes and provide a smooth flow of work at the central processing facility.

By taking a TBC approach the team was able to set a target lead time of 3-4 days for a process that currently takes two weeks. Using IT, some firms can now complete the process and return a policy to the customer within twenty-four hours. None of the recommended process changes required doing VA activities any faster; no one was required to work harder. The key was to focus on the NVA activities.

The traditional IE approach, by focusing on task efficiency, would miss valuable opportunities to--

a) remove time by reducing delays and inventories;
b) eliminate certain tasks altogether;
c) institute parallel processing;
d) use IT capability to simplify the transfer and communication of data.

## VII. Summary

Table II summarizes our view of how Just-In-Time and the principles of Time-Based Competition have evolved along certain dimensions from traditional IE principles. Traditional IE, as practiced by the followers of Taylor and the Gilbreths, took a task-oriented approach to work simplification. JIT takes a broader view, applying many of the same principles to entire processes-- essentially, adding people and process to the discipline. TBC expands the principles of JIT to entire systems that deliver value to customers. It concentrates on all key value-adding processes simultaneously and makes extensive use of information technology to improve response times.

Traditionally IE has emphasized centralized control of the workplace and its standards; work methods were studied by experts, standards were set, workers were trained and even coerced into following those standards. Under JIT control is decentralized; management actually empowers the workers to recommend and make process improvements. As a customer-driven system, TBC retains local control but adds coordination across teams responsible for the entire process. Time-based competitors have process teams for their key processes which are led by process owners.

To serve the demands of mass production, IE developed tools and techniques that maximized local efficiency. JIT evolved out of a greater need for processes with global efficiency. However, a desire to deliver higher levels of customer satisfaction led to time-based competition as a combination of JIT and information technology on a wider scale for global effectiveness.

## References


1. Adler, Paul S., "Time-and-Motion Regained," *Harvard Business Review*, Jan-Feb, 1993, pp. 97-108.

2. Barnes, Ralph M., *Industrial Engineering and Management, McGraw-Hill*, 1931 (republished by Hive Publishing Co., Easton, Pa, 1976).

3. Blackburn, Joseph D., *Time-Based Competition: The Next Battleground in American Manufacturing*, BusinessOne Irwin, 1991.

4. Blackburn, Joseph D., "Time-Based Competition: White-Collar Activities," *Business Horizons*,35,4 (July-August, 1992), pp. 96-101.

5. Drucker, Peter F., *Managing for the Future: The 1990s and Beyond*, Truman Talley Books/Dutton, New York, 1992.

6. Going, Charles B., *Principles of Industrial Engineering*, McGraw-Hill, 1911 (republished by Hive Publishing Co., Easton, Pa, 1977).

7. Jelassi, Tawfik, CORTAL vs. Credit Commerciale de France, INSEAD Case, 1993.

8. Merrills, Roy, "How Northern Telecom Competes on Time," *Harvard Business Review*, 67,9 (July-Aug, 1989), pp. 109-115.

9. Ohno, Taiichi, "The Origins of Toyota Production System and Kanban System," Proceedings of the International Conference on Productivity and Quality Improvement, Tokyo, 1982.

10. Peppers, Susan, "Time Compression at Northern Telecom," Owen Graduate School of Management Research Report, Vanderbilt University, 1989.

11. Stalk, Jr., George and Thomas M. Hout, *Competing Against Time*, The Free Press, 1990.

12. Thompson, C. Bertrand, *The Taylor System of Scientific Management*, A.W. Shaw, Chicago, 1917 (republished by Hive Publishing Co., Easton, Pa, 1974).

13. Taylor, Frederick W. , *The Principles of Scientific Management*, Harper & Bros., New York, 1911.

14. Womack, James P., Daniel T. Jones and Daniel Roos, *The Machine that Changed the World*, Harper Perennial, New York, 1991.

**TABLE 1**
**Analysis of Lead Times and Value-Adding Activity in White-Collar Processes**

| Process | Industry | Average Lead Time | Value-Adding Time | % Value -Adding Time |
|---|---|---|---|---|
| New Policy Application | Life Insurance | 9 days | 7 minutes | 0.16% |
| New Graphic Design | Consumer Packaging | 18 days | 2 hrs | 1.4% |
| Prototype Development | Footwear | 125 days | 2 days | 1.6% |
| Consumer Loan | Commercial Bank | 2 days | 34 min. | 3.5% |
| Patient Billing | Hospital | 10 days | 3 hrs. | 3.75% |
| Financial End-of-Month Closing | Motor Vehicle Equipment | 11 days | 5 hrs. | 5.6% |
| Engineering Change Orders | Airframe Mfr. | 21 days | 1.75 days | 8.5% |
| Engineering Change Orders | Mechanical Controls | 25 days | 5 days | 20% |

**TABLE 2**

**Evolution of Principles: IE to JIT to TBC**

| IE | JIT | TBC |
|---|---|---|
| Task-oriented | Process-oriented | System-oriented |
| focused on the work center | adds people and process | adds the customer and information technology |
| centralized process control | decentralized process control | customer-driven coordination of process teams |
| local efficiency | global efficiency | global effectiveness |

**Figure 1**
**Insurance Application Process**