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Abstract

In our longitudinal study of an ERP implementation using a grounded theory methodology we explored changes in organizational control. We observed contradictory and even paradoxical outcomes from ERP-enabled increases in visibility to organizational operations and associated increases in the control of these operations. Based on these observations, we developed a preliminary framework of the changes in control and visibility we observed. The framework contributes to theories of organizational control and is the source of recommendations for managers involved in ERP implementations.

Keywords: ERP systems, managerial control, organizational change, grounded theory

Introduction

The salient and identifying characteristic of ERP systems is their ability to integrate business processes by standardizing data, storing it in a common, shared database, and ensuring that this data is accessible to whoever needs it on a real time basis (Davenport, 1998; Klaus et al., 2000; Shanks and Seddon, 2000). The business processes affected range from simple transactions conducted on the shop floor to strategic planning activities in the executive offices, and even outside the organization to processes involving customers and suppliers. Organizations are motivated to purchase such systems because, among other benefits, they expect these properties to lead to enhanced information capture, increased transparency and better information flow (Bernroider and Koch, 1999; Newell et al., 2003; Ross and Vitale, 2000).

The opportunity for increased managerial control through this improved visibility of operations has drawn the attention of researchers (Hanseth et al., 2001; Sia et al., 2002). Sia et al. (2002) examine the potential for both increased panoptic control and employee empowerment. In their view control is enhanced through an ERP system's ability to track workplace behavior, and the ease with which a worker's actions may be observed by managers and peers. Because workers also have greater visibility of data, they no longer need to pass all decisions to higher-level management, so should experience greater empowerment. Certainly the underlying characteristics of ERP systems suggest that both these outcomes are possible. In their research case, the tendency towards more control was stronger than the move towards empowerment.

By contrast, Hanseth et al. (2001) argue that despite the standardization, streamlining, and integration of business processes inherent in ERP systems, which should make them an ideal control technology, the actual result of an ERP implementation is often a loss of control, particularly when the implementation context is a global organization. Specifically they observed that in attempting to establish common work practices across various divisions (and thus making it easier to monitor and control the processes from head office), various irreconcilable local differences required that the "universal" solution evolve into specific site "variants." In addition, users extracted data from the ERP system and put it into locally created "extension" applications using Lotus notes or spreadsheet software, not visible to headquarters. These developments led to less control rather than more.

In our own longitudinal study of an ERP implementation in a global organization we also noticed changes in organizational control. Once they came to our attention via our grounded theory method, we started to collect data that would help us understand

the relationship between ERP systems and control. Our observations identified a paradoxical outcome – control was simultaneously enhanced and decreased – but unlike the findings of Hanseth et al. (2001), this dichotomy did not depend on the differential needs of globally separate organizational divisions, but could occur within single units and single processes. Through our analysis we have developed a framework of different ways in which control was affected, and the paradoxical outcomes in many of these situations.

Overview on Organizational Control and Information Systems

One standard definition of control is "attempts by the organization to increase the probability that individuals will behave in ways that will lead to the attainment of organizational objectives" (Flamholtz et al., 1985). This definition assumes that organizations have objectives, and that individuals working in organizations are purposeful and goal seeking, but their goals may differ from the organization's. Thus, from a managerial control perspective, controls are needed to align workers' behaviors with the firm's objectives. One way to achieve this alignment is through monitoring outcomes. An organization's planning system starts by setting goals and standards. As the operational system of work structures and behaviors produces outputs, the measurement system collects performance information. Finally the evaluation and reward system compares goals and standards to the performance outcome information, and determines rewards and corrective actions (Flamholtz, 1983). ERP systems, as they execute routine work transactions, offer immediate visibility to work activities and performance, providing managers with real-time outcome control information.

Extending this managerial control perspective, Abernethy and Brownell (1997) list three types of organizational control, namely accounting, behavioral, and personnel. Accounting controls represent conventional managerial control, focused on output, as described above. Behavioral controls focus on the process, using devices such as operating manuals, standard operating procedures and reporting structures to specify acceptable behaviors directly. Personnel controls include training, hiring, and socialization processes designed to ensure that individuals employed in the organization behave to further organizational objectives. In addition to the transactional information, which supports accounting control, an ERP system provides behavioral control through its structure. For example, specific organizational roles are assigned to perform each transaction, so only certain individuals have access to a transaction and are responsible for executing it. The system tracks who performs each action, and when it is completed. There are also control points along the way, so that a process cannot continue until specific actions are taken.

Arguments have been made in the literature both for the value of increased organizational control, and for the value of empowerment and the redistribution of control, although usually the case is made for only one side or the other, and the contradictions are not explored. On one side of the argument, managers never seem to have enough control and are continually searching for new control mechanisms (den Hertog and Wielinga, 1992). Explanations for this perceived need for more control include globalization and the resulting need to coordinate global operations (Hanseth et al., 2001); the increased speed of production, markets, and communications (Beniger, 1986); and increased global competition and the resulting need for reduced costs and increased global efficiency and productivity. More control is assumed to bring predictability and with predictability, the need for buffers such as extra inventory is reduced, thus reducing costs and increasing profitability. The perceived need for more control is a driving force behind the growth of computerization in organizations (Beniger, 1986), and is typically a reason managers choose ERP systems (Hanseth et al., 2001). Other reasons include increased visibility of operations, increased standardization and integration of processes, and increased discipline in organization operations, all of which are aspects of organizational control.

On the other side of the control debate are arguments that more control is undesirable. For individuals, tight controls with pre-specified behaviors may result in deskilling and an unsatisfactory work environment. For organizations in dynamic, global environments, pre-specifying objectives and the behaviors of individuals (i.e., behavioral control) may result in failing to respond to rapidly changing environments. Instead, organic organizations with empowered workers, increased worker skills, and decentralized controls are needed (Applebaum and Batt, 1994; Heckscher, 1994). According to this literature, tighter and more centralized controls are likely to lower organizational performance, contrary to the expectations of managers implementing increased controls, such as through ERP systems.

Beyond these contradictory points of view, there is evidence of an underlying paradox, namely that the more managers attempt to gain control, the less control they actually have. Specifically, counter forces operate so that as managers implement additional controls, less control is achieved. One counterforce in the literature is an increasing spiral of needs for more control. A control system increases control, but the control system itself must be controlled so that the result of increased control is a need for more

control (Beniger, 1986). For example, accountants monitor and control organizational operations, thus increasing organizational control, but they also shift the control problem to auditors, who control the accountants.

Surprises, side effects, and unexpected outcomes of control mechanisms, especially from computer systems as control mechanisms, are other counterforces that undermine the supposed benefits of increased control. These unexpected results often produce organizational drift from the path towards organizational objectives, which in turn generates a perceived need for more control (Ciborra and Hanseth, 2000). Furthermore, as organizations become more integrated, e.g., by using integrated ERP systems, organizational components become more interdependent. Changes, mistakes, or undesirable side effects in one organizational component then easily affect others. The result can be large organizational consequences as small mistakes in part of the organization are magnified and accelerated in other parts. Thus, tight controls and integration can produce organizations that easily oscillate out of control.

Evidence of various forms of this paradox came to light during our observations of an ERP implementation at a major global organization. Rather than engaging in the discussion of whether controls are inherently good or bad, we are exploring what controls were actually put in place with the implementation of an ERP system, and how they evolved over time. In particular the following questions, although not the original focus of the study, emerged from the data as worthy of further examination:

- In what ways do ERP systems enable and inhibit organizational control?
- How do stakeholders respond to these enabling and inhibiting aspects of control?
- What are the actions and processes by which forms of control evolve?

The Study and Methodology

We are studying a multi-year, multi-phased ERP implementation at a company (ACRO) that is a global leader in the design, assembly, and post-sales service of certain high-precision industrial products. Our primary objective is to develop a theoretical understanding of IT-enabled organizational change in the context of Enterprise Resource Planning (ERP) systems implementation. This study takes the perspective that IT-enabled organizational change is an emergent and dialectical process that evolves from the sequence of social interactions that occur over the course of system implementation and use. To date, implementation is complete in the component production, assembly, and service plants, and is in progress in the engineering design and testing areas. While ACRO's corporate headquarters, engineering design, and assembly operations are concentrated along the entire east coast of the United States, component production and after-sales service plants are scattered throughout North America, Europe and Asia. Our study has followed the implementation of SAP at the main plant, where engineering design and some production and assembly is conducted, one production and assembly plant, which also conducts product testing, two repair facilities, and the separate location that houses the large ERP implementation team.

We use the Glaserian form of grounded theory methodology to develop insights into ERP implementation and use (Glase and Strauss, 1977; Glaser, 1978). For each of the three implementation phases studied (two complete, and one on-going) we collected data through observations and interviews. Using power users and implementation team leads as our key informants, we sat in on meetings, observed testing, attended training sessions, and sat in the war rooms during go-live. In addition to interviewing the power users (before go-live, shortly after go-live, and several months after go-live) we asked them to suggest other users we might interview. Starting in July, 2000, we have made 154 trips, conducted 70 interviews (some of which were group interviews) with 60 different people. Interviews are on-going, but as the implementation phases we are observing are past their go-live dates, we are no longer making observations, as there are few relevant meetings or training sessions to attend.

Initial interviews, lasting anywhere from 30 to 60 minutes, employed an interview protocol that addressed some broad themes using open ended questions. These themes, suggested by our initial research objectives, included existing job processes and responsibilities (focusing on current task structure, flexibility and communication patterns) and expectations regarding how the new software would alter these. Subsequent interviews followed up on these themes and included new questions suggested by information from previous interviews. One of the broad themes that emerged from the data (rather than our initial questions) concerned issues of control, and we started to explore this theme in greater depth Field notes and interviews were transcribed, and coding has been on-going. Starting with some broad codes suggested by our research questions, we now have 48 codes that we have grouped into ten broad categories.

The Case Study – Observations of Intended Outcomes

We start by presenting some findings related to the first question addressed in this paper, specifically ways in which a newly implemented SAP system enabled organizational control. As discussed below, ERP systems improve accounting control by increasing visibility in terms of both the amount of information and the speed at which it becomes available. This increased visibility of all aspects of an organization's business processes is one of the major benefits organizations expect from their ERP investments.

At ACRO, with 20,000 employees and world-wide distributed operations, coordination and control issues and their financial implications are a major concern. For example, because of the high cost of the precision products and their component parts, and the long lead times required to obtain many items, inventory costs are a large portion of budgets. Controlling inventory costs requires information about planned orders from customers, the components needed to build each ordered product, and the availability and location of these components now and in the future. As the following examples show, visibility to such information did increase as intended, and the expected control benefits were realized.

In the first example, a person in materials explained how the system encouraged care and discipline:

> You have to make sure that you do what you're supposed to do….Before when we did something to configure a bill of material, it wasn't talking to other systems, so if you made a mistake, it wasn't going to stop somebody over there. It may not have been absolutely correct, but as long as they were building to the right configuration, everything went out. But now if something is not right here, it's going to affect [somebody] over on the assembly floor….Everything is out in the open. I think things are starting to be done the way that [they] should. The material is coming in in a timely manner now….You can't have what you call "in transits" hanging out there forever. There are reports that are drawn now that show exactly what's in transit….Everybody is driving to clean that stuff up….
> Q. Who looks at those reports when they come out?
> A. Everybody in materials, from higher management down….

Finance was also pleased with this easier access to information. With SAP they have visibility to transactional information as it occurs and no longer have to wait until the end of the process to receive it, which means they can catch errors earlier, and prepare invoices as the product is made. Improved visibility was also credited with improving planning of purchases for inventory:

> What SAP is going to give us is the ability to build databases that show piece part scrappage. So you can predict, if this part scraps out 50% of the time, and I'm going to have 10 shop visits of that model over the next six months, I know I need to position material here – five of these pieces. That's the beauty of SAP, is that it will give us (inaudible) planning to manage our inventory. And I think out of all the things that I have seen, that's the best thing. Also labor, it has the ability to put in standard labor by module, hours, and then you can run reports to see where you are on a daily basis. It's not the end of the cycle. You can run that [product item] and say, "Okay, tell me that this module is finished and complete, so how many hours was it?" And if it's over your threshold, you can go to the floor very quickly and say "You were 400 times over on your hours. I need to know what happened." And engineering will know within a certain time period what happened. Oh I did a service bulletin, something scrapped out late, we had to penetrate deeper, all sorts of things that can happen, you can document it. But if you wait to the end of 30 to 60 days, you're going to go, "Oh my, I don't know what they did." (Interview with controller, repair facility.)

Increased visibility not only served as a tool for better control of inventory, it also gave workers greater access to information with which to make decisions and meet customer demands. For example a customer representative who regularly fields calls from customers on topics outside his area, such as billing or invoices, used to feel frustrated because the best he could do was redirect the call. Now he can usually answer questions on the spot because the information is available in SAP. In a second example an inventory planner was delighted that he now had visibility to world-wide inventory information, which was particularly valuable when there was a critical shortage. "…before we didn't have access to information like that. We had to go to either our spares group or call each place, where now at a flick of a button you can grab that information."

The Case Study – Observations of Unintended Consequences

In addition to these intended and desirable outcomes, there were also unintended consequences of enhanced visibility and other controls. Where these unintended consequences created problems, either for individuals or for the organization, a variety of responses, both sanctioned and unsanctioned, were observed. In general, as is discussed more fully below, problems arose because of different requirements across organizational locations and functions for the way data was defined, its timeliness, and its accuracy.

In several instances increased visibility to transactional data, which was intended to support better planning, ended up being confusing or difficult to interpret. For example the legacy MRP system, which specified what items to order based on the parts required for upcoming assembly plans, used to run once every two weeks. The data was already out of date – neither timely nor accurate – when it became available. With SAP the MRP schedule could be published every day, which was helpful for internal planning. External suppliers, on the other hand, who used this information to plan their own production, complained about the unstable schedule.

In general the problem was that as visibility increased, more people had access to data in its early forms, before the values were complete and accurate. While local managers wanted greater visibility to real-time data to better control operations, there was some concern that these data were partial and not sufficiently accurate as the basis for decision-making elsewhere. With localized legacy systems, people close to the source of the data are generally in a position to assess whether data is provisional or firm. An ERP system broadcasts information to individuals farther from the source, and so less able to judge its validity. In the end, in the example above, the decision was made to return to bi-weekly reports to external suppliers.

In other cases increased global visibility led to a loss of local control. For example increased visibility to inventory data was intended to improve access to and usage of global supplies (and so lower inventory costs), but this removed local control, which led to local inefficiencies (and so increased production costs). In the legacy systems, local organizations had control over their own inventory and could order a few extra pieces to cover accidents or part failures. Under SAP the inventory is held in a warehouse, and only the parts listed on the bill of materials for imminent assembly can be ordered. Without the "safety" inventory, periodic failures lead to production delays. As a response, some engineers are building in "extras" on the bills of material, which reduces their accuracy and increases inventory.

While the examples above reflect a simultaneous gain and loss of control related to the tension between global and local needs, the next example examines issues that arise between different functional areas. SAP gives everybody access to the same information at the same time, but this necessitates identifying a common definition for data. Whatever the definition is, it is more appropriate for some functional areas than others. For example, because of the way finance wants to record costs, an item is considered the responsibility of a manufacturing cell only once an operator records labor hours, which may happen hours or days after the product has physically moved to that cell. Until work starts in the cell, the system records the product as being in the previous cell. For products with varied work flows, manufacturing has much more difficulty finding items. The system provides accurate visibility to accounting, but reduced visibility to those on the manufacturing floor. The consequence was an increase in the amount of work needed to perform some manufacturing jobs. Their response was to start generating private stocks of data visible only to themselves. Had the definition been changed to support manufacturing, the information would not have provided finance with the information it requires.

Even within one functional area, such as production, controls might support certain organizational objectives while subverting others. Legacy systems typically lag the actual work – they are purely historical systems of record. For example a worker may fill out a form to requisition inventory. At some later time, this information is put into the system. As long as there is a lag between a transaction or event occurring and when that event is entered into the system, there is no real-time visibility to operations. To promote real-time visibility SAP has procedures to ensure that workers do not work ahead of the system. Because the complete information may not be known, or the person with the authority to make the transaction may not be available, this information requirement may lead to a work stoppage.

Another form of control implemented by the company was to require that data from different sources match – e.g., in the receiving area the arriving item must match a purchase order. The intention was to improve control over financial transactions. The assumption was that data would be error free, so legitimate transactions would go through smoothly. Because simple human error and mechanical failure are inevitable, the consequence of these controls was that legitimate transactions were sometimes problematic. A common reaction to problems was to set such items aside. Because the problems were not addressed, a further consequence was loss of visibility to these items, leading to production delays. One response (aligned with the original intentions)

was to increase manpower to focus on resolving problems. Another response, which undermined the controls, was to order additional items in response to production delays.

In the final example, increased visibility led to decisions to delay data entry, reducing its timeliness, and ultimately reducing visibility. Early planning information may not be accurate and might need to be changed over time, but SAP assumes correct information and provides poor support for changing information. For example, to order any material for a customer order a bill of materials for the entire order is required. This means the bill of materials must be finalized as early as the earliest lead-time for a part within it. Unfortunately ERP systems such as SAP do not readily accommodate the reality that some data, such as customer orders for the next year, are not perfectly accurate, nor that product design can change even after production has started.

Since most transactions in an integrated system have automatic ripple effects in other functional areas, reversing an action involves not just undoing the action taken, but also undoing all the secondary effects. To avoid having to reverse transactions, users are reluctant to enter estimated data. Customer service managers at one facility used to enter an order as soon as possible, and update it as new information became available. Once SAP was implemented they began to create orders on their own computers, and not enter them into SAP (and so not making them visible) until the last possible moment. Of course waiting for more accurate information reduces the planning advantages that early information is intended to provide. As another unintended side effect, even their fellow local users who previously had visibility no longer have visibility.

Discussion

In this study we investigated the ways in which ERP systems enable and inhibit organizational control, how stakeholders respond to these enabling and inhibiting aspects of control, and the actions and processes by which forms of control evolve. Our case study observations show both aspects that enable more control and aspects that inhibit and decrease managerial control. Furthermore, the same ERP characteristic can both increase and decrease control, leading to paradoxical outcomes.

For the intended consequences, stakeholders are generally pleased with the added visibility and control and use the new information to better respond to customers and to better understand the business to make better decisions in the future. It may be too early yet to know whether these intended consequences will produce less desirable consequences. For example financial controllers may learn to use their new visibility to organizational operations to engage in much closer oversight of daily activities, thus limiting worker autonomy. For the unintended consequences, we observed the start of private stores of information, delayed entry of information into the system to increase its accuracy, and a search for ways to order extra parts.

At this point in our study we have seen the early stages of how control evolves over time. From the initial creation of new controls we saw either a reversal (e.g., switching back to publishing information to suppliers on a less frequent basis) or a response that left some planned controls in place, but removed controls elsewhere. We expect to observe additional examples as we continue our interviews.

Contributions to Theory

The paradoxical effect of ERP systems on organizational control, as described above, is largely related to these systems' integrated nature, together with the flawed assumption that the same data will serve many purposes. We suggest a framework that relates different dimensions of data to different types of integration for examining some of the contradictions an ERP system introduces. We identified three dimensions of data, namely the way it is defined, its accuracy, and its timeliness, all of which need to be standardized to effect control, and at the same time need to vary, depending on the organizational perspective of the data user. An ERP system integrates organizations across geographic locations, across functional boundaries, and across the different stages of organizational activity, from planning through operations, to post-hoc assessment. By considering these three dimensions of integration, we can identify some of the specific paradoxes of control associated with ERP systems.

From a geographic perspective, a major tension is between the appropriate levels of data accuracy and timeliness. Early information can be inaccurate, while it takes time to ensure accuracy. Locally, an operation needs control information on a real-time basis, which calls for timeliness. Local personnel can fairly easily assess which data are valid and which are estimated, so they are prepared to forgo a degree of accuracy to achieve timeliness. A more distant location, however, would normally prefer to wait for correct information.

Across functional areas, control issues arise over different preferences for the way data is defined. For example finance needs a way to establish "ownership" of an item in order to determine when a sale was made or the item was received or shipped. For this reason, at ACRO location was defined by ownership, that is, location only changed when ownership changed. Production, on the other hand, would prefer to define location in terms of physical locality, not ownership.

For the different stages of organizational activity, we again observed issues related to timeliness and accuracy. For example, in a planning context people regularly work with estimated data, but they expect it to be timely. On the other hand those who report on outcomes or are responsible for evaluating performance need the data to be accurate. While everyone would like both, and the vendors of ERP systems suggest that both will improve, in general there is a trade-off to be made (Ballou and Pazer, 1995). One of the constraining factors with systems like SAP is that they implicitly assume perfect accuracy, and to maintain data integrity, make it difficult to alter information as new data arrives. As a result, timeliness and the associated control benefits are often compromised.

Controls that ignore the complexity of organizational objectives may stimulate unexpected and inappropriate responses. While these contradictions have always existed, the implementation of ERP systems highlights them through integrating across an organization's internal boundaries. Where loose coupling was previously used to mask some tensions, an ERP system introduces a transparency that brings them to the fore.

Managers have always recognized these tensions, and indeed the art of management is to strike an appropriate and dynamic balance. In general, "ignoring the contradictory nature of organizations may be dysfunctional for managers and researchers" Quinn and Cameron (1988, p.13). Unfortunately the rhetoric surrounding control has rarely explored its dialectical nature. With an ERP system these issues can no longer be ignored. Our study is one of the first that examines the dialectical and paradoxical nature of control. This paper represents a step toward a richer theory of control that is theoretically sound and also provides insight for managers attempting to balance the tensions involved in ERP systems and the emerging dynamics of control they enable and inhibit.

Contributions to Management Practice

In the context of an ERP implementation this is a central issue that managers must address, and leads to some implications for managers. First, in deciding to invest in an ERP system, managers must recognize that while the specific benefits and enhanced control they anticipate from increased visibility may indeed be realized, additional costs are likely due to various unintended consequences. While these outcomes are unintended, they should not be unanticipated. Many organizations work hard to accommodate the different needs of various functional areas during an ERP implementation, but they also need to consider the different dimensions of the data and the different control tasks.

Second, in introducing such a system, managers must acknowledge that while the organization as a whole may benefit, certain individuals and departments may be somewhat or even significantly worse off. Providing these groups with additional resources, or changing the reward structure to reflect a new balance between conflicting objectives (between speed and accuracy, for example) will smooth the introduction of such a system. Finally, designing the system in a way that explicitly addresses the conflicting objectives must be accompanied by training that similarly emphasizes the increased interdependence of different functional areas and the resultant necessity for changes not only to tasks but also to priorities.

Conclusion

In this paper we have not only highlighted the paradoxical nature of the control problem inherent in an ERP implementation, but we have also provided some specific examples of the type of problems that may arise, and that managers need to address. As this study is ongoing, our findings will be refined as we continue to collect and analyze our data.

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