

# Introduction

Social scientists have struggled for years to develop a theory of organizational structure and change that effectively integrates an organization's social and technical systems. Agreement is virtually unanimous on several general points: that organizations are composed of social and technical systems;<sup>1</sup> that these systems are interdependent; and that changes in one usually occasion adaptation in the other. But agreement breaks down over the relative weight to be given to social and technical systems in explaining why organizations take the shape they do and, more important, why they change. Winner stated the central issue succinctly: "On the one hand, we encounter the idea that technological development goes forward virtually of its own inertia, resists any limitation and has the character of a self-propelling, self-sustaining, ineluctable flow. On the other hand there are arguments that human beings have full and conscious choice in the matter and that they are responsible for choices made at each step in the sequence of change" (1977, 46).

Each idea has its advocates in the field. On the one side are researchers who contend that the technical system of an organization determines its structure (e.g., Woodward 1965; Thompson 1967; Khandwalla 1974;

1. Borrowing from sociotechnical systems theory (e.g., Trist 1981), we may define social systems as made up of people—as individuals and groups—joined together by a set of formal and informal relations that regulate their behavior and orient them toward the achievement of particular goals (individual as well as collective). Technical systems consist of the physical equipment and processes through which inputs are converted into outputs.

Adler 1987). From their perspective the social system of an organization is compelled to mold or adapt itself to the contours of the “core technology,” that is, the dominant technique for converting inputs into outputs. Changes in the technical system of an organization resulting from external or internal innovation translate directly into changes in organizational structure and functioning. On the other side, however, technology and organizational structure are held to be the product of choice, most broadly of social choice. Organizations choose the markets they compete in, the techniques they employ to produce their goods or services, and the shape or structure they find most appropriate to achieving valued goals (Child 1972; Child 1985; Braverman 1974; Edwards 1979).<sup>2</sup> From this perspective, then, technology is made to conform to the contours of the social system of the organization. Abrupt or unexpected changes in technology may occasion adjustments; but more commonly, the technical system is adjusted within limits imposed by the social system of the organization.

On the surface, it might seem odd that such divergent perspectives could persist in the face of opportunities for an empirical test. Still, as Bedeian (1980), Francis (1986), and others have pointed out, the empirical evidence has yet to yield a clear-cut winner. Only in the broadest sense have organizations been shown to adopt similar structures in response to their core technologies—or to alter themselves in patterned and predictable ways in response to the same exogenous technical stimuli (Woodward 1965; Tushman and Anderson 1986). Even these studies have not demonstrated conclusively that technology has an independent influence on structure (see Hickson, Pugh, and Pheysey 1969; Mohr 1972; Blau et al. 1976).<sup>3</sup> Efforts to show that organizations exercise choice in selecting and matching technology and structure have proven equally inconclusive in part because the data presented—largely in the form of case studies (e.g., Piore and Sabel 1984; Shaiken 1985; Child 1985; Wilkinson 1983; Buchanan and Boddy 1983; Perrow 1983)—do not allow for generalization and in part because the variables that are

2. I include within this “camp” researchers working from Marxist labor process theory because most claim that technologies are chosen on the basis of managerial strategy to control work and workers—a narrow but nonetheless clearly social dimension of the organization. I return to this point later in the chapter.

3. Moreover, they do not easily account for the potential effect of factors outside the set of variables traditionally included in the study of technology and organization. For example, arguments advanced from the “new” institutionalism (see DiMaggio and Powell 1983) could be just as compelling: similarities in structure could be the product of *coercive* pressures (e.g., from regulators), *normative* pressures (e.g., from outside constituencies), or *mimetic* processes (e.g., simple copying of competitor behavior).

hypothesized to intervene in the process of strategic choice are too complex to afford empirical tests of a conventional sort (e.g., Sabel 1982).<sup>4</sup> The stalemate has propelled some researchers into a search for better measures of technology and structure and more refined data sets with which to test their propositions (cf. Stanfield 1976; Comstock and Scott 1977; Kelley 1990). Others have tried to find a middle ground between the extremes (see Clark, McLoughlin, Rose, and King 1988; Hrebiniak and Joyce 1985; Tushman and Romanelli 1985). A few, meanwhile, have proposed wiping the slate clean and starting over.<sup>5</sup>

The unsettled nature of the debate might be of no great interest outside the academic community if not for the fact that social, economic, and technological changes of considerable magnitude are taking place globally. In light of those changes, time-honored notions about hierarchy, bureaucracy, and the structuring of work are coming under increasingly intense and critical scrutiny—by managers, technologists, and workers alike. If, as a growing number of analysts suggest,<sup>6</sup> history can no longer be relied on as a guide to action in the current era—much less to organizational survival in an uncertain future—then the relationship between technology and organization is by no means an idle issue. Once again we are left to answer critical questions: If new technology does indeed drive organizational change, how does it do so? What are the mechanisms through which similarities and differences in structure come about? Alternatively, if organizations can structure themselves through technological choice, who makes those choices and how?

Rather than go back to the drawing board in an effort to answer these questions, I argue in this book that it may be most productive to embrace the divergent (perhaps even contradictory) arguments that underlie the debate and to use them as the foundation for a theory of how social *and* technical systems are jointly responsible for organizational structuring and change. In other words, both the technological determinist and social choice perspectives offer important insights about the properties of the system that they consider to be determinant. These

4. Barley (1986; 1990) provides an important advance in this direction through his systematic observations of the social interactions stimulated by the introduction of new technology in an established social system. Yet his analysis does not account for the process whereby new technology—of a particular sort, with particular objectives already built into it—shows up in the first place.

5. Barley (1986; 78), for example, has suggested, "Rather than continue to scrutinize research for additional methodological and conceptual flaws, a more fruitful ploy may be simply to embrace the contradictory evidence as a replicated finding."

6. See Piore and Sabel (1984), Thurow (1992), Drucker (1988), and Dertouzos, Lester, and Solow (1989).

insights should not be dismissed. But both perspectives share a common flaw: because they focus attention primarily on the structural outcomes or impacts of change, they tend to portray the relationship between technical and social systems as static and unidirectional. By neglecting the process of change—especially the process through which choices of technology are made—they generally fail to capture the dynamic and interactive nature of the relationship between the technical and social systems of an organization.

The core argument of the book can be stated rather simply: to explain what new technology does to organizations—or as it is commonly put, “how technology impacts organizations”—we must also explain what people are trying to do to organizations and, by extension, to themselves by means of new technology. Two points are central to this argument. First, it is not enough to claim that technology “impacts” organizations; it is essential to ask as well how and why particular technologies are chosen. Second, it is not enough to claim that technology is the simple product of social or strategic choice; it is essential to ask as well how technological alternatives were themselves framed, how the objectives or interests of different organizational actors shape the range of possibilities considered, and, most important, how differences in objectives or interests influence the outcomes of change.

The bulk of the research literature has neglected the process of change because it cannot be easily represented as a quantifiable variable; by contrast, structural outcomes or impacts can be enumerated and compared. Unfortunately, this situation has led researchers either to overlook variations in process as an explanation for differences in technology’s impacts or to assume that the nature of a process can be inferred from observations of outcomes. However, close examination reveals that at least some of the confusion that has hounded prior research can be attributed to the fact that the process of technological change occurs within a social and historical context encrusted with embedded interests and ideologies about what problems can or should be “solved” by technology. These interests and ideologies *are* influenced by organizational structure, but they are also influenced by factors that cannot be easily deduced from formal structure or inferred from the observation of outcomes. Included among those factors are professional and occupational values and concerns about social status that guide people’s thinking about what constitutes meaningful work. A particularly important organizational group whose activities and worldviews

have escaped direct attention are the engineers and technicians whose job it is to devise and implement new production technology. The influence of these factors becomes apparent only when we focus explicit attention on the process of change.

In this chapter I lay the foundation for an analytical framework that incorporates insights from both the technological determinist and the social choice perspectives. This framework, which I refer to as the “power-process” perspective, begins by accepting as legitimate two seemingly incompatible assumptions: first, that the physical world does indeed constrain the range of alternative ways human beings can organize the production of social goods; and second, that the social worlds (i.e., the organizations and institutions) that human beings create influence the way they understand and act on the physical world. In other words, neither “world” subsumes or masters the other. Therefore, the core problematic is not which world structures the other, but *how they structure one another*. Of necessity, this framing of the problem forces us to conceive of technology and organization as engaged in an ongoing process of structuring. It also allows for the possibility that differences in objectives and interests among human beings will yield different understandings of the physical world—not only how it does work, but how it *should* work. If no one social group (profession, occupation, organizational stratum, class, race, or gender) can lay claim to the “truest” or the most “real” understanding of the physical world, then we are forced to conceive of the relationship between technology and organization as *mediated by the exercise of power*, that is, by a system of authority and domination that asserts the primacy of one understanding of the physical world, one prescription for social organization, over others.

In subsequent chapters I present the results of a three-year study of the process of technological change in a wide range of industrial organizations. This study focused specific attention on the choices that shaped both the technical and the social systems of work. By contrast to prior works in the field, including those that claim to analyze the change process, I did not limit the investigation to the implementation of new technology. Rather, I extended the definition of “process” to include the activities that preceded, as well as followed, formal decisions to implement new technology.

The case studies offer four significant insights—insights that could not have been derived from the study of technology’s “impacts.” First, the studies demonstrate that the choice of technology is rarely a straight-

forward and rational affair, despite the many efforts of change proponents to justify their actions in a language and with measures that proclaim their rationality. A central and previously unexplored feature of the process of technological change is the opportunity it provides for different categories of organizational actors to try to put in place their own unique worldviews about the “proper” way to organize work. Close examination of these worldviews suggests that neither engineers nor workers respond passively to change; rather, they actively attempt to shape the content of technological change to make it accord with their conceptions of “real engineering” and “real work.”

Second, the case studies show that the choice of technology represents an opportunity to affect not only the performance of work but also the status, influence, and self-concept of those promoting change. That is, new technology may be far less attractive for what it does than for what it says symbolically about its creators and proponents. Critical in this regard are the efforts of manufacturing or process engineers—who are considered (and often consider themselves) to be “second-class” corporate citizens—to gain a measure of status and recognition in the eyes of the product engineering community.

Third, the case studies suggest that, although the structure of power and authority within an organization often influences the range of technological alternatives considered, in some cases change may be initiated in the hopes of altering that structure itself. That is, change may be undertaken not in adherence to organizational strategies and objectives but in conscious efforts to thwart them. Both situations are possible because the process of technological choice remains largely invisible to both top management and shop-floor personnel.

Finally, although the case studies offer evidence that cooperative approaches to labor-management relations may facilitate more effective and creative use of new technology than adversarial relations do, real cooperation requires fundamental change in the process of designing and implementing new technology. The separation of technology design and implementation in time and space dramatically reduces the opportunities for meaningful “user” (i.e., worker and lower management) participation in the change process. Thus, in the absence of a crisis that forcibly suspends historical practices, technology designers often have little incentive to solicit input from those who are the object of change. As a result, new technology frequently confronts the rest of the organization as an exogenous force—one that can be countered only through overt political action.

Beyond whatever insights the case studies may offer about the process of technological change and its influence on the outcomes of change, the studies are, I think, valuable for what they reveal about the challenges facing managers, engineers, workers, unions, and educators as they contemplate the future of the industrial enterprise. Most important, the research findings suggest that traditional assumptions about the relationships between product and process design and between product and process engineering organizations must be dramatically altered—perhaps even reversed—if manufacturing firms in the United States are to regain a competitive posture in the world economy. Although I am not alone in suggesting the need for structural change,<sup>7</sup> I do contend that structural change by itself will be far from sufficient. A prerequisite for change of that magnitude will be the creation of what I refer to as a “process aesthetic” or a philosophy of manufacturing that values the integration of the technical and the social systems of production, rather than values one at the expense of the other. The obstacles to change are enormous—not simply because existing practices are so deeply entrenched but because changes of the sort I propose will have dramatic implications for the way all the relevant parties (including academic researchers and engineering educators) think about the process of production.

Before presenting the case studies and their implications, I will discuss the body of theory I encountered in preparing to do the research.

## BRIDGING DETERMINISM AND CHOICE

For all the brickbats that social scientists have lobbed at technological determinists, valuable insights may be gained from seriously considering technology as an independent entity. Most important among them is the recognition that the physical properties of raw materials do constrain the range of alternative ways that inputs can be made into finished goods. Even in the face of debates as to what might be the most efficient (or safe or environmentally sound) way to manufacture, say, printed circuit boards, our knowledge of physics and chemistry suggests that electronic signals must be provided pathways along which to travel. Thus, physical necessity constrains the range of alternative technologies

7. See, for example, recent works by Hayes, Wheelwright, and Clark (1988), Dertouzos, Lester, and Solow (1989), Cohen and Zysman (1987), and Womack, Jones, and Roos (1990).

for making printed circuit boards.<sup>8</sup> Clark et al. (1988, 12–15), for example, suggest that any given technology has a finite “design space” within which it can be altered or adjusted by organizations. The broadest bounds on design space are the engineering system principles (or known properties of raw materials and transformational processes) and the physical embodiment of those principles in specific combinations of hardware and software.

Moreover, technology may not have a mind of its own, but it is often *experienced* by people and organizations as an exogenous force. Many new technologies are created by one set of actors for use by another set: for example, one firm’s product often becomes another firm’s process. As Abernathy and Clark (1985) noted with respect to product technology, once a “dominant design” has emerged among a group of competitors, it confronts nonusers and new entrants as an established “fact.”<sup>9</sup> Even if a new technical process is the outcome of activities undertaken inside an organization (e.g., an internal research and development [R&D] lab), the origins, limits, and possibilities of a technology are often unfamiliar to the ultimate “end users.” Thus, technology tends to be experienced and represented as a “self-propelling, self-sustaining, ineluctable flow.”

However, even as we recognize the distinctive constraints imposed by the physical properties of technology, the social context within which technologies are created and used must not be overlooked. Simply put, new technologies do not fall from the sky. Inattention and ignorance may lead technology to be experienced as an independent force, but both inattention and ignorance are themselves the outcomes of social processes. Although many developments and their consequences cannot be anticipated in advance, it does not follow that their production should be excluded from analysis. More important, perhaps, *it does not follow that the social system of an organization is necessarily subordinated to the technical system.*

The contribution of the social choice perspective resides in its emphasis on the “embeddedness”—to borrow a term from Granovetter (1985)—of technology in social processes and relationships. Rather than being

8. This is the case even when we recognize that “laws” of physics and chemistry are themselves social and historical constructs (see Fleck [1935] 1979; Kuhn 1967; Latour 1987). That is, research may result in discontinuous shifts in scientific and technical knowledge, but *at the time in which these laws are being applied*, they represent real and hard constraints on the range of alternative ways to accomplish transformative activities.

9. See also Sahal (1981), Abernathy and Utterback (1978), Marquis (1982), and Tushman and Anderson (1986).



objective, technology is *infused with objectives*. By rejecting the notion that technology does anything by itself, the social choice perspective forces an accounting for the way in which interests and ideologies come to be attached to, and expressed through, physical processes. Although labor process theorists (e.g., Braverman 1974; Edwards 1979; Noble 1984; Marglin 1974) have often oversimplified the issue by asserting that technology is shaped by the interests of a single class (i.e., capitalists),<sup>10</sup> the critical idea is that choices are made even when they are not heralded as formal decisions.

Nonetheless, the social choice perspective falls short in two important respects. First, it subordinates the technical system almost completely to the social system. Technology either appears infinitely mutable in the face of social pressure or receives little direct attention at all.<sup>11</sup> Second, the social choice perspective fails to provide clear guidance or a methodology for examining how interests and ideologies are expressed through the choice of technology, by whom they are expressed, and when in the process of change this expression occurs.<sup>12</sup>

## THE POWER-PROCESS PERSPECTIVE

The framework I propose builds on insights offered by both the determinist and the social choice perspectives and addresses their theoretical shortcomings as a prelude to empirical investigation. The power-process perspective responds directly to the pattern of contradictory findings and takes up a challenge posed some years ago by Perrow (1983, 540):

10. To a significant degree this is a product of the failure of Marxist labor process theorists to go inside organizations to study technological change processes. Their hesitance derives in part from the ambiguity of the organization—especially economic organizations—as an analytical construct in Marxist theory. Efforts by Goldman (1983) and Gordon, Edwards, and Reich (1982) clarify the issue somewhat; but on the whole, Marxists have operated from the assumption that class relations are far more significant than organizational structures in explaining the evolution and use of new technology. Ironically, their attribution of single-mindedness of purpose to capitalists and managers far exceeds that which most mainstream analysts would be willing to accept (see, for example, March 1981).

11. Clark et al. (1988, 11) state the issue nicely: “The problem with recent research has been that an obsession with technological determinism has obscured the need to include an analysis of technology as one of the many factors which shape the outcomes of technological change. Put another way, the technology baby has all too often been discarded with the determinist bath water.”

12. As I argue later, this failure comes about because both case studies and cross-sectional analyses usually begin in the final stages of change—at the point of implementation or afterward—thus ignoring antecedent activities or presuming that they are largely unimportant.

The early work on technology and structure, including my own, recognized a one-sided and general connection, *but it failed to recognize how structure can affect technology and speculate about the large areas of choice involved in presumably narrow technical decisions*, choices that are taken for granted because they are a part of a largely unquestioned social construction of reality—one that should be questioned.<sup>13</sup>

Most important, to transform the analysis from one that is static and one-sided to one that is dynamic and interactive, it is essential to pay explicit attention to the *process, as well as the outcomes, of technological change*. Inattention to the process of technological change has been even more detrimental than Perrow implies: it has resulted in analyses that are ahistorical, that underestimate differences in the logics that underlie technical and social systems, and that either oversimplify or ignore altogether the mediating influence of organizational choice.

In this section I lay out the major arguments for the power-process perspective. I indicate where we can build from prior research and where we must introduce new concepts and relationships to fill the voids in the literature. From this base I then describe the research design that guided a set of comparative case studies of the process and outcomes of technological change in four manufacturing firms.

## HISTORY MATTERS

History ought to play a central role in explaining the relationship between technical and social systems in organizations. Indeed, it seems quite straightforward to suggest that prior investments in social and technical infrastructure (e.g., standard operating procedures, formal and informal production standards, fixed capital equipment, and other technical routines) are likely either to influence future investments or to serve as the historical “legacy” against which visions of the future are juxtaposed. Yet history—especially organizational history—has been neglected in all but a few empirical investigations. Instead, researchers have favored investigations that yield cross-sectional pictures of outcomes for comparative purposes. Decontextualization of this sort may make sense when, as Barley (1986, 79) notes, organizational structure is

13. Emphasis added.

defined in formal and abstract terms and technology is taken as a given. However, when it is not obvious which is the fixed point around which the other pivots, longitudinal study of context and process becomes critical.<sup>14</sup>

History matters for several reasons. Most important, the choice of temporal context has serious implications for how we define “process” and, therefore, for how attentive we are to the variety of activities associated with technological change in organizations. Obviously, cross-sectional studies like the ones that have dominated research on technology and structure (e.g., Khandwalla 1974; Woodward 1965; Tushman and Anderson 1986) stand at one extreme: the temporal context is narrowed to a single moment in time, and process disappears as a potential source of explanation for variations in outcome. The activities associated with the configuration and actual use of new technology, as well as the social system adaptations that may still be evolving at the time of investigation, are pushed into the background in the effort to get a clean “snapshot” of the outcomes of change. At best, proxy measures are substituted for direct investigation of important dimensions of process; for example, R&D expenditures as a fraction of gross revenues serve as an indicator of “ability to change,” and the number of days lost to work stoppages substitutes for “worker resistance to change.” More commonly, however, process dynamics are ignored altogether.

Although researchers who adopt a case study approach are generally less restrictive in their choice of temporal context, most case studies focus on discrete episodes of change. Their investigations are bounded on one side by a decision to introduce a new technology and on the other side by the incorporation of the new technology into routine operation.<sup>15</sup> As a result, process is equated with “implementation,” and analysis of the change process is restricted to efforts to explain variation in the adjustments that occur in the social system—and occasionally in

14. As I argue below, longitudinal and historical approaches pose formidable methodological challenges not normally encountered in cross-sectional, outcome-oriented research. At minimum they require multiple methods of data collection, access to people and records far beyond what is usually required (or usually available to researchers), and interpretive techniques for sorting through what are often very different accounts of the same process. These challenges alone may help explain why studies—as well as theories—of the change process have been few and far between.

15. This limitation is as common in case studies based in a technological determinist perspective (e.g., Adler 1990) as it is in those rooted in the social choice perspective (e.g., Shaiken 1985; Wilkinson 1983) or Marxist labor process theory (e.g., Zimbalist 1979).

the technology itself—as implementation proceeds (see Leonard-Barton 1987; Rice and Rogers 1979; Clark et al. 1988).

Overlooked in both cross-sectional and case study research, however, are aspects of a broader process of change that might provide a more complete picture of the relationship between an organization's technical and social systems. Specifically, I refer to change efforts and options that do not qualify for investigation because they fall outside the temporal bounds normally affixed even to case study research. In fact, there appears to be an implicit hierarchy of attention in studies of technological and organizational change: most likely to be studied are the spectacular successes, followed by the spectacular failures. Least likely to be studied, however, are the change options or alternatives that may have been *considered but were not selected* for implementation (even though they might be resurrected later on), followed by the change options that were *disqualified* from serious consideration because they violated existing assumptions about the “proper” way to structure work. Failures, for-gone options, and unorthodox propositions represent no less important a part of the process of change than the “successful” or completed ventures that have received most attention in past research. Indeed, they are likely to provide critical insight as to how and why a new technology comes to be recognized as a candidate for adoption. But to include them, we must consciously extend the temporal context for investigation.

By extending the temporal context beyond a single moment in time or a discrete episode of change, researchers can define process in such a way that it becomes a meaningful venue for investigation. At a minimum, it becomes reasonable to ask how developments in one system (technical or social) influence not only the structure of the other but also perceptions of the range of possible structures. For example, the introduction of automated equipment to a formerly labor-intensive production process is frequently accompanied by growth in staff (even the establishment of entire departments) responsible for overseeing and refining its use (Udy 1959; Hunt 1970; Hickson et al. 1969). This adjustment has been cited as evidence for the “centralizing” effect of complex and sophisticated technology on organizational structure (Woodward 1965; Perrow 1967). Yet this adjustment, viewed as part of a historical process, could also have the “impact” of reducing the range of technical systems that will be considered (or recognized as possible) at any subsequent moment in time; that is, through the accretion of “automation” expertise, the staff is likely to become predisposed to automation of

technical systems even when pursuit of further automation is not the optimal response.<sup>16</sup>

More extensively, the power-process perspective forces us to distinguish among the activities that make up the process of technological change. Prior research, as I argued earlier, has usually ignored those activities or treated them as subordinate aspects of implementation. Even when more elaborate multistage models are proposed (e.g., Wilkinson 1983; Buchanan and Boddy 1983; Clark et al. 1988),<sup>17</sup> researchers usually pay greatest attention to the activities that *follow* a formal decision to adopt a new technology.<sup>18</sup> By contrast, I argue that the analysis cannot be limited to the final moments of change, that is, to implementation only. Rather, we must include the full range of activities associated with the introduction of new technology, including the *identification* of problems to be solved and solutions to be attached to problems; the *selection* among alternative technologies and, within a given technology, among alternative configurations; and finally, the *implementation* of a chosen technology. Only by attending directly and explicitly to each of these activities can we uncover variations in process and, by extension, to assess what they add to our ability to understand variations in outcome.

However, as should be apparent from the earlier example of automation's possible "future" effects, the analysis of any individual instance of change—no matter how attentive it may be to the activities that make up the process—cannot be undertaken in isolation from the history of changes in either the social or the technical system of an organization.

16. As Perrow (1983, 521) speculated in an essay on the limited influence of human factors engineering in new equipment design, "It would appear that machines and equipment are designed so that they reinforce existing structures and reproduce those structures in new settings." More recently, Cebon (1990), in a study of energy management in universities, found that institutions that maintained a centralized and highly trained staff of engineers were very good at devising and implementing large-scale and very sophisticated systems for regulating heating, cooling, and electrical usage; they could not, however, easily accomplish relatively small-scale technological solutions (such as substituting energy-saving light bulbs for more conventional ones), and they were even less effective at engaging user involvement in energy conservation. Conversely, institutions that maintained a decentralized system for energy delivery, control, and capital budgeting were quite good at small, money-saving changes and at mobilizing changes in energy usage among faculty, staff, and students; they could not, however, accomplish major system changes.

17. For example, Clark et al. (1988, 31) identify five main stages in the process of introducing new technology: initiation, decision to adopt, system selection, implementation, and routine operation.

18. Unfortunately, it is often difficult to tell whether the added stages have real explanatory significance or whether the concept of implementation has merely been shrunk in scope.

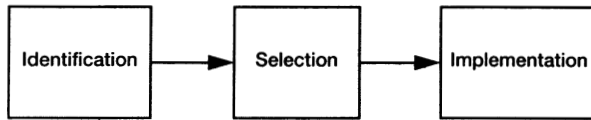


Figure 1. Stages in the process of technological change

Convenience might suggest that investigation be limited to the problems or solutions under consideration at a given moment in time. However, such a restriction would risk the loss of valuable insights about the historical antecedents of what may be defined in the contemporary era as an “important” problem or an “appropriate” solution. Moreover, such a restriction would make it very difficult to gauge the significance of any particular departure from past practice. Likewise, I suggest, to overlook for the sake of convenience the historical roots of the other activities that make up the change process—that is, selection (“choosing within a technology”) and implementation—would risk the sacrifice of additional insight.

For these reasons, I contend that it is essential to analyze the process of change from three different directions: first, as an individual instance of change, complete with attention to the sequence of activities that link process with outcome; second, as an instance of change to be compared with other instances of change (both contemporary and historical); and third, as a distinct set of activities each with a history of its own. (See figures 1–3.)

This sort of historical triangulation increases both the breadth and the depth of data available for analyzing the process of change. It allows factors that are specific to the history and circumstances of change in particular organizations to be identified and compared internally and then externally to change processes in other organizations, competitors and noncompetitors alike. It does not limit research only to changes that were completed; instead, it opens the door to learning about the dynamics of change from failed or stillborn efforts. Finally, and perhaps most important, it provides the opportunity to acquire a better understanding of the factors that influence both the real and the perceived range of possible social and technical systems in an organization.

However, the addition of a historical perspective—no matter how sophisticated it may be—cannot by itself resolve the contradictory arguments of the technological determinist and social choice perspectives. Extending the temporal context leads us part of the way to explaining how, in Perrow’s terms, “structure can affect technology.” But a critical

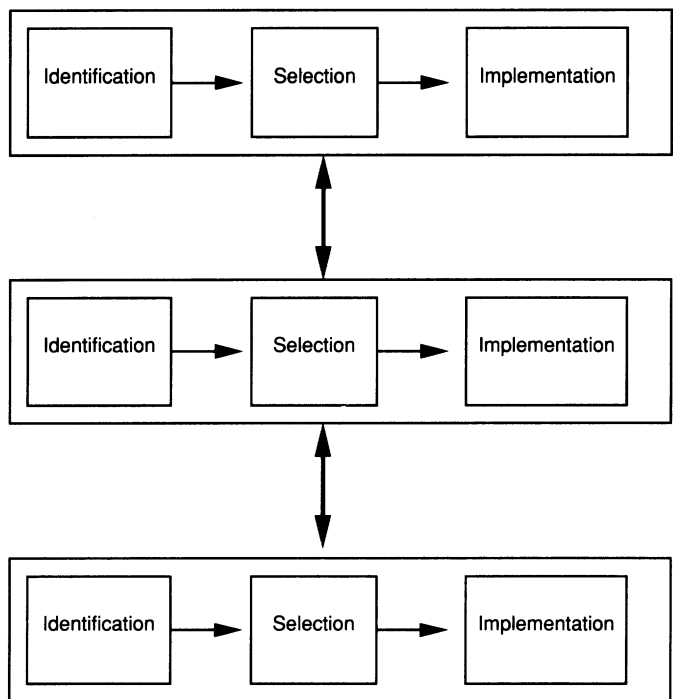


Figure 2. The process of technological change viewed comparatively

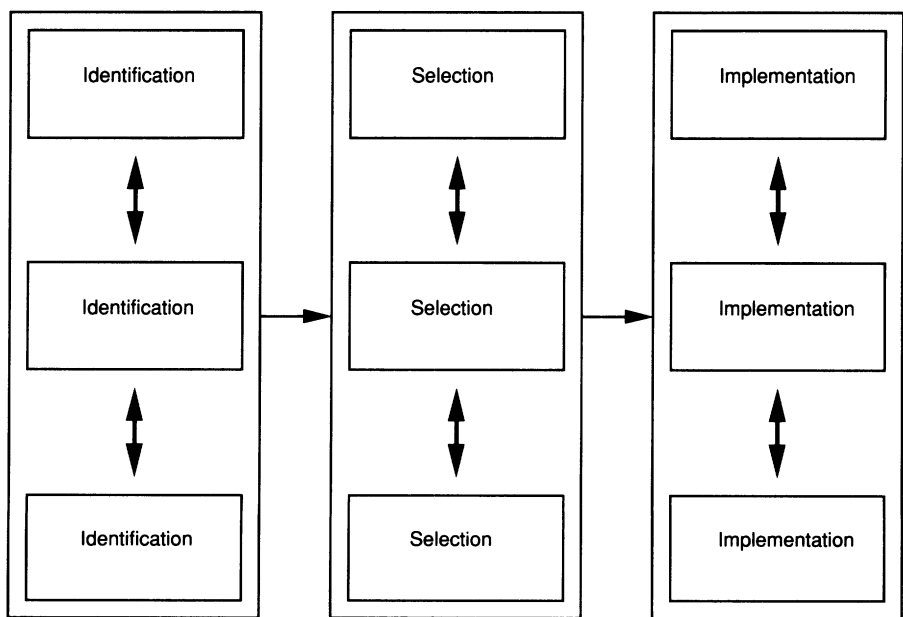


Figure 3. The process of technological change viewed comparatively by stage

feature of the theoretical debate that remains to be addressed is the relative influence of technical and social systems in organizational structuring and change. To that end, we need to extend the organizational context so that we can distinguish the physical properties and limits of technology from the social meanings that may be attached to it, the objectives that may be embedded in it, and the uses to which it may be put.

#### DISSIMILAR LOGICS IN AN ORGANIZATIONAL CONTEXT

The logics underlying the technical and the social systems of an organization differ in profound ways. Trist put it most succinctly: “The technical system follows the laws of the natural sciences while the social system follows the laws of the human sciences and is a purposeful system” (1981, 37). However independent the social and technical systems may seem, he added, “They are correlative in that one requires the other for the transformation of an input into an output. Their relationship represents a coupling of dissimilars.” Virtually all participants in the debate on technology and structure would concur with Trist’s characterization. However, as I noted at the outset of the chapter, agreement breaks down when it comes to the relative influence of those systems in organizational structuring and change.

In many respects the simplest and most obvious answer is also the most correct: that is, both are influential. But to be precise, it’s essential to add that they are influential in different ways. The key to understanding the influence of each—and the significance of their difference—is to begin with a closer examination of the logics that undergird them. Through such an examination, it will become clear that organizational objectives and the relative capacity of different organizational groups to define them play a vital role in the “coupling of dissimilars.” It will also become clear that at least part of the disagreement among researchers can be explained by their tendency to confuse determinism with dominance. That is, those who place their bets on technology as the determinant influence are not completely wrong; however, because they so rarely investigate how technical systems are constructed organizationally, they underestimate the influence of concerns about authority and control in organizations on the choice of technology. Those who argue from a social choice perspective put organizational objectives closer to the heart of the analysis; but because most overlook the constraining influence of technology, they far too often slip into simplistic analyses of