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Institutional conformity and technology implementation: A process model of ergonomics dissemination

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Abstract

This paper examines the process of implementation of work-place ergonomics within thirteen plants of the largest division of an automobile manufacturing firm. The process began as plants reacted with varying degrees of conformance to institutional pressures to utilize ergonomics in job design. While all thirteen plants to some degree "adopted" an ergonomics program, varied conformity reactions were manifested in different internal processes which in turn led to different types and levels of implementation. A grounded theory approach was used to build an overall process model that encompasses all plants' processes. Based on the model, ergonomics adoption is viewed as a value-laden process. The internal organizational consequences are then discussed in terms of contrasting types of internal goals, strategic structures, and implementation approaches. Theoretical as well as practical implications of the model are presented. A new direction for future research in the field of technology adoption and implementation is proposed.

Keywords. Technology implementation, Technology adoption, Organizational culture and change, Institutional theory, Ergonomics, Human factors.

1. Introduction

The Occupational Safety and Health Administration (OSHA) has begun to issue heavy citations to manufacturing companies that knowingly fail to reduce ergonomics-related health risks. For instance, The New York Times, Business, August, 1988, reports that OSHA has fined meat packing companies on the order of several million dollars for failing to improve potentially unhealthy ergonomic conditions. Due to increasing media coverage, the public has also become more aware of ergonomically related disorders such as the Carpal Tunnel Syndrome (CTS). Moreover, as the existing labor pool is ex-

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pected to decline drastically in this decade (Jackson, 1989), more corporate energy is expected to be spent on maintenance of health of existing workers. For example, in 1990, Pacific Bell launched an $8 million program to reduce stress and strain among workers who use video terminal displays (VTD) (Bureau of National Affairs, 1990). Ergonomic issues are, therefore, expected to play an important role in corporate strategy making, not only to avoid heavy fines and damaging publicity, but to alleviate the impact of the workforce transition.

It has been argued that ergonomics research is essential to understanding "human-at-work" systems and "stress–strain" relationships in the work place (Rohmert, 1986). Many researchers have studied ergonomics as an approach to reducing work-related stress (e.g., Ferguson, 1973; Murphy, 1984; Hawkins, 1987; Melamed et al., 1989). However, the research scope of its organizational implications has been limited to the participatory aspect of its implementation (e.g., Chaney, 1969; Joseph et al., 1986; Pope, 1987; Liker et al., 1990; Orta-Anes, 1991).

The degree of cooperation between management and workers on work environment and work place designs is noted as an important factor influencing the implementation of ergonomics (Kvalseth, 1980; Liker et al., 1984; Majchrzak, 1988). The participative approach to ergonomics implementation has been shown to be successful in a number of industries in different countries (Noro and Imada, 1991). The literature, however, largely lacks discussion of the organizational process through which the purported success has been achieved. To the best of our knowledge, no study has been conducted to-date on the overall process of how ergonomics is disseminated and implemented in organizations.

The purpose of this paper is twofold. One is to develop a process model of ergonomics implementation in manufacturing environments. The other is to elucidate elements of the process which influence the effective utilization of ergonomics tools and knowledge. By doing so, we hope to make practical as well as theoretical contributions. To some degree the insights gained from this study should be applicable to technology implementation in general, though ergonomics has some characteristics that set it apart from other types of technologies.

There are at least three features of ergonomics that make it interesting for the study of implementation of technology. First, it is intended by its creators to positively influence both the technical and human systems of work. That is, if properly applied, ergonomics methods should improve the technical quality and efficiency of production while making jobs safer for the worker. Second, application of the technology is characterized by a high degree of uncertainty and "equivoque" to use Weick's (1990) term. While for some ergonomics tools there are clear guidelines on what is acceptable and unacceptable, for others it is a judgement call. For example, OSHA has no formal quantitative standards to identify unacceptable ergonomic conditions. Moreover, the benefits of ergonomic improvements may not be visible for many years after implementation and there is not a clearly measurable cause-and-effect relationship between implementation and outcomes. Third, ergonomics as a body of technology has been very underutilized in industries. The lack of implementation has been the main basis for OSHA citations. OSHA has been determining negligence in ergonomics through "willful violation", identifying cases where companies failed to implement improvements to known ergonomics problems. For example, OSHA has uncovered instances in which plants had outside consultants identify ergonomics problems but did not take any actions to improve the jobs.

The paper is based on qualitative field research in thirteen plants within the same division of a large automotive manufacturer. We compare and contrast the different implementation approaches tried by these plants and their consequential outcomes. Hendrick (1986) and Geirland (1989) point out that past research in ergonomics has focused largely on technical and engineering aspects and little on the implementation of ergonomics in organizational context. Our process model will describe the organizational dynamics of implementation activities and their implications for broader theoretical issues.

2. Literature review

The term *ergonomics* derives from the Greek words *ergon*, work, and *nomos*, law. Ergonomics, then, means laws of work or, by extension, rules or principles of physical or mental activities. Ergonomics concentrates on the cognitive and physiological effects on individuals of the technologies in their environment (McCormick and Sanders, 1982). McCormick and Sanders define the goal of ergonomics as "to guide the application of technology in the direction of benefitting humanity" (p. 4). In this light, ergonomics may be regarded as a technology to guide technology, by setting design and job set-up guidelines based on the principles of human factors.

Work-place ergonomics is a special subfield of ergonomics. It typically focuses on repetitive manual labor in the work place. In the cases in this field research, it mainly focuses on the physiological limitations of workers, beyond which, if repeatedly exerted, some serious negative health effects may be incurred. Some examples of negative effects are irreparable physical damages such as loss of hearing or severe back pain. It concentrates on transforming the adverse job conditions that could inflict physical damages to workers into a friendlier configuration that will keep workers within their natural physiological inclinations (Chaffin and Andersson, 1984) to better handle work stress and to maintain physical health. Work-place ergonomics, thereby, advances the idea of fitting jobs to workers, not workers to jobs.

In this paper we view "ergonomics" as a set of technologies for improving the workplace and as an interesting example of technological innovation in the workplace. While technology is often thought of as hard tools and equipment, Tornatzky and Fleischer (1990, p. 12) define technology more broadly as "tools or tool systems by which we transform parts of our environment, derived from human knowledge, to be used for human purposes". In accordance with this definition of technology, ergonomics as a field of academic inquiry has developed a scientifically based set of tools for transforming the workplace so it is more suitable for humans in the system, mainly from physical and psychomotor perspectives. The available ergonomics tools range from biomechanical lifting criteria to psychophysical and metabolic work criteria (Chaffin and Ayoub, 1975; Garg and Ayoub, 1980).

The literature on implementation of technology more generally is both voluminous and heterogeneous (see Tornatzky and Fleischer (1990) and Majchrzak (1988) for reviews). Quite often, this literature focuses on one level of analysis. For example, there are numerous studies which look at the effects of user participation in the implementation of some form of information technology (King and Rodriguez, 1981; Baroudi et al., 1986; Franz and Robey, 1986), but these studies stay at the level of the individual user providing little understanding of the broader organizational processes involved. There have also been studies that look at the characteristics of firms (e.g., size, formalization, core technology) that predict their adoption and implementation of technology (e.g., Collins et al., 1988; Collins et al., 1992), but these studies generally stay at the organizational level and make little sense of the internal dynamics of the firm.

There is, of course, literature that discusses the within-organizational dynamics of technology implementation. Tornatzky and Fleischer (1990, Chap. 9) summarize the literature in this area. They present four different perspectives on technology implementation: the technocentric perspective, which focuses only on the technical aspect of technology; the sociocentric perspective, based on the organization development (OD) tradition; the conflict/bargaining perspective, which addresses the political dynamics of implementation; and the systems design perspective. What is notable in this summarization is Tornatzky and Fleischer's choice of level of analysis. They choose a-priori the level of organization as the level of analysis, arguing that it subsumes all levels below. Indeed, this broad-brushing of all intra-organizational dynamics under the level of organization tends to be a general tendency of the literature in this area. For example, Walton (1989) develops a model of information technology implementation based on a wide range of case examples. His model can also be called an organizational level model because to develop it he uses data from individual level to organizational level. An explicit differentiation and integration among the different levels within organization seems to be lacking.

The explicit differentiation of intra-organizational levels is crucial in avoiding "biases of misspecification and aggregation" (Rousseau, 1985). For example, it would be wrong to mix managerial-level with organizational-level phenomena or to assume managerial-level phenomena apply at the worker level. In our model, we make distinctions among processes at three different levels within organizations. We distinguish processes with manifest consequences for individual workers, those for middle-level actors, and those for top union and management leadership. The *individuals* signify workers whose jobs are ultimately affected by the process; the *middle-level actors* signify implementers who analyze jobs, design the necessary changes, and oversee the implementation; and *top leadership* means plant-level management and/or local union leaders.

We first separately discuss the impact of exogenous pressures on these three levels—top leadership, implementers, and workers. Then these separate discussions are joined into an overall process model as we discuss the effects phenomena at one level have on those at another. We call variables that affect variables at different organizational levels "cross-level" variables, and the overall process model the cross-level model.

Our research method is largely inductive, taking a grounded theory approach (i.e., Glaser and Strauss, 1967; Miles and Huberman, 1984; Patton, 1988; Eisenhardt, 1989; Yin, 1989). The method was viewed as appropriate because ergonomics is a relatively new technology, at least in practice, which has not been extensively studied from an organizational perspective (Hendrick, 1986; Geirland, 1989). Thus, our focus is on building an empirically-based model of the process of implementation (Strauss and Corbin, 1990), not on the statistical verification of hypotheses.

Following the logic of induction, we describe the research process first and propose our model second. We realize that this leads to a non-traditional paper flow, but it seems most compatible with the logic of grounded theory. In accordance with Eisenhardt's (1989) recommendation, we relate emergent concepts to prominent existing theories (e.g., institutional theory (Meyer and Rowan, 1977), enactment theory (Weick, 1979), theories of participative management (Lawler, 1986), etc.) as we present the model and discuss our findings.

3. Method

3.1. Background

This paper examines the process of implementation of work-place ergonomics within the plants of the largest division of an automobile manufacturing firm. This division is responsible for body stampings, final vehicle assembly, and some trim items and had been in pursuit of ergonomics since 1983. The division and corporate management as well as the national union promoted the general value of ergonomics to plants. The plants were urged, but not required, to implement ergonomics programs. Our research took place in the fall of 1988, just prior to the launching of a corporate-wide, mandatory program in December of that year. Thus, we studied the implementation process within the period when the adoption was voluntary at the plant level.

As Tornatzky and Fleischer (1990) point out, the boundary between adoption and implementation is fuzzy. In our study the thing to be adopted and implemented was an ergonomics program. We view plants as having "adopted" an ergonomics program when the plant leadership (generally management working with union leaders) decided to set up an ergonomics program and assigned ergonomics to some formal structure. Thus, charging an industrial engineer with the task of applying ergonomics or setting up a committee to work on ergonomics would both mark the adoption of an "ergonomics program". The processes that occurred within the plant from this point on to apply ergonomics knowledge and tools to the design and improvement of jobs are all viewed in this study as part of implementation of the ergonomics program.

The implementation activities of ergonomics entailed improving adverse job conditions. They were largely focused on the redesign of existing jobs. Ergonomics considerations can, at least in theory, come into play either at the initial design phase of the workstation layout or at the redesign phase while the work is in process. Whereas improving at the design phase is highly recommended (Joseph, 1986), it often does not happen that way, especially in an organizational context with an extensive division of labor among engineering specialists in which human factors specialists (if they exist) are among the least powerful actors. (See Perrow (1983) for a discussion of the general state of human factors engineering.)

We, therefore, focus the scope of our inquiry only on those improvements at the *redesign phase*, after the plant operation was already set up and in production. Virtually all of the activities of the implementers revolved around the redesign of existing jobs. Some plants systematically worked their way through production lines, generally finding some opportunity for improvement on each job, while others focused only on selected jobs known as "problem jobs", while still others picked a few generic improvements that would affect a large portion of the workforce.

All plants were unionized and were represented by the United Auto Workers (UAW). The level of involvement of local union leadership varied. The plant-level union in most cases was in some way involved in the implementation process at all three organizational levels. The union generally sympathized with the humane goals of ergonomics, while showing some concern over the potential for management to use ergonomics to justify head count reduction or tighter production standards. Even in some cases where the plant-level management and union had a traditional, adversarial relationship, the union at least took a "hands-off" approach to the ergonomics program and did not hinder in any major way the process of implementation. We observed in general that the level of involvement of the line workers in the implementation process was directly proportional to the level of the local union support.

3.2. *Organizations and informants*

Thirteen plants constituted the sample for our investigation. Each plant selected for this research met one simple criterion — it was known to have adopted a formal ergonomics program (beyond simply sending people to training) in the period between 1983 and 1988. A division-level internal audit of ergonomics programs had been conducted by the company just prior to our study and was provided to us as a basis for sample selection. There were 17 plants identified as having some formal ergonomics program, and 13 of these plants were included in our study. The four plants we did not include were those that did not respond to our letters and phone calls. We acknowledge that our theory building effort may suffer from having truncated the sample by not including the plants that did not adopt ergonomics. We chose plants with existing ergonomics program mainly because we were more interested in building a theory of implementation than a theory of adoption.

Summary data on the 13 plants are presented in Table 1.[1] The sample plants ranged from plants which made fewer than 5 job changes as a result of the ergonomics program to plants which made over 100 job changes. The age of the programs as of 1988 ranged from 2 years to 5 years. As shown, plants S1 to S5 were Stamping plants that stamped out car body panels and structural members and welded parts together; plants A1 to A7 were Assembly plants that assembled parts and painted final automobiles; and plant T1 was a Trim plant which sewed and assembled automotive seats.

Despite the difference in the number of years into the program, all plants had sent some people to corporate-sponsored ergonomics training, set up some formal structure (or assigned ergonomics to an existing structure) and as a result had done some work on ergonomics. The plants chose different ways to organize their ergonomics programs since the division usually gave no advice on how to structure their programs. This meant that we were going to observe a wide variety of implementation styles. The consequences of these varied implementation experiences was what we were seeking to understand.

A few of the plants had very recently (within the six months prior to our visit) reorganized their ergonomics programs in anticipation of the new corporate-level program which explicitly specified the use of ergonomics committees including equal union and management representation. In all of these cases the committees had rarely met and accomplished little by the time of our interviews (e.g., they had been trained but did not meet during summer

[1]The names of the plants have been coded to insure anonymity. The assigned numbers will correspond to each respective plant in the remainder of this paper.

TABLE 1

Overview of 13 auto manufacturing plants

Plants	Top leadership support[a]	Approximate number of implementers[b]	Approximate number of ergonomic job changes	First year of ergonomics program	Number of informants
Stamping					
S1	strong	> 20	> 100 unique changes[c]	1984	4
S2	none	6	2 unique changes 1 generic change[d]	1987	6
S3	weak	2	1 unique change	1987	6
S4	weak	1	10 unique changes	1987	5
S5	weak	3	< 5 unique changes	1985	7
Assembly					
A1	strong	> 10	> 150 unique changes	1985	4
A2	strong	> 10	> 150 unique changes	1985	5
A3	weak	4	10 unique changes	1983	5
A4	weak	2	5 unique changes 1 generic change	1985	4
A5	moderate	5	30 unique changes 1 generic change	1983	5
A6	strong	2	2 generic changes 5 unique changes	1984	3
A7	weak	4[e]	15 unique changes	1983	5
Trim					
T1[f]	moderate	3	1 generic change	1985	5

[a]Top leadership refers to management leadership and/or local union leadership.
[b]Implementers refer to all people in the plant directly involved in redesigning the jobs and acquiring resources for the actual implementation.
[c]Unique change implies individually-tailored changes for each job.
[d]Generic change implies a type of change that affects a group of jobs.
[e]This is the number of the original ergonomics implementers in this plant, before the agenda of ergonomics was absorbed by the automation committee in 1984.
[f]At this plant, three projects were selected and one implementer was assigned to each project. Only one of the three projects was actually implemented.

changeover to a new car line). Thus, in these cases we focused on the organization and outcomes of the program prior to the reorganization.

To pave the way for our research, a division-level executive sent each plant a letter stating that we would be contacting them for the purpose of gathering information on their ergonomics program. Lest plants should be reluctant to cooperate, the letter stated clearly that our visit was not intended to be an audit of their program. Subsequent phone calls were placed to each plant by the researchers to set up mutually acceptable visitation dates and to gather initial data on its program structure and key actors. Plants were asked to identify and provide all key actors involved in their ergonomics program for interviews.

3.3. Data sources

All data were gathered in visits to the plants in 1988. Thus, data collection was retrospective. This research relied primarily on three data sources: (1) semistructured interviews, (2) documents, and (3) observations.

Semistructured interviews

An interview tool was developed, based on our early experience with a stamping plant and an assembly plant (discussed below) with which the university had been involved in developing an ergonomics program (Liker et al., 1989). It consisted of 15 open-ended question categories, focusing on various aspects of the program process. There was no fixed wording used to inquire about these variables. We let the conversation flow at its own pace, and since this was an inductive study, we often pursued unexpected, but interesting lines of discussion (e.g. Sutton and Callahan, 1987). However, in the end, we made sure we covered all of the variables in our interview tool. The interview process in general lasted from 4 to 8 hours, during which time we would interview one or more groups of informants. In several cases we made return visits in order to pick up other key informants mentioned by those interviewed. We stopped interviewing when no more new information was forthcoming: it marked our data saturation point (Glaser and Strauss, 1967).

Documents

The ergonomics training records, lists of job changes, minutes taken in the ergonomics committee meetings, and memos from the division office were gathered and used to add information. Access to these documents was largely dependent on the plants' record keeping effort.

Observation data

We were taken on plant tours at all plants to see the ergonomics changes in action. We were able to see how some of the changes noted on paper were actually implemented or not implemented. We saw how workers responded to the changes in some cases and how in other cases, they just ignored the changes made. An example of this is workers pushing an ergonomically designed hoist off to the side and manually loading a machine.

Prior involvement with plants

The second author had prior involvement as a consultant to assembly plant A1 and one stamping plant S1 (see Liker et al., 1989) helping to develop the design of the program and providing graduate student technical support to ergonomics committees. Both of these plants had participative, team-oriented programs and were among the most active in making ergonomic improvements. One might argue that the success of these two plants was attributable to the involvement of an outside consultant; however, most of the plants were assisted to some degree by university faculty and graduate students acting as consultants. For example, the trim plant T1 had extensive faculty involvement acting as outside experts and the plant only changed one aspect of the plant — seats for sewers — which were intended to be changed anyway.

3.4. Data analysis

The method of analysis used here is based on recommendations by Patton (1988) of generating initial sets of variables and generating grounded theory as described by Glaser and Strauss (1967) and Miles and Huberman (1984). The basic approach involved three stages of data collection and analysis: (1) transcribing notes of two researchers at the end of each plant visit into a case record, (2) forming a theoretical disposition, continuously comparing emerging concepts against data, and (3) modifying the theoretical disposition whenever deviations occur. This iterative procedure was repeated until an adequate conceptual framework emerged.

As recommended by Van Maanen (1983) and practiced by Harris and Sutton (1986) and Sutton and Callahan (1987), our analysis was concerned more with identifying theoretical elements that were similar across all plants than those that remained peculiar to a plant. However, when a case was observed that contradicted the general model, the case was not discarded but rather was regarded as the source of a new perspective (Poole and Van de Ven, 1989).

The data analysis consisted of variable definition, coding, bivariate data plotting, and model building. First, we identified a set of key variables that seemed to distinguish common processes and outcomes at different plants. These variables were first nominated as we visited the plants and subsequently underwent iterative revisions as more data were collected. We then defined the key variables in terms of their bipolar endpoints (e.g., participative versus expert driven).

Second, coding was done by both authors who independently classified plants on each of the key constructs, then discussed the results, and reached consensus on the classification of each plant. We found that we could not identify all plants as fitting either one or the other pole. For example, when we attempted to classify plants as using either expert-driven or participate approaches to job design, we found that some plants had a strong degree while others had a moderate degree of worker participation. We thus distinguished the level of participation into no/weak participation, moderate participation, and strong participation. We also found that some plants used a combination of participative and expert-driven approaches so we coded them as having both. The resulting variables and the coding of each of the thirteen plants are shown in Table 2, adopting the format of the "cross-site table" recommended by Miles and Huberman (1984). We did not attempt to compute inter-rater reliability of the two coders as the coding evolved through an iterative process (i.e., coding, discussing the results, then recoding, etc.). We felt for these exploratory purposes the benefits of discussion throughout the coding process outweighed the benefits of coding all cases independently then computing reliabilities.

Third, following the advice of Miles and Huberman (1984, Chap. 5) we constructed scatterplots showing the relationship between selected pairs of variables. We present examples of these in the Final Process Model (Section 6) to highlight a few key relationships (Figs. 2–4). The plotting of each plant was based on judgements of where the plants stacked up relative to each other on each of the variables coded. On a 2×2 matrix, we marked each axis with a variable — the antecedent variable on the vertical axis and the consequent variable on the horizontal axis. We then placed each pole of the variables at each end of the axes: the bipoles of most of the variables describe a continuum (i.e., typically going from one end of a pole to the opposite direction decreasing in strength, becoming zero at the mid point, and then increasing in strength towards the other pole). The placement of plants in the 2×2 space was based on our original coding plus judgements as to the relative location of the plants with respect to the others. For example, in Fig. 2 Plant 6 was slightly less participative than Plant 1 so we placed it slightly toward the expert pole. (See Miles and Huberman (1984) for further illustrations of qualitative scatterplots.)

Fourth, we began to put the related variables together into an overall process model. This again was an inductive and iterative process based on a grounded theory methodology, not on a deductive multivariate causal modeling approach.

Despite our efforts to be rigorous in our data analysis, we need, however, to qualify the degree of representativeness of our final model in terms of its fit with evidence. As discussed above, the final model focuses on the patterns that were similar across plants rather than particularistic patterns. As Sutton and Callahan (1987) note, we too acknowledge that just as a quantitative researcher does not expect a set of independent variables to explain 100 percent of the variance in a set of dependent variables (Mintzberg, 1979), the proposed model fits well with the evidence but not perfectly.

We now start presenting our findings by introducing a model that represents the process of ergonomics implementation as four stages. These four stages were generic across the top leadership, implementer and worker level so we refer to these as the within-level processes. The concept of "stages" is similar to Berger and Luckman's (1967) notion of how the reality of actions is internalized by the actors who commit those actions. Once we discuss these stages, generic to all three levels, each level will then be discussed independently in a separate section in terms of its key process variables. Building on the four

TABLE 2

Cross-plant comparison of ergonomics implementation dynamics

Process	Stamping plants					Assembly plants							Trim	Examples of each pole
	S1	S2	S3	S4	S5	A1	A2	A3	A4	A5	A6	A7	T1	
Top leadership level														
Goal	W		c	c	c,w	W	C,W	c,w	c,w	w	c,W	C	W	"We don't make ergonomic changes, unless it helps us automate lines." (C) "We really wanted to help the workers feel better at the end of each day." (W)
Structural arrangement	T		s	s	s	T	S,T	t	S,t	t	S	t	s	"We decided to hire an ergonomist to lead our program." (S) "We sat together with union reps. and figured out who was going to be on the ergonomics committee." (T)
Implementer level														
Jointedness	L,M	L,m	l,m	m	m	L,M	l,M	m	l,m	l,m	l,m	m	m	"We (the local union) support ergonomics because it is going to help the workers." (L) "The top management is 100% behind ergonomics. They gave us their commitment." (M)
Internal pressure	G	G	i		i	G,i	G,I	i		g	I		i	"We get together to discuss ergonomics problems on our own time if things get busy on the floor." (G) "I am committed to ergonomics. I even work on ergonomics on my own time". (I)
Job analysis	Q	e,Q	e	e	e	e,Q	E	e	e	e	E	e	E	"I run the computer program before we make any changes." (E) "A lot of ergonomic solutions are common sense. We do a lot of brainstorming." (Q)
Design approach	P	p	e	e	e	P	e,P	e,p	e	e	E	e	e	"Workers come to me with problems and I do the best I can do to help out." (E) "We always talk to the worker before we finalize any kind of change." (P)
Justification approach	B	b,r		r	r	B,r	R	b		b	r	R	R	"We never have to prove anything in numbers as long as it is an ergonomics change." (B) "We have to show on paper how much money this change is going to save the company." (R)
New job design	g,U	g	u			g,U	g,U	g,u	u	u	G		G	"We replaced all the old floormats with the new, impact-absorbing floormats so that the workers' feet won't hurt so much." (G) "We look at one job at a time." (U)

Worker Level														
Involvement	P	P	p			P	p,r	r	r	r	P		p,r	"We ask workers to voice their opinions as soon as we start redesigning their jobs." (P) "When workers complain about the job changes, we then try to make the additional changes." (R)
Attitude	A	A	*			A	A,r	a	*	a	A		a	"Workers are in general very happy with the changes." (A) "Some workers plain refuse to use the new ergonomic tools." (R)

Legend for Table 2

Process variables	Poles	
Goal of ergonomics	c = cost benefit	w = worker health improvement
Structural arrangement	s = specialist setup	t = team setup
Jointedness	l = local union support	m = management support
Internal pressure	g = group influence	i = individual influence
Job analysis	e = engineering	q = qualitative
Design approach	e = expert	p = participative
Justification approach	b = belief-based	r = rationality-based
Job design	g = generic changes	u = unique changes
Involvement	p = proactive	r = reactive
Attitude toward change	a = acceptance	r = rejection

Note: Upper case letters refer to strong presence of attribute; lower case letters refer to moderate presence of attribute; and no letters refer to weak or no presence of attribute. An "*" indicates insufficient information.

stages of process and three levels of organization, a final cross-level model will be presented.

4. Four-stage model of within-level processes

In questioning respondents about the history of their programs we identified four sequential stages that occurred overarching all levels within the organization. These four *within-level* stages are included in the model as external pressure, enactment, internalization, and institutionalization. We describe these stages as though they are deterministic, but in reality different plants went through these "stages" in different time spans and the division between stages is fuzzy. As stated previously, we were searching for common, not deterministic, tendencies in the plants visited. For example, Mintzberg and Waters (1990) describe the strategy-making process as a pattern in a stream of actions. We were seeking common patterns, noting interesting variation around the common patterns.

External pressure represents the exogenous impetus for each within-level process. Enactment is the immediate action consequence of external pressure impinging on each level. Internalization signifies the cognitive process contingent on the action taken. Institutionalization (Goodman and Dean, 1982) means eventual organizational consequences pertaining to each within-level process.

4.1. External pressure

A process is a flow of events. External pressures with respect to each level were exerted to set the flow in motion. As in Parson's (1960) discussion on the process dynamics of a hierarchical organizational structure (i.e., manufacturing plants), a hierarchically higher organizational level impacted socially as well as technically the activities of the lower organizational level.

External to the manufacturing plants, divisional and national union leaders sent corroborating messages in public speeches and internal memos that said ergonomics was "a good thing". The divisional leaders even sponsored training available to all plants free of charge. What was interesting in our study was that facing these external pressures, the plants seemed to have behaved as if, borrowing Scott and Meyer's (1983) terms, they were in a highly "institutionalized sector" rather than in a highly "technical sector". This was in contrast to the observation of Scott and Meyer that manufacturing organizations operate in a highly technical sector, based on technical rationality.

When we describe the process of ergonomics adoption as an "institutional process", we mean that the exogenous messages were ambiguous on the exact relationship between the adoption of ergonomics and the purported benefits such as medical and workman's compensation cost savings. They provided no documents that proved ergonomic changes will lead to such benefits. Without concrete verification, the value of ergonomics took on the shape of "institutionally legitimated elements" (Meyer and Rowan, 1977; DiMaggio and Powell, 1983). That is, in the absence of clear scientific evidence of a cause-effect relationship between implementing ergonomics and receiving valued benefits, plants tended to adopt ergonomics to achieve legitimacy in the eyes of the parent organizations — division headquarters and national union. Following institutional theory, we call this external pressure on plants the "institutional pressure".

Consistent with the description by the institutional theorists (i.e., Meyer and Rowan, 1977), top leadership conformed by setting up a "formal structure". It instituted a structural set-up to start the implementation process in motion, and the implementers got activated subsequent to this structural conformity.

The one plant that did not follow this pattern was Plant S2, an aging stamping plant. The plant manager did not buy into ergonomics and take advantage of the division-sponsored training or otherwise seem to respond to division management pressure. But implementers emerged as self-appointed champions of the ergonomics program. The key leader in this case was the appointed UAW health and safety representative who had a background in ergonomics and was active in human factors professional associations. He took it upon himself to contact a professor at a local university, who was not involved in the division-level program, and pay for his consultation through union funds. The health and safety representative managed to gain the enthusiastic commitment of a number of hourly workers who participated on ergonomics committees. With a minimum of formal buy-in of their top leadership they were actively seeking ergonomic changes. This bottom-up effort was unique enough that we single it our for more detailed description in the discussion section later in the paper.

However, in all 13 plants, workers were affected by the dynamics that occurred at the implementer level. The redesign activities of jobs by implementers became the exogenous jolt for the worker-level process. Overall, a form of decision at one level prompted movement at the level below. Therefore, this organizational decision from a hierarchically higher level is called the *external pressure* for the next level process.

4.2. Enactment

The immediate effect of the external pressure on each level is manifested in *enactment* in that level. Consistent with Weick's (1979) enactment theory, action took place first, followed by the internalization of action committed. Weick argues that "acting" often precedes "thinking", contrary to the common notion of thinking before acting. Due to their bounded rationality, human beings tend to act first and then bracket a segment of their experience to internalize or "make sense" of what has happened.

This is what we observed in our cases. We were told on many occasions that when they got the memo from the division and the union president or heard about the ergonomics program at a national meeting, the first thing they did was to organize a joint committee (i.e., team consisting of union and management representatives) or to assign ergonomic job changes to a specialist (e.g., engineer). It appeared to us that they did not have a lengthy discussion about the plant-level purpose of the ergonomics program prior to taking these actions. For example, the top managers and the union leaders alike told us that they knew that they "didn't have to do it but still went ahead and did it" because they "respect" the person who initiated the memo and what he said. In some plants where we made repeated visits, the manager at first could not tell us clearly why they started the ergonomics program. As we made more visits, his level of articulatation about the goals of their ergonomics program increased, an indication that rationales followed action.

At the implementer level, once implementers were trained, enactment took place as job design activities. At the worker level, the action was some level of involvement in the process, ranging from proactive involvement in the design phase to no involvement until the job change was made (see Table 2). Job design activities and worker involvement led to subsequent internalization in each respective level, which will be discussed in the next section.

4.3. Internalization

Internalization at each level involves some sort of mental process contingent upon action taken by the actors at that level. Management justified their action by retrospectively articulating the goals of their ergonomics program. As shown in Table 2, the goal of the ergonomics was expressed in terms of either worker health maintenance, cost savings, or some combination. Without publicly acknowledging that their action was largely due to conformance to institutional pressures, they were looking for reasons for having taken actions, or in Weick's (1979) language they were engaged in "retrospective sensemaking".

Action taken by the implementers gave rise to internal pressure to keep the ergonomics program alive. The internal pressure emerged as a cognitive state of being committed (Salancik, 1977) that to a degree bound individual(s) to their behavioral acts. When implementers met together (when more than one person was involved), their actions reinforced one another and generated greater commitment. As indicated in Table 2, in some cases the internal pressure was confined to one or two individuals, but in others it was extended to a group of people.

Depending on their level of involvement, the worker's willingness to accept the changes seemed to vary (i.e., Kvalseth, 1980; Lawler, 1986). Their attitude toward change is considered internalization at the worker level, based on the definition of attitude as a "value conception" applied to a specific object or situation (Scott, 1965; Rokeach, 1970). In one plant, the degree of acceptance varied between two workers who worked on the same job on different shifts. When the day-shift worker was involved, but not the night-shift worker, in redesigning of the job on which they worked, the former accepted the change willingly but the latter was often disgruntled by it. In other words, the worker's attitude toward a job change was also contingent on the nature of action, in this case involvement, taken. We should note that in general workers' attitudes toward the changes were quite positive and overt resistance comparatively rare as indicated in Table 2. It seemed that the workers generally saw the changes as making their jobs easier and reducing stress.

4.4. Institutionalization

As a result of the preceding sequence of events, varying degrees of *institutionalization* occurred at each level. We introduce three aspects of institutionalization which parallel closely Goodman and Dean's (1982) characterization of institutionalization of organizational change. We discuss below legitimization, socialized elements, and routinization, while they describe social facts, multiple actors, and persistence.

When the plant leaders authorized the goal of ergonomics, they gave "legitimacy" to ergonomics (i.e., Parsons (1960) discusses how an organizational goal leads to legitimization of values associated with that goal). The level of legitimacy correlated closely with how easily implementers were able to "borrow" the tooling and maintenance personnel to work on the proposed changes. In other words, the more ergonomics was accepted as a "social fact", the easier it was to utilize the necessary resources.

As implementers met together for discussions and struggled together to install the changes, they seemed to have developed a new group culture. Smircich (1983) discusses culture as a by-product of people coming together and sharing a system of social cognition. The emergence of this group culture was manifested as new "socialized elements" closely linked to implementation activities. The socialized elements were a set of ergonomically specialized language, shared stories (good and bad), heuristically understood roles as opposed to official titles, ritualistic meetings that they held regularly, and camaraderie among implementers (Table 3 shows the rating of these elements with respect to each plant).

As the worker-level consequence, the job changes were installed. Although all changes were designed to reduce the physical stress level jobs imposed on workers, some changes became institutionalized by becoming a part of the routine, but some changes were resisted or ignored by the worker and just "eroded away" (Zucker, 1988).

TABLE 3

Cross-plant comparison of socialized elements

	S1	S2	S3	S4	S5	A1	A2	A3	A4	A5	A6	A7	T1
Specialized languages	3	3	1	1	1	3	2	2	1	2	3	1	1
Shared stories	3	3	2	1	1	3	3	1	1	2	2	1	1
Indigenous leaders	3	3	2	1	2	3	3	2	2	2	3	1	2
Roles	3	2	1	1	1	3	2	1	1	2	2	1	2
Rituals	3	2	1	1	1	3	2	1	1	1	2	1	1
Collectivity	3	3	1	1	1	3	2	1	1	2	2	1	1

Legend: 1 = weak, 2 = moderate, 3 = strong.

5. Description of the key process variables

The variables listed in Table 4 are a subset of those in Table 2. These were the variables that were most important in describing the cross-level dynamics of the implementation process. We call them the key process variables. They have thus far been alluded to in terms of the singular four-stage within-level process. In this section, we isolate and discuss these variables more explicitly in terms of the three organizational levels. The variables represent for each organizational level the first three stages of within-plant process leading up to the last stage of institutionalization. For simplicity we treat all key process variables as nominal (though most could be viewed on a continuum) and define them in terms of their "poles". We concentrate on the description of these variables and leave how these variables are related to each other for the next section.

5.1. Top leadership level

Structural conformity refers to the ways top leadership responded to external pressures (i.e., conformed) to create an ergonomics program. Some plants conformed by setting up a new structure and some by utilizing an existing structure. This structural conformity was manifested in two types of *structural arrangements*: team structure or specialist structure. In some cases top leadership set up a new structure such as a new joint committee (i.e., a cross-functional team with both union and management representation), a new specialist position (i.e., ergonomist, ergonomics coordinator, etc.), or some combination of the two. On the other hand, top leadership in some cases added ergonomics to the responsibilities of an existing structure, either an existing committee structure (e.g., automation committee) or a staff member (e.g., industrial engi-

TABLE 4

List of key process variables

Level	Variables	Poles
Top leadership	structural conformity	initiation of a new program structure utilization of an existing program structure
	goal of ergonomics	worker health and well-being improvement cost-savings
	structural arrangement	team specialist
Implementer	design approach	participative expert
	job analysis	qualitative engineering
	internal pressure	group individual
	new job design	unique generic
Worker	involvement	proactive reactive
	attitude toward change	acceptance rejection

neer). The top leadership then related the action to the *goal* of cost-savings, to the enhancement of worker well-being, or to some combination of the two.

5.2. Implementer level

Implementers were charged with identifying problematic job designs from an ergonomics perspective, which were risk factors that tend to be associated with excessive fatigue, soreness, and health problems, and prescribing ways to redesign jobs. A participative approach to the *job design* is defined here as the direct inclusion of line workers among the implementers. These line workers, who were in fact union members, acted as representatives of their hourly co-workers in the plant. In one case where a union-company joint effort was used (Plant S1), the committee eventually reviewed most of the jobs in the plant, often inviting the workers whose jobs were being reviewed to the meeting, and implemented the necessary changes (see Liker et al. (1990) for more detail).

In plants that took the expert approach, one or two well-trained implementers identified "problem jobs" and devised ways to improve these jobs. Workers and top leaders looked to them to provide ergonomics solutions to these jobs.

Plant A6 had two such expert implementers who identified ergonomics problems, focused on the most prevalent problems in the plant, and offered solutions that affected most of the jobs in the plant (i.e., shock absorbing gloves and floormats).

The qualitative approach to *job analysis* involved brainstorming or informal discussion among the implementers about problems with the jobs. It was not uncommon for the implementers to probe for ideas from the workers who worked on the jobs they were analyzing by inviting them to the meetings or through informal conversation. On the other hand, the engineering job analysis entailed resorting to more analytic tools to identify problems (e.g., the computer modeling packages of work postures and metabolic energy expenditures). For example, the particulars of precise worker posture and the weight of the load at a problem job would be entered into the computer. The computer output would then point out the specific body parts where excessive stress was being exerted.

Implementer-level dedication to the ergonomics program is listed as *internal pressure*. The internal pressure arose through the action of individuals acting alone or groups acting collectively. In Plant A6, where a safety engineer and a union representative were assigned to the implementation task, they did not work together closely as a team, but they independently made significant contributions to making ergonomic changes. The safety engineer ran the computer analysis program frequently to test the feasibility of the proposed changes and also was in charge of distributing ergonomic devices to workers, and the union representative administered internal surveys to probe for the need for the proposed ergonomic changes and made video tapes of their accomplishments. We recognize this plant as having strong individual pressure. In Plant A1, on the other hand, a group of people (more than 10 as shown in Table 1) worked together closely. Initially, there were traditional adversarial relations between the management and the local union. But, as people from both sides met together to collaborate on making ergonomics changes, they "set aside their differences" and "became a team". Strong group pressure for the survival and expansion of the ergonomics program subsequently emerged.

As shown in Table 1, *new job designs* are categorized as either unique or generic. When individual jobs were considered in redesign, each job was analyzed in a comprehensive way to determine the unique stresses in the particular job-person configuration and job changes were designed to address these particular stresses. We call these changes unique changes. But some changes involved the design of generic solutions to problems that affected a set of jobs. Some examples are shock absorbing gloves made available to a large portion of the workforce, floormats for entire production lines, and ergonomically designed seats for an entire sewing plant. We call these generic changes.

5.3. Worker level

Worker *involvement* in changing their own jobs can be either proactive or reactive. Proactive involvement entails getting involved in the initial layout stage of the job redesign. In Plant S1, the workers were formally invited to the meeting when their jobs were going to be analyzed for possible ergonomics risk factors for the first time, prior to any redesign. Reactive involvement, on the other hand, means having no involvement until the job change is made. Typically in this case, the worker would complain about the change that is implemented, and the implementers would then try to accomodate the complaint. For example, in Plant A2 one specialist was often put in charge of changing several jobs and said he could not find enough time to consult the workers in advance. It was, therefore, not uncommon for the specialist to redesign a job alone and after implementation iron out any worker complaints. Once the change was implemented, the worker could either reject the change by resorting to the old job configuration or accept the change by using the new configuration. One example of rejection we observed was a worker who pushed a new ergonomically designed hoist off to one side and loaded and unloaded parts without it. Acceptance meant using the new workstation and tools as redesigned. The cognitive stage of preference suggested by these behaviors is referred to as the worker's *attitude toward change.*

6. The final process model

The framework of the process model shown in Table 5 combines the four stages and the three organizational levels. All the key process variables shown in Table 4 appear in Table 5. All variables appear just as they did in Table 4, with one exception of job design activities which reflect two variables in Table 4, namely, job analysis and design approach. The variables under institutionalization stage come from the discussion of the four stage model. Organized

TABLE 5

Variables of the process model

Level/Stages	External pressures	Enactment	Internalization	Institutionalization
Top Leadership	institutional pressure	structural conformity	goal of ergonomics	legitimization of ergonomics
Implementer	structural arrangement	job design activities	internal pressure	new socialized elements
Worker	new job design	worker involvement	attitude toward change	ergonomic job changes

with respect to stages and levels, Table 5 serves as a summary of what has been discussed in the previous two sections and aids in the building of the final process model shown in Fig. 1.

The final model (Fig. 1) is generated first by rotating Table 5 at 45 degrees so that the external pressure variable of each level comes directly under the action variable of the preceding level. Arrows are then added to indicate the direction of the process. Following Burgelman's (1983) convention in his process model of internal corporate venturing, the solid arrows represent the flow of main activities and the shaded arrows indicate delayed, peripheral effects. The *main activities* reflect the direct process of ergonomics implementation beginning with structural conformity at the leadership level to ergonomic job changes at the worker level. *Delayed effects* represent the peripheral organizational processes that happened subsequent to the main process. The delayed effect shows the institutionalization process in the leadership and implementer levels.

Notice that each key variable under external pressure, enactment, and internalization is measured in terms of the two poles as discussed in the previous section and shown in Table 4. Depending on the strength of each pole of these variables, different paths leading to different outcomes were observed. Since where each plant stood on each of these variables played important roles in the eventual implementation process, readers may want to refer back to Table 2 while reading through this section.

When plants that displayed similar antecedent conditions were grouped together, a common pattern leading to common outcomes began to emerge. As each plant process told a story, the 13 stories together began to tell a grand story of the general process model in Fig. 1. We first discuss the primary se-

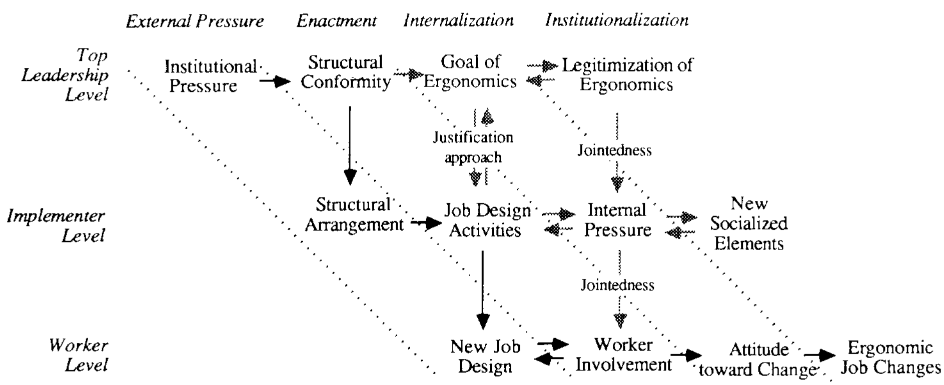

Fig. 1. The process model. Solid arrows represent the main process, shaded arrows depict delayed effects in the process. (Notes: (i) Job Design Activities includes the job analysis (qualitative vs. engineering) and design approach (participative vs. expert). (ii) The process of three plants ends at Structural Arrangement. (iii) The process of one plant starts from Internal Pressure.)

quence of activities indicated by the solid arrows, followed by the delayed effects indicated by the shaded arrows.

6.1. *Sequence of main activities*

The sequence of activities considered here reflects processes internal to plants. As mentioned earlier, these internal processes were set in motion as plants accepted, to varying degrees, the institutional values of ergonomics. The main activities constitute paths leading from institutional pressure to ergonomic job changes.

Top leadership level

Once the process was set in motion, the manner of *structural conformity*, whether a new program structure or an existing structure, played a crucial role in the subsequent processes. Out of the twelve plants whose program was externally induced, nine plants formed a new structure and three plants (Plants S4, S5, and A7) used an existing structure. When a new structure was formed, whether it was a team or a staff, the ergonomics program seemed to have gained a brand new identify and internal legitimacy. In this case, the program was looked upon (though sometimes with skepticism) as an "up and coming thing" and something that had top leadership's "blessing".

On the other hand, we observed that in the three plants that utilized an existing structure ergonomics got little to no priority. The existing structure already had its customary agenda to carry out, which in the three cases studied continued to be the main priority. Most of the purported ergonomic job changes at these three plants were really not motivated by ergonomics considerations but rather were traditional productivity changes that only got labeled as ergonomic changes retrospectively. For example, at Plant A7, ergonomics was assigned to their "automation committee", made up mainly of engineers who were sent to ergonomics training. We examined a list of their proposed and implemented projects and many were labeled as ergonomics projects. Every "ergonomics project" that was implemented was an automation project which could be cost justified in labor savings. Other ergonomics projects that could not be cost justified in this way were labeled as "closed" (a decision was made not to make the change).

In the model, these three plants are regarded as having no further process beyond assigning ergonomics to existing structures; their process of ergonomics dissemination ended at structural arrangement. In these cases, management's response to institutional pressure was to symbolically conform — they could point to an "ergonomics program" which in reality lacked ergonomic substance. As Meyer and Rowan (1977) would predict, structural conformity was "decoupled" from daily activities.

Implementer level

Once a new structure was established, the stage was set for the ensuing ergonomics processes. A scatterplot between the type of *structural arrangement* and the form of *design approach* is plotted and shown in Fig. 2. (Recall design approach and job analysis together constitute *job design activities.*) There appears a rather clear trend, a positive correlation. The stronger the team set-up, the stronger the participative design activities; and the stronger the specialist set-up, the stronger the expert design activities. Another similar scatterplot (not shown here) revealed a positive trend between the *design approach* and the *job analysis*. It showed that a strong participative approach is associated with using a qualitative approach to job analysis (i.e., relying on members' judgements), whereas the expert activities are associated with the engineering approach (i.e., using formal methods such as computer models). In sum, the team setup generally led to qualitative analysis, and the specialist setup led to formal engineering analysis.

This relationship was somewhat puzzling to us, mainly because the team structure always included technical personnel (i.e., industrial engineers) who could easily utilize the various types of engineering techniques. We later realized that this was related to the style of the justification rationale imposed on the implementers by top leadership. When a team structure was used, top management seemed to be more willing to accept a qualitative justification rationale without a more analytic engineering rationale. Staff experts assigned in-

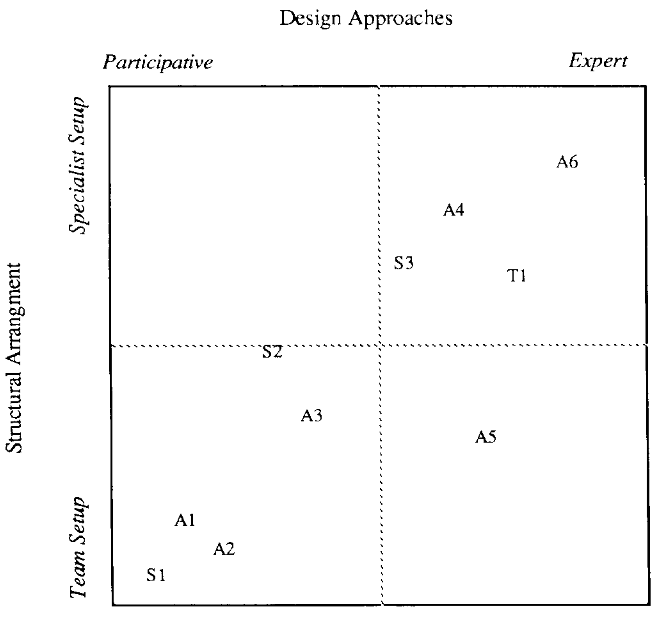

Fig. 2. Structural arrangement versus job design approaches.

dividually to ergonomics generally were under pressure to justify their recommendations with hard data from formal engineering analysis. We speculate on the reasons for this in the discussion section.

The scatterplot in Fig. 3 shows an interesting trend, a positive relationship between *design approach* at the implementer level and the types of *ergonomic job changes.* When the implementation process involved strong participative activities, as it did in three cases (Plants S1, A1, and A2), it induced a large number of unique changes at the worker level. For example, the participative program in Plant S1 went through one production line at a time and evaluated each and every job individually for ergonomics risk factors. Based on this evaluation, each job was individually redesigned, using solutions such as customized tilt stands and relocated palm buttons.

When an expert approach was prevalent in the implementation, one or two widespread generic changes were more typically implemented at the worker level. An example of a generic change is the redesign of chairs for seamsters who sewed seat cushions in the trim plant (Plant T1). Over 90% of the workers in the plant were affected by this change. Other ergonomics projects in this plant included controlled experimental investigations to choose the best floor mats for workers who had to stand to do their jobs, as well as studies of gloves. Changes were never implemented in either of these two projects. One indus-

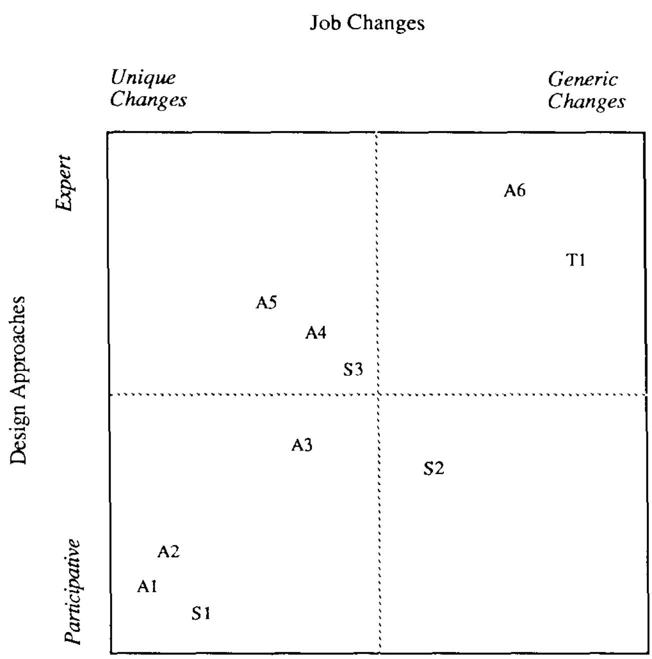

Fig. 3. Job changes versus design approaches.

trial engineer in this plant became personally committed to ergonomics as she had a background as a line worker. She identified a number of jobs that required unique changes but was never able to put together the support to systematically evaluate and redesign those jobs--the efforts of the plant ended at generic changes. We also discuss this interesting finding later in the paper.

Worker-level

Steps between the *new job design* and the final outcome of implemented job changes are distinguished by the type of *involvement* of workers leading to workers' accepting or rejecting *attitude toward change.* (As mentioned earlier, what we actually observed was behavioral acceptance or rejection of the changes). During plant tours, we observed many times that "implemented" changed were not being used by the workers. For example, a localized rail to transport parts or a new power tool designed for less torque was being ignored by the workers. We discovered that these were almost always engineering changes that involved minimal or no upfront involvement of workers. On the other hand, when we saw changes in use, someone (i.e., line worker) was often eager to point out whose idea (i.e., one of the other line workers) it was in the first place and elaborate on the "cleverness" of the idea.

As many scholars (see Ives and Olsen (1984) for a review in the case of information technology) have observed, the higher the proactive involvement of workers, the higher the rate of acceptance of the changes installed. In fact, this was shown to be true in a statistical comparison of ergonomic job changes in a separate study of two automotive engine plants, one which used proactive worker participation and one which did not (Orta-Anes, 1991). In the non-participative plant workers resisted the change in 23 percent of the cases compared to 2 percent in the participative plant. In the case of the non-participative plant 67 percent of the workers who initially resisted the change ultimately accepted the change once they had an opportunity to participate in redesign decisions.

6.2. Delayed effects

There are several delayed effects in the model. These effects are peripheral to the main process described above but are important in their own right. The discussion of these effects will be presented in the order of goal of ergonomics, legitimation of ergonomics, internal pressure, and new socialized elements.

Goal of ergonomics

The common characteristic of the plants that had worker health improvement as the goal of ergonomics was to require little to no formal justification for the expenditure of resources (i.e., Plants S1, A1). For these plants the justification was belief-based in that the top leadership merely repeated the initial belief that ergonomics was "a good thing" for the workers. The implementers did not have to justify the expenditure "with numbers" as long as it was for ergonomics (unless it was a very large expenditure). But when the goal was cost savings, the top leadership adopted a rationality-based approach. Although they had not been able to definitely pinpoint and quantify the benefits of ergonomics implementation (by their own admission), these plants yet tried to prove the expenditure typically by evaluating Workman's Compensation Claim records, medical records, safety records, survey results, etc. Documenting benefits was difficult for these plants because human factors issues are not easily quantifiable (Perrow, 1983). For example, in the case of the cumulative trauma disorders (CTD) there are significant time delays between cause and effect and typically competing explanations for causes (e.g., work-induced soreness versus the results of too much tennis playing or fly-fishing).

Legitimization of ergonomics

Legitimization is often described as one of the key consequences of an institutionalization process (i.e., Zucker, 1987). According to Parsons (1960), legitimization takes place in the direction of a system's value orientation. In the plants studied, the value orientation was first reflected in the goal of ergonomics publicized by the top leadership. Depending on the type of the goal, the ergonomics program gained legitimacy among the management leaders or among both the local union and management leaders. When the goal was purely cost-related (i.e., Plant A7), the perceived legitimacy of ergonomics was limited to the management side of the leaders. The local union leaders in Plant A7 would have "no part of it". On the other hand, when the goal emphasized worker health, the ergonomics program gained more overarching support and legitimacy from both the union and management.

The jointedness between the local union and management seemed to have been a key factor in establishing the local plant environment for ergonomics implementation. For example, when a group of people was assigned to the implementation, without the local union being part of the plant leadership which legitimated ergonomics, the activities were largely limited to one or two individuals making sporadic changes (i.e., Plant A3). All plants with strong internal pressure (either group or individual) showed some level of jointedness between the local union and management.

Internal pressure

As mentioned earlier we distinguish *individual* pressure from *group* pressure within ergonomics implementers. Typically, a team structure coupled with strong union-management jointedness led to a participative approach. The participative approach then gave rise to strong internal group pressure. As shown in Fig. 4, a participative (versus expert) approach to job design was positively associated with internal group pressure in support of ergonomics.

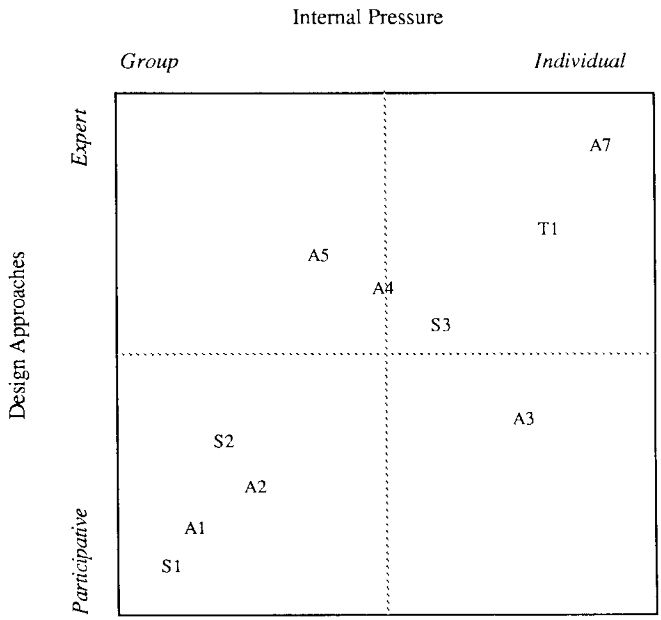

Fig. 4. Job design approaches versus internal pressure.

In Plant S2 where the internal pressure was indigenous, rather than exogenous as in the other 12 plants, their ergonomics process started with internal pressure. A group of energetic dedicated implementers were collectively taking the leadership role and "fighting and scratching" to make the changes. The implementation process was largely participative but also had some engineering flavor when analyzing jobs (see Table 2). The reason for this latter flavor may be due to the fact that the implementers were still trying to gain official support of the top leadership, and showing the job improvement results in terms of engineering perspectives was perceived as the way to gain that support.

The structural arrangement of specialist setup led to an expert approach which generally gave rise to strong internal individual pressure. For example, the top leadership of Plant A6 appointed one safety engineer and one union representative to act as their ergonomics specialist. The top leadership of the plant designated an existing joint health and safety committee as the steering committee for the program. The design activities had to be reported monthly and approved by the Steering Committee which the engineering and union representative found "cumbersome and frustrating."Despite this bottleneck, the two implementers worked hard to make changes, exhibiting strong individual pressure in the process.

New socialized elements

As for internal pressures for change, internal individual pressure did not lead to further implementer-level process beyond building the dedication of the few staff members involved. On the other hand, the results of the internal group pressure were much more colorful. It went further to the development of new socialized elements. As people met and worked on projects together outside of their routine production activities, they began sharing common experiences related to various change efforts (e.g., the successes and the failures) as well as sharing a common ergonomics language (e.g., biomechanical model, repetitive trauma, energy expenditure, etc.). In Plant S1, the cross-functional task force in one area of the plant was led by an industrial engineer. Workers in the plant playfully chided him referring to him as the "stopwatch man", (despite the fact that time standards were no longer set using a stopwatch). Historically, workers and the industrial engineer had been adversaries who would never think of working cooperatively. Task force members, staff and workers, in these cases often became committed to ergonomics to the extent of having almost religious passion about the need to spread the word.

A more structured view of the process of socialization can be obtained from Table 3 (Section 4.4). When the scores in Table 3 are rearranged from high numbers to low numbers with respect to each plant, a pattern appears. The pattern reveals a fairly strong ordering in the development of socialized elements: first leaders, then roles, languages and stories, and lastly collectivities and rituals. This is consistent with our own impressions of what happened: the indigenous leaders appear first, often independent of the official structural setup; then the implementers begin to develop roles and start to share similar language and stories; and they finally reach a stage of collectivity and ritualization as we saw in a few plants such as Plants S1 and A1. Furthermore, comparison of Table 1 and Table 3 reveals that the socialized elements were more closely related to the strong internal group pressure than the historical longevity of the ergonomics program. Plants that had older, engineering-based programs did not exhibit as much development of socialized elements compared to plants that had a shorter program history yet stronger group pressure.

We have discussed thusfar the sequential dynamics leading to legitimization of ergonomics at the top leadership level, new socialized elements at the implementer level, and job changes at the worker level. Note that we have done this by grouping together similar early approaches among plants and by observing that these groupings were closely related to certain types of intermediate processes as well as to final outcomes.

7. Discussion

The empirical basis for this paper was the implementation of work-place ergonomics in thirteen plants in the same division of a large automotive company. A model representing the implementation process was developed based on a grounded theory approach. To introduce this model, four sequential stages of within-level process were discussed first, and key process variables in each of the three levels of analysis were discussed next. The four stages and three levels of analysis were then combined to form a table of variables which became the building blocks of the final model. The final model describes the key variables and flow of presence of work-place ergonomics implementation observed in these thirteen plants. We now recapitulate and highlight in more detail the key lessons and theoretical implications of this model.

7.1. Ergonomics adoption as a value-laden process

The key impetus for ergonomics adoption came, not from a market-driven rationale, but from a value-driven rationale at the division level. Despite the fact that they were manufacturing plants known for their bureaucratic enterprises in which new technologies are adopted in an "objective" and "calculable" manner (Weber, 1946, p. 125) to overcome competition and to meet market demand (Mansfield, 1968; Mansfield et al., 1977), the plants adopted ergonomics based on institutional, value-laden exogenous messages. The divisional offices and the national union consistently sent corroborating messages that they urged plants to adopt ergonomics because it was "a good thing" for the workers and "other" plant operations. How ergonomics could exactly benefit the overall plant operation was still quite ambiguous to plants, but what was clear was that the divisional offices and the national union valued ergonomics. Plants, therefore, began to adopt ergonomics by conforming with this institutionally legitimated notion of ergonomics as "a good thing".

It was, then, institutional motivations which were the impetus for the adoption of ergonomics, not Weberian rationalistic motivations. Based on DiMaggio and Powell's discussion (1983), institutional motivations arise, not from an organization's desire to meet market demand, but from its desire to gain legitimacy from its political as well as value-promoting organizational environment. By value laden we do not necessarily mean that any of the adopting plants were only motivated to protect the well being of their workers. Even at Plant S1, one of the most active ergonomics programs with a highly publicized goal of worker welfare, the plant manager admitted to us in private that his major reason for being interested in the program was to gain legitimacy in the eyes of division-level management. (His plant was several times targeted to be shut down and business was being reduced. By becoming a model citizen the plant had managed to stay open for at least a decade after it was targeted to be closed — it remains operating at the time of this writing though with a very much reduced production volume and workforce compared to its peak.) Conformity to external pressures occurred as plants succumbed to varying degrees to the institutional values of ergonomics.

The plant leadership was then left with the task of explaining to their internal stakeholders what they intended to accomplish with ergonomics. (Had the adoption been mandatory, it would have been easy to explain: they could have merely said that they were told to do this.) The plant leadership eventually used two types of internal goals for ergonomics. One type of goal was the improvement of worker welfare, by simply stating that ergonomics is "a good thing" for the workers. The other type of goal elaborated on "other" benefits of ergonomics. Although no one really knew exactly what these "other" benefits entailed, some plants believed that implementing ergonomics would help reduce workers' compensation and medical costs or improve quality. It is, however, important to note that these were largely unsubstantiated claims, in that they were never verified in business documents or statistical study. They were, in essence, a type of rational myth (Meyer and Rowan, 1977): purported benefits were myths yet became the rational goal of ergonomics. In sum, two types of internal goals were used: worker welfare and cost savings. We discuss in the next section the impact of these two goals on the overall implementation process.

7.2. Goals of ergonomics

The plants with a worker welfare goal in general tended to be much more active in implementing ergonomics than the plants with a cost savings goal. The plants that told us they implemented ergonomics simply because they felt it was a good thing for the workers were much more vigorous and persistent in their efforts to implement ergonomic job changes. On the other hand, plants that told us that they implemented changes to improve the "bottom line" showed sporadic and intermittent implementation efforts.

One reason for this may be the differing ways of justifying the expenditures in making changes. For the implementers of the plants that adopted the principle that ergonomics was a good thing for the workers, all they had to do to justify the expenditure (for modest expenses) was to state that it was for ergonomics. But for the implementers that worked for plants that emphasized economic benefits of ergonomics, they had to cost-justify even inexpensive changes. It seemed that this extra step impeded the implementation process, creating a time-consuming bureaucratic process which often led to rejection of the request. We are not suggesting that cost-benefit analysis is always bad for technology implementation, but we are saying that, in the case of ergonomics, focusing on economic benefits and requiring economic justifications for new change projects actually hindered the implementation process.

We have emphasized that a characteristic of ergonomics is difficulty in measuring benefits and causally attributing benefits to ergonomics changes. However, this is not a characteristic that is unique to ergonomics. Many new technologies have a variety of intangible benefits that are not clear or calculable (Goldhar and Jelinek, 1983; Dean, 1987). For example, the introduction of flexible manufacturing systems might have some direct labor savings but the more substantial benefits are apt to be intangibles such as increasing the "flexibility" of the system and thereby leading potentially to increased market share, customer satisfaction, and even making the difference between long-term survival versus going out of business (Ettlie, 1988; Tombak and Mey, 1988).

7.3. Utilizing old structure versus new structure

Plants either assigned ergonomics to an existing job function or committee or created a new structure for ergonomics. In the case of new structures, the level of ergonomic job changes varied among plants from 5 to 10 changes to more than 100 changes, but there were virtually no ergonomically motivated job changes in the plants that utilized existing structures.

Out of 13 plants, 10 plants had a newly organized ergonomics committee or a newly appointed ergonomics coordinator or ergonomist. But 3 plants (Plants S4, S5, A7) utilized an existing structure. One of these plants (Plant A7) utilized its automation committee, and the other two utilized their industrial engineers. These entities, however, already had a working agenda associated with their roles. The committee was busy making automation changes and industrial engineers were preoccupied with making traditional engineering changes. Only when the changes they had made happened to resemble ergonomics-related changes, were they then labeled as such, retrospectively. For all practical purposes, the adoption of ergonomics at these plants made no real impact.

7.4. Participative approach versus expert approach

The participative approach was associated with implementing *unique changes*, changes customized to the unique conditions of each job. The expert approach was associated with implementing *generic changes*, changes not tailor-made for each job but applied to a larger set of jobs. There are a number of possible explanations for this phenomenon.

One explanation views the distinction between generic and unique changes as a reflection of the commitment of management and perhaps of the implementers. The ergonomics training courses suggested that a rigorous job analysis procedure be used for each job looking at the job as a system of interrelated parts. However, doing this on a job-by-job basis is tedious and may be hard to justify economically. To get the largest payback, monetarily and in visibility, it is probably better to focus on generic changes. Thus, with perhaps little more effort than it takes to evaluate and improve an individual job, one can affect many jobs in the plant (e.g, installing new seats for the entire plant). We are not suggesting that one type of change is necessarily better than the other for the overall plant operation; however, we are arguing that the generic approach can be achieved with less commitment and it becomes easier to document an ample return on investment.

For example, in Plant A6 where generic changes were made (i.e., replacing floor mats to reduce feet soreness) the implementers documented absenteeism before and after the change and were able to show a significant reduction in absenteeism which justified the cost of the expenditure. No particular commitment to ergonomics was necessary on the part of plant management to fund the improvement and the implementers received notoriety. Even in the case of the seat redesign in Plant T1, the management planned on replacing the seats, which were very old anyway, so investing in the design of ergonomically correct seats required little marginal investment. Recall that in this case plant management was not willing to support unique changes identified by an engineer who was particularly passionate about ergonomics.

A second, and perhaps complimentary, explanation is that the participative approach created more diversity than the engineering approach. A greater variety of opinions, ideas, and human resources to better deal with varied problem jobs in the work environment was present in the participative approach. In other words, ample "requisite variety" was present to deal with the complexity of the work environment (Conant and Ashby, 1970; Weick, 1979) and to produce unique changes. On the other hand, the expert approach by the engineering staff was initially intended to implement changes based on established engineering principles. One might say, however, that their requisite variety was more limited than in the participative approach and their scope of consideration was bounded. Their scope was bounded by their own rationality (Simon, 1976), the limited information they had at their disposal, and top leadership's close scrutiny. Their effort to be completely knowledgeable and anticipating of consequences of job changes actually limited them to making only a few generic changes, and to ignore unique changes affecting particular jobs.

We learned further that the participative versus expert approach made a difference in the job analysis approach. In general, when individual experts were assigned to ergonomics they were more likely to use formal analytic procedures such as computer models. By contrast, joint teams tended not to use these formal tools despite the fact that engineers were on the committee. We believe this reflects the goals of the plant leadership. Generally, they did not set up a participative approach unless a major goal of the ergonomics program was to benefit worker health. In this case they would approve moderate expenses for projects simply because they made sense ergonomically. For example, at Plant A1, the joint committees actually had a graduate student attending every meeting who was willing to do the job analysis on the computer and report the results to the committee. Most often they felt the analysis was unnecessary. They only requested it in borderline cases or when the expense was sufficiently high that they felt they needed formal justification to request funds from management. On the other hand, managers who assigned expert staff to ergonomics were generally after cost reduction and closely scrutinized the costs and calculable benefits of each change. This did put pressure on the implementers to document the rationale for all ergonomics projects. Since clearly attaching dollar figures to benefits of ergonomics is so difficult, implementers often resorted to using analysis procedures to legitimize the ergonomics project in scientific terms. This was not simply their opinion but the computer "proved" the change was needed.

7.5. Externally induced versus internally generated programs

Although there was only one plant (Plant S2) whose ergonomics program was an internally generated program, it was so unique that it warrants a separate discussion. The implementation process at this plant began with internal pressure from implementers. The implementers were not responding to institutional pressures and top management did not impose a particular structural arrangement. Ergonomics had not yet gained legitimacy at the top leadership level, yet the implementers continued to try to justify their activities to plant management. As discussed above, implementation was driven by a UAW health and safety appointee who had contacted a professor at a local university. Together they trained and mobilized a large group of hourly workers, whose enthusiasm and personal contacts brought engineers into the process.

Cohesion among implementers was extremely strong. They repeatedly told us that they emphasized "we" over "I" and were busy giving credit for what little accomplishments they had made to each other. We observed a strong set of socialized elements among these implementers (see Table 3). However, the quantity of technical job changes was much smaller than at the other plants which also exhibited strong socialized elements. They spoke to us about how they had to "cut through red tape" to accomplish any type of job change. Not having a strong impact on technical job changes can be attributed to not having top leadership's commitment. Therefore, it confirms our earlier conclusion that official acknowledgement of management and the establishment of a formal structure was important in gaining internal legitimacy and thus allocation of internal resources. This single case is contrary to the suggestion by Beer and Huse (1972) that bottom-up advocacy of workplace innovation can be just as effective as innovations that have top management support.

8. Implications and directions for future research

8.1. Theoretical implications

We have taken the view in this paper that the adoption of ergonomics was an institutional phenomenon. Institutional pressures came externally and took the form of beliefs which preached the goodness of ergonomics. According to institutional theorists (Meyer and Rowan, 1977), there is a gap between the goal of the top leaders, which is to conform, and the goal of the workers, which is to produce. Top leadership makes structural changes as a sign of conformity, but due to their conflicting goals the structural change has little social or technical effect on within-organizational activities (Meyer and Rowan, 1977; see Zucker, 1987, for a review). This is commonly described as "decoupling" of institutional conformance from internal operations. More recently, however, some case studies have surfaced instances where institutional pressures actually caused "close-coupling" of institutional conformance and internal operation (i.e., Covaleski and Dirsmith, 1988). We have seen in our multi-plant field study evidence for both phenomena.

In the plants that set up new program structures and had top management support, institutional beliefs, instead of being decoupled, were internally perpetuated to the lower levels of plant organization, particularly when a team setup was used. Conformance to the exogenous beliefs about the value of ergonomics did not end at the level of structural arrangements but went beyond it. New institutional elements were developed among the implementers and job changes occurred on the production floor. Hidden in this process are institutional pressures actually leading to value-laden rationales for the actions. Though management may have had other motives, the stated motive of worker health promotion gained internal legitimacy and internal support was generated to continue and sustain the ergonomics initiatives. On the other hand, the plants which translated external institutional pressures to internal economic goals showed conformance as being decoupled from the daily activities. These plants, by virtue of having instigated official titles for ergonomics, were able to publicize their conformance, but internally ergonomics made no impact. In conclusion, it seems that in order for institutional beliefs to propagate into the internal operation, its value aspect, not economic benefits, needs to be promoted and instilled within the organizations.

8.2. Managerial implications

There are three important implications. First, it appears that management motivations for implementing ergonomics will influence the ultimate success in actually making real change on the shopfloor. If they focus solely on short-term cost reduction they are not apt to make far reaching ergonomics improvements. Second, when implementing ergonomics, it appears important to consider establishing a brand new structure. It seems to harness implementers' energy more effectively and offers internal legitimacy and identity. Third, when devising a job design strategy, management should consider the kinds of changes sought. If the desired impact of ergonomics is well focused on one type of change, the engineering approach may be sufficient.

For example, if a meat-packing company wants to specifically reduce the number of Carpal Tunnel Syndrome cases of meat cutters, it may be sufficient to conduct an in-depth engineering analysis of work processes associated with wrist motions of meat cutters. Some kind of generic changes can minimize the stress on the wrist, for example, by changing the design of cutting knives (Armstrong, 1986). Employee inputs may still be desired, but this can be accomplished through a more impersonal technique such as a formal survey as we saw in Plant A6. Even a modest level of worker input through a survey might provide ideas which lead to a better, more acceptable design and gain some support from the work force. In Plant T1, the implementers lamented that they should have gotten more user input as there was considerable resistance to the newly designed seats.

However, if the desired goal is to tailor individual jobs to fit the worker, the team-based, participative approach should be seriously considered. For example, if a diversified assembly plant that has many different job classifications wants to improve the design of all work stations, it should look at different jobs individually and customize the changes. Therefore, a participative approach would be more effective, in terms of the quality of the changes and employee acceptance, than an engineering approach.

8.3. Implications for future research.

The inference about the role of values has implications for adoption motivation and internal goals, which have largely been overlooked in the past technology literature. It first points out that there is institutional motivation for technology adoption, apart from the more popular theme of economic or strategic motivation. It secondly points out that there are value-laden internal goals which emphasize doing something right rather than doing something economically beneficial and that value-laden goals even with no clear reference to economic benefits can serve to be more effective in implementing technology. The first point has implications for organizations' strategies toward their external environments, and the second point has implications for organizations' strategies toward their internal operations.

A few questions arise. In what situations do we see institutionally motivated technology adoption? How universal is it? Is it always true that value-laden internal goals are more effective in implementing technology than economic goals or is this a situational phenomenon? If it is situational, on what factors does the answer depend (e.g., type of innovation, environment, degree of calculable cause–effect relationships, etc.)? Based on our field study, we have only scratched the surface of answers to these impending questions. We think these are important questions that need to be addressed in future research. In the past, institutional motivation for technology has largely been overlooked, while the economic motivation has received ample attention (e.g., Link and Tassey, 1987). Likewise, scholars of technology transfer have overlooked the role of human values in the implementation process, although organizational scholars have recognized organizational culture as having an important impact on organizational effectiveness (Wilkins and Ouchi, 1983; Denison, 1984, 1990; Gordon, 1985) and values as having more appeal to workers than strategic economic plans (McNeil, 1987).

The distinction between institutional and economic motivations is particularly noteworthy if we accept the notion that the early adopters tend to be more economically driven as opposed to the late adopters who tend to be more institutionally driven (DiMaggio and Powell, 1983). For example, the early Japanese adopters of just-in-time (JIT) inventory systems implemented it primarily to save costs resulting from work-in-process (WIP) inventory (economic motivation). But, when it was recognized as a world-class manufacturing technology, a lot of American companies "got on the band wagon" and began instituting JIT (institutional motivation) without fully realizing the technical requirements for implementing it. (For more details of manufacturing technology transfer between Japan and the United States, see Dertouzos et al., 1989; Pascale, 1990, Schroeder and Robinson, 1991; Womack et al., 1990.)

When one of the major automobile manufacturers adopted JIT, it tried to reduce work-in-process inventory by immediately requiring its vendors to supply parts just-in-time. But the vendors' internal process was not ready to accommodate the request. The result was vendors building warehouses right next to the plants which were requesting JIT (Pascale, 1990). The WIP inventory was not eliminated but merely transferred. In a survey of 453 automotive suppliers in 1988 (Helper, 1991) almost half agreed that "we are implementing JIT mainly because our customers demand it" and "JIT only transfers responsibility for inventory from customers to suppliers". The JIT example illustrates how economic internal goals were indeed effective for the early adopters (in Japan) but were not effective for the late adopters that were more institutionally motivated. Had they focused on less concrete but more value-laden aspects of JIT (i.e., the value of long-term cooperative relationships with vendors, referred to as use of supplier "voice" by Helper (1991)), the late adopters might have been more successful in implementing JIT.

A similar failure of implementation was described in the in-depth case study of the implementation of employee participation by Moch and Bartunek (1990). They note that the company in their study implemented the form of the participative program but did not change their traditional values based on efficiency and top-down control. They demonstrate how this traditional value framework created a set of self-defeating cycles which led to the attempted change to new participative structures becoming absorbed in the traditional control systems. The result was that the traditional organizational structure never really changed.

We concur that we still do not fully understand the organizational dynamics of institutionally motivated technology adoption. It seems to occur more in certain types of industries such as health care (Alexander and D'Aunno, 1990).

Nor do we understand the conditions under which value-laden internal goals are better or, if they are better, how to create and instill them in organizational contexts. We close this paper leaving the aforementioned set of questions largely unanswered. It is, however, important for future research to look more deeply into this type of institutionally-motivated technology adoption and the manner with which organizations translate it into internal operations. The misapplication of technology, such as failure to effectively implement useful ergonomics improvements we witnessed in some plants, needs to be minimized and eliminated. Perhaps, a better understanding of the role of institutional motivations in technology adoption and of the role of organizational values in technology implementation can provide one fruitful avenue of inquiry.

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