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The Role of Organizational Reality in Implementing Technology

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Abstract

Reports on ***the*** structurational model ***of technology*** which shows how workers who had ***the*** power to make ***the*** implementation successful affected ***the*** data that was collected and ***the*** extent to which management was able to use ***the technology*** to influence their work. Systems for recording job-related data; Analyzing ***organizational*** processes; Application ***of the*** structurational theory.

A Field Study

As this field study indicates, the social structures of an organization can influence how well those in the organization take to new technology. This was apparently the case at a boiler manufacturer that implemented an automated system for recording hours spent on labor. The structurational theory of technology is used to explain why the manufacturer was successful in its implementation of the new system.

Analyzing the activities of a plant by assessing labor and machinery utilization levels can be difficult. This stems from difficulty of defining what is the optimal level of plant utilization. Experts have pointed to the difficulty of measuring capacity utilization because of its intricate ties to how labor activities and machine hours are managed on the plant. The study shows how an ORLT system can offer greater data precision than a manual system, depending on the level of worker acceptance of the information system. In this article, the structurational model of technology, developed by Wanda Orlikowski of M.I.T., is used to illustrate how the technology adaptation process influences the level of utilization of the workers and machinery of the plant.

The question addressed in this study is whether an ORLT system that uses bar-coding technology and production routers can be used to improve the accuracy of shop floor data collected, and how the process of adapting such technologies influences the objective of improving the productivity of the workers. The data collected using the existing manual system was prone to many errors. In this system, the production supervisor manually entered the workers' hours on employee time tickets, and the supervisor's memory of how the workers spent their time was the basis for allocating hours to jobs. Hence, in the manual system, the disassociation between performing an activity by a worker and recording the labor hours by a supervisor offers many chances for errors in the hourly production data. Management saw automating as a means of eliminating such disassociation and improving the reporting accuracy of hours worked by humans and machinery.

Empirical field data was collected using both a manual system and an ORLT system. A comparison of the relative accuracy of labor hours and machine utilization data was carried out. The management intended to use the information to convince workers of the need to improve their productivity and the accuracy of shop floor reports. This information was expected to improve directly the production planning decisions of the plant which, in turn, was expected to provide insights into the impact of allocating labor hours to jobs, and the other costing practices of the plant. The structurational model of technology shows (1) how workers who had the power to make the implementation successful affected the data that was collected and (2) the extent to which management was able to use the technology to influence their work. Workers were successful not only in obtaining a more stable production environment (i.e., with a lesser threat of layoffs), but also achieved greater decoupling of activities from their wages. Another objective of this study was to use the structurational model of technology to illustrate the importance of understanding the interactions among technology, human agents, and the practices of an organization when implementing an information system.

Systems for Recording Job-Related Data

Online real-time (ORLT) systems gather and process data. In an ORLT system (e.g., a SAP system), all the necessary processing steps can be applied to each transaction separately rather than having to apply each step sequentially to an entire batch of transactions. Consequently, with such a system, the results of the data processed are available as soon as the data is entered into the system. A common processing step in accounting is referred to as "updating" accounts. This means that with an ORLT system, as soon as the data is entered, most of the information relating to an account is immediately updated making it available to the users on the spot. For example, as soon as the hourly information is entered into the information system, the updating process instantaneously determines the labor charges to jobs using the actual rates of employees.

The transaction information (e.g., the hourly production data) which is required to be inputted into such a system can be collected using peripherals such as magnetic bar-code readers (MBR). In a production environment, production maps, bill of activities, or production routers can be used to show the production steps in a bar-coded format, which are scanned into the system using MBR. The advantage of using an ORLT system is that all the data is immediately converted into usable information which is timely for making decisions that could not have been made with a batch system.

One such production decision is to determine the hours chargeable to jobs. Such hourly information provides more accurate full absorption job costs as compared to using the practical available hours of a plant. Without an ORLT system, the practical available hours are used to allocate production overhead costs to jobs. According to McGuire and Heath (1997), the difference between the practical available hours and the chargeable hours is the excess capacity of a plant. According to Cooper and Kaplan (1991), the cost of maintaining such excess capacity, which is included in the production overhead costs, should not be included in job costs. However, using the available capacity hours rather than the actual chargeable hours to calculate the overhead burden rates can include a charge for maintaining the excess capacity, which can result in overcosting jobs. With competitive prices, overcosting jobs can cause otherwise profitable work to appear to be unprofitable. In addition, with an ORLT system, actual labor rates can be used to determine the actual costs of labor rather than using a standard labor rate. All these improvements, which follow from using an ORLT system, contribute to increasing the accuracy and timeliness of job cost information.

Structuration Theory: Analyzing Organizational Process

Giddens' theory of structuration (1979,1984) is a social theory that incorporates both the subjective and objective dimensions of social reality. This theory has been used by researchers for analyzing a variety of organizational processes. For these researchers, the structuration theory offers the opportunity to embrace both the subjective and the objective conception of the evolving social reality of an organization. The structuration theory recognizes that human actions are both enabled and constrained by the structures of an organization. It also recognizes that structures themselves are the result of previous human actions. Furthermore, in this theory, structures are not necessarily limited to physical structures but are understood as a general concept, which manifests itself as the structural properties of any social system.

According to Giddens (1979), structural properties include the rules and resources that people use in their everyday interactions. These rules and resources not only mediate actions but also the human actors help reaffirm the rules and resources. According to Giddens, through human actions, patterns of interactions become established as standard organizational practices (e.g., the way a worker's time is allocated, the means of manufacturing a product, or how employee productivity is evaluated), and over time, these practices become institutionalized, forming the structural properties of an organization.

Giddens (1979) states that in an organization, human actors create and recreate three fundamental elements of social interaction: meaning, power, and norms. Though these elements are not separable, for analytical reasons they can be treated as distinctive parts, which are examined from the perspective of a human agent and as the institutionalized properties of an organization. According to Giddens, human interaction involves the constitution and communication of meaning, and power is understood as a "transformative capacity" (Giddens, 1979; Macintosh and Scapen, 1990), which refers to the power of human actions to transform the social and material worlds around them. Further, the organization resources, which workers bring to and mobilize in their interactions, mediate the use of power. Giddens believes that the existing structure of domination in an organization is reaffirmed whenever there is asymmetry of resources, which is drawn upon by human actors in their day-to-day interactions. Furthermore, the existing structure of domination by one party over another can also be undermined when the existing asymmetry of resources changes.

In Giddens' theory, norms can be looked at both from a human actor's perspective and from the institutional perspective. From a human actor's perspective, norms refer to organizational rules of conduct that govern appropriate human behavior. The rules can be expressed formally through the application of normative sanctions, and informally through the organizational culture. Norms from an institutional perspective constitute organizational structures of legitimization. According to Giddens, rituals, practices of socialization, and the established traditions of an organization sustain legitimization in an organization. These notions surrounding the concepts of domination and legitimization are the key concepts in Giddens' structuration theory.

The Structurational Model of Technology

Orlikowski (1992) first attempted to use the structuration theory to reconceptualize the notion of technology and to reformulate it to address the relationship between technology and the practices of an organization. She considers the development and use of technology as another structural property of an organization. According to Orlikowski, human actors who are working in a given social context can physically construct technology, but technology can also be socially constructed by the different meanings workers attach to it and the various features they emphasize when using the information system. However, once the technology is developed and deployed, it tends to become institutionalized. In the process of becoming institutionalized, Orlikowski argues that technology can lose its connection with the humans who constructed it and gave it meaning, and, when this happens, technology appears to become part of the objective, structural properties of an organization.

In Orlikowski's technology model, there are two key concepts. The first concept is the "recursive notion of technology" and refers to the fact that technology is not merely used by humans to accomplish their actions, but is also created and changed by humans. The second concept is referred to as "interpretive flexibility" which means that "the interaction between technology and organizations is a function of the different actors and the socio-historical contexts implicated in its development" (Orlikowski, 1992, p. 405). In other words, interpretive flexibility refers to the degree to which users of the technology can engage in the constitution of the technology both physically and socially during its use. Thus, the extent of interpretive flexibility will partly depend on how rigid the technology is; that is, the extent to which it requires human appropriation for its effective use.

Exhibit 1, which is Orlikowski's structurational model of technology, demonstrates the dual nature of the relationship between human agents and technology, and how technology can influence the practices of an organization, such as the social relationships and task assignments, which again influences the actions of human agents. According to Orlikowski, the enacted use of technology can be different from the intended mechanical operation of it, particularly when users do not use the system as intended. Users can transform the embedded rules and resources inherent to the use of technology and, hence, the institutional context and objectives of the creators and implementers of the technology. For example, Wynne (1988,p. 152) noted how "implementing design commitments and operating technological systems involves the continual invention and negotiation of new rules and relationships, not merely the enactment of designed ones. This develops the technology in unanticipated ways as it is normalized." Thus, the Wynne study showed that when users of technologies had to deal with unstructured social situations that deviated from what was believed to be normal, they transformed the purpose for which the technology was initially intended.

Applying the Theory: The Riley Stoker Corporation

Riley Stoker Corporation (RSC) is the firm that cooperated in this field study. The company obtains work by quoting on both large and small jobs to manufacture boilers and boiler components. RSC needed an information system to support the manufacture of a diverse line of custom boilers that have a high labor content. The firm could not afford the distortions in product costs that a traditional cost accounting system created. The distinctive products that are made require skilled labor activities that are unique, and monitoring these activities required that they be made visible to both the workers and the management.

The boiler industry operates under oligopolistic market conditions, where the initial capital investment has been a barrier to entry. In the 1960s, the industry was profitable, with jobs being quoted on a cost-plus basis. The 1970s saw a handful of large firms entering this market. In the early 1980s, the U.S. economy hit hard times, and, since then, this industry has been saddled with surplus manufacturing capacity. Currently, competing for jobs on the basis of price is the primary means of gaining market share, and being able to follow the cost leaders in the industry is essential for survival. These developments, in conjunction with the special requirements for products such as custom design and expensive materials, require very accurate and timely cost information. Based on interviews with the production personnel, it was learned that an attempt to provide more accurate information by introducing a bill of activity that tracked production routings was perceived by shop floor employees as an attempt to reorganize production control significantly. However, because of increased competition and automation of the workers' tasks, the production supervisors and workers viewed the changes as necessary for survival.

Study Methodology

The project started in the spring of 1995 and is ongoing. For the study, data on the company and its shop floor data collection practices were gathered from reviewing reports, from interviews with the plant controller, and with other production personnel. The controller was the project leader who obtained the commitment and financial support from management. This field study collected data from two groups; one group is comprised of supervisors and the second group is their workers. Based on the production manager's conversation with supervisors, the willingness of supervisors in different departments to participate in the study was determined and the department with the most cooperative supervisor was chosen. The manual system served as the control group and the automated system that uses bar-coding technology in the same department served as the treatment group. This field design controlled for variations in tasks over a period of time and across departments. The treatment group consisted of workers who directly entered their activity information using MBR, as opposed to the control group where supervisors estimated the time workers spent on various jobs. A "Test Company" collected data on a real-time basis while the manual system collected data off line from supervisors.

Shop Floor Data Collection Systems

Under the manual system, a so-called blue card was filled out at the end of each day by the supervisors allocating the workers' times. The supervisor relied on his or her memory to determine the time workers spent on different jobs. The costing department then received these cards, and at weekly intervals, the cost of labor for each job was calculated based on a standard labor rate. In addition, an overhead rate of 204 percent was used to recover all other indirect manufacturing expenses. The total manufacturing cost of a job consisted of three elements: direct labor cost, based on a supervisor's estimate of labor hours multiplied by a standard labor rate; applied manufacturing overhead cost, which was based on these labor hours multiplied by a predetermined overhead rate; and actual direct material costs.

Each job is done in a predetermined sequence on a set of machines, and every manufacturing task has dedicated workers. Hence, in addition to allocating labor time by job, the system was capable of recording the level of utilization of each machine. With MBR, the only indirect labor cost that was not being traced to jobs was the supervisor's salary. Further, the same overhead rate (i.e., 204 percent) recovered this cost in addition to recovering other manufacturing overhead expenses. Hence, with the new system the overhead costs charged to jobs are likely to be higher, because more actual labor hours (i.e., the additional indirect labor hours) were traced to jobs. Further, the information by machine centers is useful for an automated plant to determine it capacity utilization.

Implementing the Information System

Department 40, the subject of this study, resembles a typical machining center. MBR were placed at key locations in the production floor in this department. Exhibit 2 shows the information entered into the system at the MBR. Each employee has a badge number that is picked up when he or she scans his or her individual identity card, which is recorded in the first field. The second field is the year/month/date information that is entered automatically whenever there is a scanned transaction. The third field captures the time when the employee changes his or her status, such as coming to work, starting work on a shop order, completing work on a shop order, and ending work for the day.

Field 4 holds transaction information that is shown in legend 1 of Exhibit 2. The codes in the legend indicate whether an employee is scanning his or her arrival/departure time or start/finish time on a job. To calculate the time employees spend on a machine doing a particular job, the information captured in both the third and fourth fields is used. To obtain information regarding a particular machine (i.e., an operation) number, the employees were required to scan the MBR on the production routers when they began and finished their work at a machine center. In addition, the difference between the finish time and the start time at each machine was calculated and adjusted to reflect appropriate breaks. After adjustments, in the result section, a comparison was made of the actual online time to the supervisor's allocated time for each employee. The actual cost of raw materials was also recorded using bar codes on materials and other components.

Field 5 in Exhibit 2 contains the shop order information that has to be scanned into the "Test Company" (TC). The shop order number used at RSC is analogous to a job order number used in a typical job-costing environment. Each shop order has specific routing information through the production departments. The suffix number on the orders helps maintain the relationship between components and the subcomponents being made. Field 6 holds a unique suffix number for each shop order. "Production Planning and Control (PPC) Department" uses suffix numbers to break a large shop order into small batches. The employees scan the appropriate bar codes from the production router for the machine centers, and this information is captured in field 7. A new "Production Scheduling Router" uses sequential machine numbers to refer to different operations to be performed on a job. For a complete assembly of a boiler, the PPC makes several routers for each of the major components and then releases them at appropriate times to the supervisors of different production departments. Ease of use and simplicity make data entry errors unlikely, and the system has validation procedures to assure integrity.

Variable Measured

The bar-coded data is used as the benchmark to evaluate accuracy improvements in the manually reported data. The variable compared was the charged hours using the supervisors' manual blue card system and the workers' bar-coding system. The difference between hours reported using the manual system less the hours coded using the bar-coding system is referred to as the "error." These errors are investigated for their effects on decisions at the employee, departmental, and job levels. To make decisions regarding an individual worker and the utilization of a machine center, detailed data is required. For this reason, an error statistic that looks at the absolute amount of the error regardless of its sign is used. Peters and Oliva's (1981) error statistic referred to as the "Mean Absolute Deviation" (MAD) is used. The mean absolute deviation is equivalent to the average error when all errors are of the same sign and is calculated as follows:

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The (1- MAD) statistic is referred to as "Percent Accuracy."

The Results of the Field Study

The results are based on analysis of more than 2,000 transactions that occurred in Department 40 between April and May 1995. The department had six full-time employees and a number of part-time workers during these months. Job number 95505003 was the largest job this department worked on during this period. In addition, the employee with badge number 2138 is used for the analyses because he had bar code hours for all the corresponding labor hours reported by the supervisor.

Exhibit 3 is a record of the most-detailed data at the employee level and shows the aggregated hours assigned to each full-time worker in Department 40. The amount of time that a production supervisor records is substantially higher (i.e., a MAD of 12.7 percent) than the number of hours recorded by the workers using the MBR. These results were as expected, since supervisors were of the impression that they had to charge as many hours as possible to jobs. Thus, overestimating the hours employees worked on jobs was a means of accomplishing this expectation.

Exhibit 4 shows the record of 10 activities that worker 2138 performed on shop order 95505003. The data presented in this exhibit is a record of individual transactions and, in a sense, is a log of the work done on this job over a period of time. From these results it can be observed how the data aggregation process masks errors in recording what actually transpired on a particular day. Additionally, substantial recording inaccuracies are evident at the activity levels resulting in a higher MAD of 59.6 percent. This shows that the manual data collection system underestimates worker productivity on some days while overestimating worker productivity on other days, seldom getting accurate measurements. Therefore, there is little, if any, useful information with which to make decisions regarding exactly what was done, when, and where.

Exhibit 5 shows the differences in recorded levels of machine center utilization between the manual and the ORLT data collection systems. This exhibit presents an aggregated level of utilization by work centers. A MAD of 82.9 percent shows that these differences are quite substantial. At the department level, the production manager can use an average error statistic as opposed to the MAD statistic to evaluate the accuracy of production-planning decisions. For past production-planning decisions, an analysis based on disaggregating the labor hours obtained using the manual system would have resulted in substantial inaccuracies. For example, the negative average error statistic of -2.3 percent is evidence that departmental production planning was deficient. Further, a negative sign for the average error suggests that machine hours utilized by workers is higher than the hours estimated by the supervisor.

Exhibit 5 also shows that the largest error occurs in work center 4000. There were 380.8 hours recorded using the bar code system but there is no blue card hours reported. Work center 4000 was the code for idle time, which was created by the implementers of the information system. When using the blue card system, the supervisor ignored this time, whereas workers using the MBR recorded this time as well. This is a persuasive example that ORLT information was more accurate than the hours reported by the manual system. The effective use of the technology required workers to use the MBR accurately. However, one could argue that the MBR time is not the "true" hours, because it is possible for bar code measurements to have errors caused by wrong inputs by workers. However, given the circumstances at RSC, information from workers regarding what they did were likely to be more accurate and unbiased than the information reported by the supervisors.

Struturationalization of Technology at RSC

This section examines the RSC use of the automated system and the processes through which this system became integrated into the operations of the firm over time. In Exhibit 6, these processes are interpreted with use of a series of arrows shown in the structurational model of technology. The purpose of arrow "a" is to explain the objective of the firm that influenced the deployment of the new technology. Previously, supervisors had no guidelines on how to allocate their workers' times. Most supervisors had begun their careers as shop floor employees, and time allocation practices are passed down from old supervisors to employees who became new supervisors. Supervisors' loyalties in this union plant were to workers, and, hence, they had learned that the way to minimize layoff threats was to charge as many hours as possible to jobs. Based on competitive pressure, management believed that such practices for allocating worker time probably caused inaccurate job costing. As competition intensified for both large and small jobs, the stakes for making profits by cutting costs became greater. Therefore, the management objective for implementing the system was to gather information that would help improve the productivity of the workers which it believed would, in turn, help improve the efficiency of the plant.

Arrow "b" in Exhibit 6 is used to show the interaction between the shop floor workers and the information system. The bar code facilities and the production routers, which became an integral part of the new system served as the primary means to influence when and how tasks were accomplished on the shop floor. As such, the production routers and the bar code readers were deployed so that work would be executed in a standardized and structured manner. In developing the production routers, management assumed that the activities had to be performed sequentially in machine cost centers with little ambiguity about what was done and when it was done. This left little discretion about allocating work, so management expected supervisors to assign the tasks passively to workers without any reflections on how a job was to be done. On the one hand, because of the production routers the bar code system allowed supervisors to allocate the work more quickly, and relieved them of the responsibility of remembering who does what and when. On the other hand, this same tool also constrained the workers tasks to what was mapped out in the production routers, which had been prepared centrally by the production-planning department.

Arrow "c" in Exhibit 6 shows the interaction between the practices of the organization and the workers. The institutional pressure discouraged RSC workers from bypassing the steps prescribed in the production routers. The need to have the machines (i.e., operations) sequentially mapped in the production routers encouraged the plant to quote on jobs that were simpler to execute. Most such jobs were typically smaller, and because of price competition from smaller firms, the RSC track record for obtaining these jobs was not impressive. This led to further analysis of the data at the job level to find out why the RSC costs and prices were higher than its competitors.

Unlike workers, management was concerned with summary statistics, such as the total costs of jobs. Exhibit 7 shows charges of all six employees for the largest repair job undertaken during this period. This job involved making a component (i.e., a rack) for a boiler. The difference in earned hours results in a cumulative dollar error of $69; this is small compared with the total cost of the job, which was $14,041. However, as can be observed, the MAD statistic has increased from 12.7 percent in Exhibit 3 to 29.5 percent in Exhibit 7. This results in a relatively low level of accuracy -- 70.5 percent, for costing labor hours to this job. Not only is this result significant from a cost-accounting perspective, but it is also fair to point out that the supervisor's blue card hours are marginally less than the workers' bar-coded hours. The negative sign for the average errors in Exhibits 4, 5, and 7 (i.e., of -30.5, -2.3, and -0.4 percent) suggests that there is a tendency to underestimate the work of employees on the job(s) associated with these exhibits.

If supervisors are underestimating hours on some jobs, they are probably overestimating hours on others. Exhibit 8 presents a tabulation of the recorded time required to complete the 10 largest jobs in Department 40. At the individual job level, a negative percentage indicates that the supervisor underestimated the amount of labor time allocated to these relatively large jobs. The average error is modest (-6.2 percent); however, Exhibit 8 shows that errors on a job-by-job basis are much larger (i.e., MAD of 12.6 percent). The overall result is a percent accuracy score of 87.4 percent, which again suggests that the manual system is less accurate than the ORLT system.

Additionally, the average error and the average MAD for all 86 shop orders processed in these same work centers were calculated to be 23 and 37 percent, respectively. Comparing this result to the evidence shown in Exhibit 8 where the average error was -6.2 percent and the MAD statistic was 12.6 for the largest 10 jobs, it was concluded that the supervisors were overreporting hours on smaller jobs while underreporting hours on the larger, more visible, jobs.

A chi-square test (Cooper and Kaplan, 1988) based on the size of the jobs (i.e., large jobs versus small jobs) versus the size and direction (i.e., positive versus negative) of their errors was significant (i.e., $p = 0.012$), and supported the observation. The chi-square test was based on 50 shop orders where the records of both blue card and bar-coded hours were available. The 10 with the largest times recorded on the bar-coded system were considered the "large jobs." The other 40 were considered the small jobs. Based on this test, it was determined that smaller shop orders cross-subsidized larger jobs making the costing of both types of jobs inaccurate, which was of great concern to management.

Arrow "d" in Exhibit 6 shows the effect of implementing the system on the evolving institutional practices of the firm. Once the productivity tools, the production router and the bar code readers, became permanent fixtures on the shop floor, they influenced the institutional properties of RSC, such as who controlled the work allocations. In terms of the structurational model, these tools represented a set of rules and resources drawn upon by workers in their day-to-day interactions. Hence, the tools went a long way in determining the plant structures of domination and legitimization. This influenced not only how work was conducted, but also directly influenced the way in which problems were interpreted (i.e., interpretive flexibility). By centrally controlling the way work was done on the shop floor, management intended to improve the productivity of the workers. While attempting to institutionalize such control, management realized that centralization was limiting growth into profitable markets. However, for achieving accurate reporting through effective technology use, management realized that it needed the cooperation of all shop floor personnel. This meant that management could not centrally micromanage the workers' activities (e.g., it was difficult for management to make sure that the workers used the right production router for the right job at the right time). Therefore, the unintended consequence of using this technology was that workers eventually reaffirmed their autonomy, obtaining more freedom over decisions about what was done where and when. In return for providing more accurate information, workers were given greater autonomy in scheduling activities on the shop floor.

Subsequently, the production router was redesigned to capture the information on indirect labor hours caused by idle time, material handling, and moving of jobs between machines. These indirect labor hours are now reported separately, and management discretion is used in decisions about charging the related costs to jobs. When costs are not charged to the jobs, they are treated separately as the cost of maintaining the current production facilities. Workers still have to bar code the information, even when they follow alternate steps that are not shown in the production router. These changes have resulted in providing more accurate and timely information compared to the old manual system. It is the management belief that separately obtaining such information is important for improving plant efficiency and to avoid mistakes of quoting for jobs that are costly and unprofitable.

The arrows in Exhibit 6 show the continuing interactions that are shaping the behaviors of workers, while producing and reproducing the institutional structures of RSC at the same time. The dialectical cycle of relations and interactions between workers, production practices, and the technology will continue over time, as long as this system remains a major component of the RSC operating strategy to improve its plant efficiency.

Conclusion

The results of the study show that detailed hourly information obtained directly from shop floor workers was very different from the estimated information provided by the supervisors. By assuming bar-coded times are more accurate, worker idle time at work centers can be determined and bottlenecks can be carefully considered for production-planning decisions. This, in turn, should help better assess workers' productivity, and improve the efficiency of machinery utilization.

The results of the study provide two explanations for why companies may fail to see the benefits of implementing an ORLT system. First, at the higher level, the errors offset each other as specific pieces of information are accumulated and summarized for calculating the total cost of a job, and for determining work center utilization at the department level. The result of this portfolio effect is that there are higher levels of accuracy in the summary information than in the detailed worker information collected through a manual system. Hence, management may not see the benefits of accurate reporting as a result of introducing an ORLT data processing system.

The lack of acceptance is the second result that explains why many companies do not realize the anticipated benefits from installing an automated data collection system. The existing social contract between management and workers may be consistent with a manual data collection system, and to make the most of an automated system, management must understand, and participate in, the dialectic process that takes place as the organization develops new structural properties. The successful introduction of a potentially invasive technology that can be appropriated by management and workers for achieving their differing objectives may require the establishment of new social contracts that are perceived by all parties to be mutually beneficial. The implementers of bar-coding technology must recognize the importance of the "interpretive flexibility" of a technology for assuring its successful implementation. This can be difficult because better data collection methods will make information available to management that previously was only known to workers. Thus, it must be clear to both management and labor that there has been a switch in operating priorities. In this study, the management of RSC has determined that the accuracy in job costing is necessary to assure the long-term survival of the firm. This objective may conflict with past operating priorities, such as having all jobs meet budgeted cost, where management might overlook "errors" that have the effect of diverting labor hours from jobs that are in danger of exceeding their budgets to those that would be completed under budget. For these reasons, management must reevaluate past practices and be willing to make changes to assure workers that adoption of the new technology is also in their best interest and is not one-sided, namely, for the purpose of centralizing production management. Otherwise, reluctance in accepting the new technology can develop from users of the technology, thus dissipating the benefits that accrue from implementing an online, real-time data collection system.

The results of the analysis show that the supervisor on the shop floor used the existing practice of allocating workers time to make sure that all eight hours of an employee's time was allocated to jobs. This protected the supervisor and the workers from management's demand for increasing productivity. However, without detail information, management could not find ways to improve productivity. An ORLT system that uses bar-coding technology and production routers became instrumental for collecting reliable production data. This, in turn, helped workers and management to question their governing values that had been institutionalized as the organizational structures. With the new technology, management is willing to embrace a stable work force since it encourages good production practices. To obtain this goal, the issues about who should manage work allocations to machines have now been decentralized, rather than become centralized which was the management's intended objective when the technology was implemented. Thus, even with an automated system, RSC could not separate the capacity utilization issues from the labor management issues. However, organizations that implement such systems, and manage the implementation process well, can expect capacity management issues to become more transparent.

DIAGRAM: EXHIBIT 1 Orlikowski's Struturational Model of Technology

EXHIBIT 2 Information Gathered by the Automated Shop Floor System

Legend for Chart:

A - Field No.
B - Data Description

A	B
1	Badge Number
2	Yr. /Mo./Day
3	Time to start or stop a transaction
4	Transaction Code No. Refer to the Legend 1 below
5	Shop Order No:
6	Suffix
7	Operation No. Referred to in Table 1
8	Quantity Completed
9	Quantity Rejected
10	Quantity Scrapped
11	Operation Complete (Yes or No?)

Legend 1

100 -- Attend-In
101 -- Attend-out
102 -- Start operation
103 -- Finish operation
104 -- Misc. Start (Indirect time)
105 -- Misc. End (Indirect time)

EXHIBIT 3 Total Labor Hour Comparison for Each Full-Time Worker in Department 40

Legend for Chart:

A - Badge Number
B - Bar Code Hours
C - Blue Card Hours
D - Percent Errors
E - Absolute Labor Hour Errors

A	B	C	D	E
291	193.8	233.2	20.4	39.4
763	229.8	230.6	0.4	0.8
890	208.2	239.0	14.8	30.8
2138	2,357	2,422	28	65
2511	2,034	236.6	16.4	33.2
2531	136.8	179.7	31.4	42.9
Totals	1207.7	1361.3	N/A	153.6

Mean absolute deviation: 12.7%.

EXHIBIT 4 Worker Level Transaction Record for Employee with Badge Number 2138 on the Largest Job

Legend for Chart:

A - Activity No:
B - Bar Code Hours
C - Blue Card Hours
D - Absolute Labor Hour Errors

A	B	C	D
1.	8.2	8.0	0.2
2.	8.4	8.0	0.4
3.	2.2	4.0	1.8
4.	3.8	3.5	0.3
5.	4.3	4.5	0.2
6.	0.1	5.2	5.1
7.	8.3	1.0	7.3
8.	7.0	0.0	7.0
9.	2.6	0.0	2.6
10.	4.3	0.0	4.3
Totals	49.2	34.2	29.2

Mean absolute deviation: 59.6%.

EXHIBIT 5 Cost Center Utilization Levels

Legend for Chart:

A - Work Center
B - Bar Code Hours
C - Blue Card Hours

D - Percent Errors
E - Absolute Labor Hour Errors

A	B	C	D	E
4000	380.8	0	-100	380.8
4005	0	12	N/A	12
4015	25	39.1	56.4	14.1
4030	0	22.1	N/A	22.1
4060	59.2	139.7	136	80.5
4070	241.6	357.9	48.1	116.3
4090	91.2	140.8	54.4	49.6
4100	0	1	N/A	1
4105	16.6	19	14.5	2.4
4115	0	9	N/A	9
4120	61.8	100	61.8	38.2
4130	0	16	N/A	16
4135	22.1	20.3	-8.1	1.8
4165	0	0.6	N/A	0.6
Totals	898.3	877.5	N/A	744.4

Average error:-2.3%.
Mean absolute deviation: 82.9%.

DIAGRAM: EXHIBIT 6 Applying the Structurational Model of Technology

EXHIBIT 7 Comparative Labor Costs for the Shop Order No: 95505003

Legend for Chart:

A - Badge Number
B - Bar Code Hours
C - Blue Card Hours
D - Percent Errors
E - Percent Absolute Errors
F - Over or Under Charge[*]

A	B	C	D	E	F
291	91.8	105.8	15.1	15.1	507.1
763	28.1	56.5	101.1	101.1	10360.0
890	115.0	1285.0	11.6	11.6	488.9
2138	49.1	34.2	-303.0	30.3	-543.6
2511	65.4	330.0	-49.5	49.5	-1182.0
2531	35.0	25.0	-29.2	29.2	-375.7
Totals	384.4	383.0	N/A	N/A	$(69.3)

Average error:-0.4%. Mean absolute deviation: 29.5%.

[*] The charge was determined by using a standard labor rate of $12, and adding to it the applied manufacturing overhead burden rate of 204 percent.

EXHIBIT 8 Labor Hours Recorded on Largest 10 Shop Orders Using an Automated and a Manual System

Legend for Chart:

A - Shop Order Number
B - Total Bar Code Hours
C - Total Blue Card Hours
D - Percent Errors
E - Absolute Labor Hour Errors
F - Percent Absolute Error

A	B	C	D	E	F
95505003	384.8	383.0	-0.5	1.8	0.5
94101085	156.8	162.5	3.6	5.7	3.5
94566005	87.2	56.2	-35.6	31.0	35.4
95505002	63.0	47.1	-25.2	15.9	25.2
94566015	36.6	23.6	-35.5	13.0	35.5
52341001	35.1	30.1	-14.2	5.0	14.2
52318001	34.5	42.0	21.7	7.5	21.7
24794001	33.0	32.9	-0.3	0.1	0.3
94571003	25.7	10.0	-61.1	15.7	61.1
94566010	25.0	40.0	60.0	15.0	60.0
Totals	8,817	8,274	N/A	1,107	N/A

Average error:-6.2%.

Mean absolute deviation: 12.6%.

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