CORPORATE REFORM IN AMERICAN MANUFACTURING

AND THE CHALLENGE TO ECONOMIC THEORY

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Part I: The Revolution in Corporate Structure

The interviews yielded three different types of findings. First, the companies were in the process of introducing a series of deliberate, self-conscious reforms, which they themselves viewed as fundamental changes in organizational structure and practice. Comparable reforms are also widely reported in the business press. They may be taken as the markers of the revolution in process. Second, the interviews revealed a widespread consensus among the managers in all of these companies about the way in which the geographic dispersion of production and authority within the organization would evolve over the next ten years. This vision has not generally been reported in other commentaries about the evolution of business practices and it contrasts sharply in certain respects to the conventional wisdom about trends in the international division of labor; for that reason alone it is worthy of attention. It also casts the reforms in a somewhat different light than they appear when the list is presented by itself. Finally, the interviews suggested a variety of tensions surrounding the reforms. These tensions are frustrating the attempt to revise the corporate structure and might ultimately lead to unintended and unanticipated outcomes. It would require much more intensive, longitudinal case studies to develop this aspect of reform process but the interview material nonetheless suggests certain revisions of the initial hypothesis which are developed in the second section of the paper.
A. The Markers of Corporate Reform

The markers of the revolution in corporate structure and managerial practice are multifold but the essence of the changes appears to be captured by a list of five items:

1. In terms of the classic corporate structure, the most startling of these reforms is the shift to matrix management. The traditional corporation was organized by lines of business and/or function with clear lines of authority and a strict division of labor. In the new structures, there are overlapping responsibilities and managers report simultaneously to several superiors. This organizational form was not completely unknown in the past, but previously it was largely used to compromise the choice between a functional and a line of business structure and the matrices were essentially composed to these two types of units. Now, not only is this older matrix structure becoming much more common but firms are introducing other two dimensional matrix structures and in some cases, multidimensional matrices. The effect is to increase lateral communications within the organization as subordinates try to forestall conflicts among their several supervisors by resolving problems at lower levels of the organizations themselves. Matrix structures also give more independence and authority to subordinate levels of the organization and increase their direct responsibilities. Other reforms which enhance these effects include a conscious reduction in the number of managerial levels and an effort to develop decentralized systems for monitoring and rewarding performance typified by the expansion of the number of independent profit centers within the organization and of performance based compensation systems. There has also been an increase in internal competition
among components of the organization. In most cases, especially in manufacturing, this seems to have been the result of overall excess capacity but some companies have deliberately created organizational components with parallel capabilities and orchestrated a competition among them sometimes with outside vendors - for company business.

2. A second reform involves the increased use of managerial teams and of parallel, as opposed to sequential or iterative, decision-making processes. This is most apparent in engineering where the classic procedure is to pass a decision down an engineering hierarchy, starting with product engineering, passing to process engineering where the equipment is designed, and finally to industrial engineers who design the plant layout and the initial manning tables. In principle, the design can be passed back from the latter stages, but in practice, designs at one stage tend to be frozen before they move forward and are revised only when truly insurmountable obstacles arise further on. The new procedures involve groups of engineers working simultaneously on all aspects of the project and interacting with each other continuously so that process and industrial engineers have a say very early, long before the product design is complete. In some companies, the design teams include not only the company's own engineers but personnel drawn from outside parts producers and from among the production and maintenance workers as well. These new engineering procedures have been facilitated by technological developments, particularly computer aided design, which makes it possible to keep the product design fluid until relatively late in the engineering process and to simulate alternative manufacturing approaches without actually creating and testing a physical model. Much of the pressure to adopt these
new structures is also technological: the shortening of the product life cycle and the use of more flexible production equipment means that manufacturing equipment typically outlasts any single product, which was not typically the case in the past when most equipment was dedicated to a particular product design. Since the equipment is not created anew each time around, however, embedded technologies are more of a constraint on the design process than they were in the past.

In one sense, these project teams (or "Skunk works" as they are called) seem to work in the opposite direction from that of matrix management: they tend to centralize decision-making, sometimes moving engineering capability out of the shop toward higher levels of the corporation, and to blur individual responsibility. They operate like matrix management however to abrogate a strict functional division of labor, to enhance lateral communication, and to replace traditional hierarchy with more egalitarian relationships.

3. A third set of changes involve the relationship between the corporation and outside organizations with which it does business. These include both vendors and subcontractors from which the company traditionally purchases inputs into the production process, and other businesses which the company purchases in an effort to expand its product line and/or diversify. Traditionally, U.S. companies have had an arm's length relationship with suppliers, buying from a large number where possible and encouraging competition among them. The reforms involve a reduction in the number of suppliers and more permanent and collaborative relationship with those which remain. It is these new permanent partners which are asked to join the
engineering design teams: typically, they are encouraged to locate facilities close to the plants which they will supply and, as will be seen below, to feed directly into the production process.

At first glance, the collaborative relationship with parts manufacturers appears in contradiction to the internal reforms which create competition among corporate division and between corporate units and outside producers. But the contradiction disappears if one sees the thrust of the reforms as an effort simultaneously to displace the boundaries of the organization, while at the same time changing the relationship among the organizational components within those boundaries. The boundary is being moved out to encompass within a larger community of interests a number of organizations which are formally independent entities, but at the same time internal units are being encouraged to assume some of the independence of outsiders. Thus, for outsiders, this seems to involve closer collaboration and for insiders more distance.

That this is the case is especially apparent when one examines the new strategies for innovation. The old strategy was to look for new products in companies outside the organization, purchase the concerns which were producing them and integrate the new acquisition. A new division was often created for the product which had motivated the purchase and the other operations of the acquired company were closed down, sold off, or distributed among other divisions of the corporate purchaser. In the new strategy, outside companies are seen not so much as the source of a particular product but rather as a source of entrepreneurship and technological creativity that a large organization cannot maintain internally. Hence the trend is toward some form of arm's length financial participation which establishes a collaborative
relationship without abrogating the separate identity and personality of the outside organization. Interchanges among the personnel of the two companies are encouraged and the large corporation may commit itself to produce new products under license or in separate joint ventures but one organization is not folded into another. Typically, moreover, these forms of intimate collaboration with outsiders are accompanied by parallel efforts to give insiders the independence required to engage in entrepreneurial activities internally. These include opportunities to create separate divisions to produce and market new products and funds which provide seed money for corporate employees to leave the company and open their own firms on the outside.

4. Still another series of organizational reforms are associated with the movement to reduce, and ultimately eliminate, in-process inventory in manufacturing. This began as an effort to imitate the Japanese *kanban* system in which automobile subcontractors delivered parts just in time to go into production, dispensing with the warehousing which used to be required at the assembly site. The procedure has the advantage - assuming that the parts producers do not simply maintain the inventories at their own plants - of increasing the ease with which the production facility can shift from one product to another since it no longer first has to work off in-process inventories. But, for this to work out, inventories have to be eliminated not only at the entry of the production process but all along the line as well. Production without inventories, however, fundamentally changes the relationship among work stations. American manufacturing has traditionally been organized as a classic Adam Smith pin factory. Each operation was
designed to be done in isolation, in accord with its own internal logic without reference to the operations which preceded or followed it, and a premium was placed on the continuous employment of both capital equipment and labor. This approach to production encouraged - or was encouraged by - the use of highly specialized, dedicated equipment and labor. Both labor and capital were essentially useless when not engaged in their precise assigned task. It encouraged an approach to production which tried to minimize equipment downtime. Workers, when they were not needed in American shops, were simply laid off. It also created a natural hierarchy. Since each work station functioned in isolation, only the supervisor standing outside understood the whole enough to control and coordinate it. But the approach is only really feasible so long as there are large banks of in-process inventory between work stations. Only then can each work station go on operating irrespective of what happens upstream in the production process. As soon as those inventories are eliminated, attention is focussed upon the relationship among work stations in an altogether new way. In order to insure continuous production, workers are forced to relate to, and learn to understand, adjacent operations. Once they do so, they become capable of coordinating the production process and the supervisor no longer performs quite the same function. At the same time, since downtime is now inevitable, pressures are generated to find ways of employing idle resources in secondary tasks. This in turn creates an environment more conducive to flexible machinery and more generally trained labor and a management attuned to the problem of finding supplementary tasks, and this in turn creates a set of dispositions favorable to moving away from the traditional system of lay-off and recall toward
continuous employment policies. In its fundamentals, then, the impact of the elimination of in-process inventories is very much like that of matrix management and engineering teams: greater lateral communication, less hierarchy, a more broad-based, generally trained labor force and greater capacity to respond flexibly to changing market conditions.

5. Finally, these changes in corporate structure and managerial practice have been accompanied by significant changes in industrial relations. These include a decentralization of collective bargaining to the plant level, a shift in the focus of collective bargaining from the negotiation and applications of rules and procedures to the negotiation of substantive outcomes; a broadening of job classifications and permissible work assignments; a movement away from lay-off and recall based on seniority toward continuous employment; the introduction of quality circles and similar forms of worker participation in production planning and shop management; a movement in compensation from rates based on job assignment to personal rates based on skill level and "knowledge"; profit-sharing; and worker representation on corporate boards of directors. None of these changes should be too surprising in light of the changes in work organizations associated with the elimination of in-plant inventories, although they are an independent phenomenon not in any sense confined to those operations where inventory policies have been changed. But like that reform and the changes affecting managerial organization and structure they have the effect of enhancing workers' independence while at the same time reducing hierarchy and increasing the capacity and the incentive to communicate laterally across work divisions.
B. Geographic Reconfiguration

In addition to the markers of corporate reform, the interviews revealed what the informants described as a new vision of the manufacturing process. This vision could not be anticipated solely on the basis of recent reporting in the business press, yet it was very widely shared. Indeed, the way in which it was described from one company to the next was so similar that it is difficult to believe that the views being expressed were really independent. In a certain sense, however, this is irrelevant because many of the respondents were in a position to realize that vision through their own actions, and, in fact, had already moved to do so.

The central elements of that vision are as follows:

(1) Productive equipment can no longer be dedicated to a single product, because the product life cycle is now so much shorter than the life of the equipment. Hence, production will depend increasingly on Computer-Aid Manufacture (CAM): multipurpose equipment adjusted to the production of the particular product through a computer program. A corollary is that a number of different products can be run simultaneously on the same production line.

(2) The cost of direct labor as a proportion to the total is falling rapidly and will soon no longer be an important factor in business decisions. This will obviate the need to locate factories in areas with low labor costs; in the next ten years, most companies will abandon those developing areas whose low wages are their principal attraction.

(3) With decreasing economies of scale in production and minimal direct labor costs, location decisions will be dominated by pressures to
produce within the major national markets. These pressures are coming from what the engineers describe as an inevitable trend to protectionism in foreign trade. As a result, most companies plan to produce in the future in the US, Japan, the EEC, and in the large developing countries. Among the latter, Brazil, Mexico, and India are generally mentioned.

(4) The engineers believe that there will still be substantial economies of scale in product development and design. As a result, they plan to concentrate design facilities mostly at corporate headquarters but perhaps also in certain foreign centers with large pools of highly skilled manpower (again, North America, Western Europe and Japan are generally mentioned). Design will be computer-aided (CAD) and feed directly into CAM equipment at the dispersed facilities over long distance telephone lines.

The most startling thing about this vision of the manufacturing process is the geographic distribution of production and power which it implies and how that distribution conflicts with conventional views of the new international division of labor. The developing world, rather than drawing production away from the industrial nations is essentially written off. The location of production is determined by market size not labor costs. Production is decentralized but real power, responsibility, and control is not: the new technology is in fact used to centralize control at headquarters; power and responsibility may be slightly more dispersed but follow the distribution of engineering and design talent not wage levels.
C. Conflicts and Tensions

The third type of material which emerged within the interviews consisted of a series of insights into the tensions and conflicts inherent in the efforts at corporate reform. It is impossible to do justice to these findings in a format of this kind but the tensions which seem most relevant to the analytical issues discussed in the second part of this paper may be summarized as follows:

The central tension which seemed to emerge in the interviews is between the decentralization which the reforms are generating and the organization as a single entity. The question which lurks in the background, in other words, is: Can power and responsibility be delegated to individual organizational components without jeopardizing the integrity of the organization as a whole? This problem emerged in different forms in different companies, although in its generic form, it was pervasive.

It was most acute in the company which was structurally closest to the classic Chandler-Williamson corporation. This company has historically produced a group of clearly defined products for an identifiable set of markets, most of which it has dominated for almost a century. Those traditional markets are now however largely saturated; the company moreover faces sharp competition from several large and powerful competitors; and the old market boundaries are dissolving as computer and telecommunication technology combine to bring hard images, image reproduction, computer systems and long distance telephone lines, and transportation and delivery all into direct competition. The company's strategy is to use the technological competencies associated with its old product lines to develop and market new
products, but it does not have a clear idea what those new products are likely to look like. Hence, it is decentralizing authority in an attempt to give its various components the freedom to discover new directions. It talks about refocusing its activities around its "core competencies" but it does not know what these are, and one suspects that the attempt to restructure the organization in this way may be like peeling an onion. Meanwhile, the old organizational culture survives and middle management is continually frustrating attempts to change the traditional hierarchical structure. One of these managers, most tellingly explained how he had "solved" the problem of matrix management by anticipating and removing all ambiguity in the lines of authority so that pressures for lateral communication were completely eliminated.

A second company, in a different industry, but also confronting the competitive problem posed by the dissolution of barriers between transportation, communication, computers, imaging, and storage technologies created a major independent research facility to bring new technological competencies into the organization. The facility, was located close to the institutional centers where the new technologies were being developed but far away from the company's other activities. It succeeded in becoming a leader in these technological developments but without impact on the companies own products. The innovations of the research facility were almost all brought to the market by outside organizations, some of which turned out to be the company's major competitors.

The case which is most telling, however, is the company which up to now has been most successful in creating and maintaining the decentralized
organizational structure. This company manufactures a series of components which are linked together to form an operating system, like a computer network or a stereo system. The company's competitive advantage in the industry comes from the capacity of its products to network with each other in order to form systems which are peculiarly adapted to the specialized needs of individual customers. The company's operations thus divide into two major components: One of these is the production of the component parts, i.e., manufacturing in the strict sense of the term. The second component is the construction of the network or system to fit the customers' needs: this component is closely tied to sales and is essentially a service activity. Manufacturing and service must nonetheless be closely linked so that the capacity of the products to network with each other as they evolve in time is maintained; so that the people who built the products into systems are aware of the product capacities and are capable of stretching those capabilities to the maximum to meet the customers' needs; and so that the manufacturers sense the pressure of customers' needs, which are actually experienced only by the sales people, and are led to reflect those needs in subsequent equipment design.

The organizational structure which has evolved in an attempt to meet these requirements is very unstable: it has been revised several times in the last ten years and further revisions are under discussion. Hence the instability of the structure can almost be taken as its salient characteristic. Each of the structures which has emerged, moreover, involves apparently confused and certainly ambiguous lines of authority: the confusion and ambiguity are of course heightened by the continual organizational reform. There have been historically, for example, three distinct sales structures:
geographic, industry, and profession. Hence, any given client falls in principle within the territory of three sales representatives, creating a sense of competition internally which various organizational structures have sought to temper or resolve. In addition, the company sells a good deal of its equipment through third parties which provide the services involved in building the equipment into networks and hence compete with the internal sales and "service" divisions.

A second major organizational issue concerns the relationship between manufacturing and sales. The company has been unable to resolve the question of which of these two functional divisions is subordinate and how to allocate profits and resources between them. The appearance of confusion and conflict is further heightened by a corporate culture in which subordinates are encouraged to be outspoken and to challenge their superiors, and by a great deal of lateral communication and lateral movement of company personnel across the various departments and divisions.

This organizational structure is the subject of continual concern within the company itself, and outsiders are often shocked, and generally critical of the company's internal operations. Nonetheless, it is clear in interviews with personnel inside the company that it does tend to create a network of people who know - and know well - both the company's markets and its products, and that in the continuing effort to adapt one to the other, they know to whom to talk outside of their own domain. Often they have a good idea, from having worked in other parts of the company, exactly what needs to be done. Finally, the organizational structure not only necessitates the kind of lateral communication which networking entails but, as noted above, the organization's
culture encourages it as well. People are expected to take the initiative themselves and to challenge higher authority. The structure then appears to be designed to insure that the company's physical products, as they evolve in time, are likely to be compatible with each other, and that they will be stretched toward customer needs. The organizational structure is thus a metaphor for the company's product; actually, it is more than a metaphor: the product is a reflection of the structure. A great deal of deliberate effort is directed at insuring both that the company's products are capable of networking with each other and that these networks can be stretched to meet specific customer needs. But the organizational culture is such that if everybody were to be suddenly isolated from each other and left to perform their current functions on their own, the product line would continue to evolve for some time into the future in a way which promoted the twin goals of compatibility and customization. Thus, despite the instability of the company's formal structure, the organization could be said to have reached some kind of dynamic equilibrium.

That equilibrium is now being threatened by the geographic redistribution of the company's operations in response to protectionist pressures. The question which is being posed is how long the centralized design of a limited product line can be maintained in the face of the decentralization of production and sales. It seems hard to believe that the protectionist pressures, if indeed they are as a commanding as the engineers seem to believe, can be accommodated simply through the decentralization of production facilities, especially if these facilities no longer yield much employment. But in this firm, one would hardly need political pressure to
produce this result. Once production takes place in physical proximity to the customer, the manufacturing end of the business will be in much closer physical contact with sales and service than with product design. The increasing flexibility of the production equipment makes it relatively cheap to change the physical product to meet the customer needs. The organizational culture validates the pressures to do so and the kinds of organizational alliances likely to accommodate them. It may be difficult to design a totally new product at the production facilities but marginal changes in existing designs should not be too difficult to introduce. The skills necessary for these purposes are not all that different from those required to assemble, out of standardized components, a customized network and the internal mobility and staffing patterns of the company make it easy for a division to acquire internally personnel with whatever supplemental skills are required for this purpose.

Declining economies of scale in manufacturing is one of the basic hypotheses which the interviews on which this paper is based were designed to investigate. The manufacturing engineers resisted that hypothesis adamantly, so adamantly that the resistance appeared less a response to the abstract question than to real pressures within the organization. Other respondents in the company confirmed that view and were even prepared to talk about how the integrity of the product design could be invaded, which parts could be changed easily without seriously raising production costs and where a change would actually pose the kind of threat to cost control that the manufacturing engineers were attempting to protect themselves against. Clearly, in their image of the business, the customization of the product would not in the long
run be limited to the configuration of a standard set of parts. What remains unclear is how far the integrity of the standard product line is likely to be invaded. In the minds of all respondents there would be decided limits to this process. But, given the fact that the technological trends and the environmental pressures are all promoting a progressive reduction of economies of scale and a growing flexibility in all aspects of manufacturing, these limits will probably contract over time.

If the organizations reviewed for this study were to dissolve, what would emerge in their place? Williamson and Chandler draw a sharp dichotomy between the classic corporation and the market. The dichotomy implies that the changes now in progress are moving toward a set of isolated business units communicating with each other indirectly through price signals. This prognosis, however, seems to be largely a product of the poverty of the conceptual apparatus with which we are working. Outside the corporate sector, where small independent business units predominate, organization seems to be moving in other direction. Not, to be sure, toward a single integrated business entity, but toward a relatively closed community of firms variously described as industrial districts, federations, co-contractors, and networks. These communities are held together by a common industrial culture and a jargon (or language) that permits a much richer structure of communication than the impersonal price signals of the market. The development of such communities is suggested by a diverse set of case studies ranging from traditional manufacturing districts in central Italy to high tech centers in Silicon Valley and around Boston's Route 128. The attraction of geographically centered high tech communities constituted the hidden pressures
upon the classic corporation, not visible in the interviews, but more obvious when these corporations are seen from the outside; these pressures are pulling the centralized design facilities in one case, the distant laboratories in the other, away from the corporated culture and into the culture of the local scientific and engineering community. This suggests that to capture the changes in progress, we need a much richer conceptual apparatus. We thus turn, in the next section, to examine the problems which that poses.
Part II: Practice and Theory

The basic question which emerges from a consideration of evolving business practice is thus that of where the reforms are headed. Why was the tightly integrated, hierarchical corporation once considered an efficient organizational structure? What has occurred to render it less efficient now? Why do the particular reforms being introduced seem to increase efficiency? And where is the reform process headed? Which of the reforms is likely to prove stable in the long run? What kind of new organizational structures are likely to emerge as the end product of the reform process?

It is natural to turn to economic theory for an answer to these questions and, in that context, not only to ask whether theory provides the answers but also, to the extent that it does not, to use the management practices which give rise to the questions to point toward the directions in which theory could be revised.

There are two basic theoretical approaches to the understanding of organizational structure in economics. The first explains structure by reference to the exigencies of production and the characteristics of the technology; the second by reference to the problems of exchange, or transactions. The interviews upon which this paper is based were designed to explore a set of hypotheses about productive technology which I developed in collaboration with Charles Sabel in The Second Industrial Divide. Perhaps for that reason - but also, I believe, because it is more natural to the way in which the respondents themselves think about organizational problems - the views expressed in the interviews lend themselves naturally to the language of
production theory (although not necessarily to the particular theory which Sabel and I developed). The first part of this section accordingly attempts to interpret the results in those terms. The new theories of industrial organization which are exciting the main stream of the economics profession are, on the other hand, transaction based. The second part of this section discusses what it might mean to translate the interviews into the language of transaction theory and what such an effort suggests about the strengths and weaknesses of that theoretical approach.

Production Based Theories of Industrial Organization

The basic postulates of production based theories of industrial organization were initially developed by Adam Smith. They are essentially twofold: (1) productive efficiency is dependent upon the division of labor and (2) the division of labor is limited by the extent of the market.

Smith's basic idea of the division of labor, and the engineer's view of the theory underlying the tightly integrated, hierarchical organizational structures, was that productivity would be maximized by dividing the productive process into as many distinct tasks as possible and developing resources which were specially adapted to the performance of each task. The prototype of this structure was, for Smith, the pin factory. The modern prototype was Henry Ford's model T assembly. At each work station, there is a worker who is specially trained in the requirements of the particular tasks at hand and/or a machine which is specially designed for that purpose. The highly articulated functional divisions of the Chandler-Williamson corporate structure are simply an extension of this same logic: the division of
responsibilities within the organization on the basis of product lines and functions is precisely analogous to the division of work within the pin factory into the separate jobs of "wire-puller," "wire-cutter," "pin-header," "pin-pointer," etc. The organization of productive activity in this way poses, however, certain problems.

First, the extensive division of labor creates a problem of coordination. When there is an elaborate functional division of responsibility and the people who are assigned those responsibilities are narrowly specialized, they lose sight of the larger picture and they no longer possess the knowledge required to coordinate their activities with those of other parts of the organizational structure. In order to make sure, then, that the parts fit back together to form the whole, the separate elements of the productive process, or the separate divisions of the organizational structure, must be strictly subordinated to some higher authority which does possess the knowledge and the information required to coordinate the separate activities. It is this requirement which explains the tightly integrated, hierarchical structure of the old corporate organization.

Second, as Smith emphasized, the efficiency of the division of labor is limited by the extent of the market. Unless the market is large enough to absorb the increased output which the new organizational structure permits, the resources which it entails will become unemployed once the market has become saturated and, since the efficiency of these resources is achieved by specializing them to the particular tasks at hand, they will be unemployable elsewhere in the economy. By an extension of this logic, the market must also be relatively stable and predictable. Production can be maintained in the
face of small, predictable fluctuations in demand by varying inventories but, if demand fluctuations are large or unpredictable, producers will be reluctant to hold inventories and the specialized resources will be laid off. The market must be willing to absorb, moreover, a relatively standard product otherwise it will be impossible to stabilize and define the separate work tasks. Much of the evolution of the modern corporate organization can be understood in terms of the need for markets which meet these requirements.

The dominant explanation in the interviews for the changes in organizational structure was that the business environment is no longer conducive to the production of standardized products for a stable market. Any number of different explanations were offered in the interviews as to why this was the case: increased instability and uncertainty (due to floating exchange rates, fluctuations in the price of oil, interest rate variability and the like!); increased consumer demand for variety (attributable to higher incomes); a more rapid pace of technological change; and a greater flexibility in the underlying technology itself. Some of these factors are probably basic, others derivative. It may not be possible to separate out the chain of causality. In any case, it does not appear that for our purposes it is necessary to do so. The relationship to the organizational changes is clear: instability and uncertainty essentially translate into risk; they encourage the diversification of resources. The emergent organizational structure is an effort to diversify.

These views are congruent with the argument which Sabel and I developed in *The Second Industrial Divide*. We argued further, however, that the changes in the business environment (to use the managerial term) were leading to a new
technological paradigm which we called flexible specialization. This new paradigm brought back into play the principles of craft production as it was understood and practiced in the mid-19th century. Its essential characteristic is that, relative to mass production, it uses much more general resources to produce an ever-changing product. We argued that this led to a much looser organization structure but one in which, unlike the market of neoclassical theory, competition was limited by rules and procedures which forestalled wage and price cutting in such a way as to channel entrepreneurial activity into product and/or process innovations.

The interviews were not supportive of this second part of our argument. A number of the managers and engineers who participated in the study insisted that the adjustments that they were making did not imply the end of mass production at all. Instead, they suggested that the economies of scale associated with mass production were simple shifting from investments in labor training or in the physical equipment to investments in software or in marketing. A few, like the manufacturing engineers in Company I, insisted that economies of scale would continue to be important even in production itself. Indeed, the basic proposition about flexible specialization was disputed by enough of the respondents so as to create the suspicion that the remainder had simply misunderstood the hypothesis or were too polite to attack it directly.

This conflict suggests the need for a much richer typology of the ways in which production forms are accommodated to market characteristics.
Mass Production, Flexible Mass Production, and Flexible Specialization

The basic logic of flexibility would seem to imply a six-fold distinction. At one extreme is classic mass production: a productive system which is able to produce only a single product. This system has in fact probably not existed in its pure form since Ford's model T. It was replaced early in the history of the automobile industry by a second system which might be called mass production with cosmetic variation. As consumers of the products of such a system, we all have an intuitive understanding of what it means: variation in the superficial aspects of the design, i.e., the paint, the trim, the upholstery, and the capacity to add options such as radios, power steering, automatic transmission, etc. It is a little more difficult to define this alternative formally. Essentially, it seems to involve a distinction between independent and interdependent design features. Independent features—the paint, the trim, the upholstery—can be varied in isolation without complementary changes in other features of the design. The marginal costs of such variations is thus relatively low. Interdependent features such as the motor block, the chassis, and the like require a number of complementary adjustments. In principle, one might think of design features as forming a continuum in this regard (measured for example in terms of the marginal cost of adjustment). But the notion of cosmetic variation seems to imply a sharp dichotomy between design changes which are easy to make and those that are not.

The approach which the American manufacturing firms are now taking goes considerably beyond cosmetic variations. It seeks to introduce into the productive system the capacity to produce several, basically distinct designs.
This became economically feasible with the introduction of computer-aided manufacture: it involves the use of relatively general equipment specialized to a particular design by a computer program. Instead of a program which produces one design, programs are written for two, three or four designs. It is in this sense that the scale economies shift from the equipment itself to the programming. This third alternative can be called flexible mass production. Formally, it is a productive system which consists of a closed set with a finite number of elements.

Flexible specialization involves still a fourth type of variation, one in which the number of designs is not predetermined. Variety in flexible specialization is thus infinite whereas in flexible mass production it is finite.

Within systems of flexible specialization, however, one can make a further distinction between closed systems and open systems. A closed system is one in which the boundaries upon variety are fixed and unalterable. An open system is one in which the boundaries can themselves be changed. The distinction coincides roughly with the distinction between the garment industry of New York City, which produces only garments and among garments basically only those of a recognizable "New York" style, and the Route 128 Venture Club, which generates firms producing a constantly new, and different set of products.

Finally, it is useful to classify open systems in terms of the cost of moving to new designs. In any system, some moves will be incremental and some will be large and discontinuous. As will become clear below, an open system for which a change is large and discontinuous is in some respect similar to a
system of flexible mass production.

In sum, then, we have identified three types of mass production: classic mass production, mass production with cosmetic variation, and flexible mass production; and three types of flexible specialization: a closed system, an open system with marginal adjustment, and an open system with discontinuous adjustment.

When one rereads the interviews with the aid of this typology, it becomes clear that some of the respondents see the changes over which they are presiding as a shift from classic mass production to flexible mass production while others see those changes as a shift to flexible specialization. The organizational reforms which we are observing are thus associated with two distinct, albeit related, organizational paradigms. Relative to classic mass production, both involve more decentralization of authority and more general resources but the degree of decentralization and the degree of generality is different in each case.

Take first the case of flexible mass production. It is clear that it requires a change in inventory policy; either in-process inventories have to be increased to the point that there are banks of parts for each model in the repertoire, or else, in-process inventories must be eliminated altogether so that they do not inhibit the shift from one design to another. All three companies appear to have chosen the latter alternative. This inevitably involves much greater interdependence amongst work stations and hence more lateral communication within the production process. There is also more lateral communication between production and marketing, for the information from the latter is required in order for the former to know exactly what to
produce. All of this appears as a decentralization of authority.

Nonetheless, the product designs are still built into the system in advance and hence the product engineers direct the whole organization. The communication between marketing and production occurs within the context of a predetermined menu of designs as does the communication among work stations within the production process. The "despecialization" of resources is limited in a similar way: both the equipment and the work force are by definition less specialized. But their real generality may still be limited to the range of products actually being produced. From the point of view of the "humanization of work", the outcome may be particularly disappointing: the workers are likely to have more variety in their jobs than in classic mass production but production could still be taught to them as a routine, or more precisely a series of routines, which permit little scope for originality or improvisation, and however great the workers' responsibility in switching from one design to another, it would still be exercised within strict limits imposed by the design engineers. (Actually, in the companies studied, it appeared that equipment in flexible mass production was becoming quite general but worker training was not. Thus the engineers talked about equipment which would outlast any given design cycle and whose capabilities might thus constitute a constraint in design but, at the same time, about workers who were still retained for each product cycle so that there was no point in seeking their participation in the design process, however useful their participation might be in the production process itself, once the designs were frozen and the decision limited to those associated with the switch from one item on the menu to another.)
With flexible specialization, the same organizational reforms have much more far reaching effects and achieve a qualitatively different result. This is so because the menu of products is not known in advance: it is necessary to continually invent new items. In-process inventories must be eliminated: since you no longer know what will be produced, it becomes impossible to stockpile in advance. But the lateral communication in production which results is no longer simply the effect of reducing the isolation of the work stations. Workers must have a genuine skill which enables them to figure out how to do new operations. The equipment must similarly be able to produce a whole range of products. Marketing and production are forced into a genuine collaboration, which may circumvent the product designers at the center (in fact the design process is de facto decentralized).

It should be noted that all of this is true simply because the set of possible products is infinite. But if the set is also open and the changes discontinuous, the decentralized authority and general resources associated with changes within the original set or marginal expansions in the set itself may be combined with centralized authority responsible for the decision making and investments in equipment training associated with large, discontinuous changes. This is essentially the structure one sees presently in company I.

**Is Flexible Mass Production Stable?**

While it is clear in the light of the extended typology that many of the reforms discussed in the interviews were really intended to implement a system of flexible mass production and not flexible specialization, one can still wonder whether flexible mass production is likely to prove a stable
technological form given the changes in the business environment to which it is meant to respond.

Two considerations suggest that it is not. First, the tendency in all of these companies is clearly toward an increase in the range of basic designs which they can offer at any moment of time. Thus, over time, they are being pressured to move towards systems with the capability of producing two or three basic designs but ultimately towards systems capable of producing fifteen or twenty varieties. As one increases the number of varieties in this way, one must eventually cross a threshold where it seems more natural not to try to anticipate the market in advance but rather to build into the system the capacity for marginal innovation. The second set of factors which suggest that this is likely to happen involve the background conditions in which the movement towards flexible mass production is taking place. The engineers and managers interviewed all seem to share two basic assumptions. One is that the equipment will outlive any given product design and hence must be much more general than the programs which are being run on it at any moment of time. Second, the product life cycle, i.e., the time between generations of products, is decreasing. The last assumption creates a lot of pressure towards continuous design, which is essentially what is involved in an open system of flexible specialization. The first factor, i.e., the flexibility of the existing equipment, suggests that once people begin to build open systems, the systems will be relatively easy to implement.

Finally, one might add that in most of the industries studied, discontinuous changes in the product design may still remain an important factor in the evolution of the industry. To the extent that this is the case,
there is likely to remain an important central component of the organizational structure. Nonetheless, the shift from flexible mass production to flexible specialization will involve considerable decentralization over and above that which is presently being contemplated.
**Transaction Cost Analysis**

How does the engineering (or technological) view of organizational structure translate into more contemporary economic approaches? The most comprehensive contemporary statement is Oliver Williamson's transaction cost economics. As we saw at the outset, in Williamson's view, the principal organizational alternatives are the corporations and the market. In the latter, transactions are governed by contract, and the essential thrust of transaction cost economics is to identify a set of factors which make it difficult to write contracts covering certain transactions and hence lead to the internalization of these functions instead within the corporate organization. The principal forces upon which Williamson focuses in this endeavour are specialization, uncertainty, and small number. Specialization reduces the numbers of people performing any given operation. The reduction in numbers eliminates competition which might otherwise force people to reveal the true costs of performing a given task and gives rise to uncertainty as to exactly what the cost is. Such uncertainty forestalls stable, long term relationships and internal organizations arise because they merge the two protagonists into a single unit, essentially overcoming this problem.

Small numbers and uncertainty are clearly critical factors in the organizational shifts which are presently occurring, but they seem to be associated with the demise of the corporation rather than with its origins. As we have just seen, the whole thrust of the progressive division of labor is to create productive components which are so specialized that any shift in the level or composition of output renders them unemployable. Hence, the division of labor is intolerant of variability, particularly variability which is
unanticipated. The classic corporation which Williamson set out to explain existed in an environment in which these factors had been minimized. Indeed one can argue that the corporation arose out of the effort to create exactly that kind of environment, by gaining control over a set of factors which in a competitive economy tended to aggravate instability and uncertainty. In this sense, the rise of the corporation is certainly associated with uncertainty but with the effort to change uncertainty not to accommodate it. Nor does the division of labor associated with the corporation create a small numbers problem in the sense that this problem is understood by Williamson. It is true that the number of people performing a given operation is minimized (in fact, the logic of the division of labor is that only one person performs any given operation) but, by the same token, the number of times the same operation is performed over time is increased (in the logic of the problem, it becomes infinite). And this increase in the number of repetitions permits a variety of monitoring devices and incentive schemes which enable the parties to learn about the capabilities of their trading partners while at the same time extending their time horizons to the point where it justifies the investment which that learning, and the subsequent negotiation of a contract, requires.

Indeed, there is considerable question as to whether the distinction between the corporation and the contract is meaningful at all. Interviews with managers leave the impression that the amount of information generated in the classical mass production operation of the past was more than sufficient to write a series of specific contracts for each of the critical internal inputs, and that the fact that there was in reality only a single organization
had more to do with historical accident than with the logic of the transactions involved. On the other hand, the environment in which reforms of the classic corporation are now being introduced makes both contracting and tight internal integration difficult.

A more promising approach within the transaction cost tradition is suggested in a recent paper by Sanford Grossman and Oliver Hart entitled "The Costs and Benefits of Ownership: A theory of Vertical and Lateral Integration." For Grossman and Hart, the critical issue in organization theory is what they call the rights of residual control. These are the rights to make decisions concerning the redeployment of resources which are not anticipated in a contract between the parties cooperating in the production process. When these are held by organizational components downstream in the production process, the organization is tightly integrated. When they are held by organizational components upstream, the organization is more decentralized. The relative costs of allocating these rights in different ways depends upon the relative uncertainties attached to different outcomes and the distribution of the information required to make the optimal decision for contingencies which are expensive to anticipate in advance. The interview material is easily assimilated to this model: the increased instability in the business environment has made the number of contingencies which would have to be anticipated in a written contract very large. At the same time, it has promoted a flexibility of productive resources, and this has in turn meant that more and more of the critical information is located upstream in the production process (or, at least, at lower levels of the organizational hierarchy).
The ability of this model to assimilate the recent corporate changes to a transaction cost framework is, however, more limited than it appears. The critical outcomes ultimately depend in the model upon the location of the information required to make decisions which are expensive to anticipate, and the model itself does not tell you where that information is located. For that, one must ultimately turn to a production (or technologically) based theory, and it is then production, and not transactions, which determine the result.

A second limitation of this model, particularly in comparison to Williamson's approach, is that in applying it to the problem of corporate reform one loses the market as a referent. Actually, this does not happen in Grossman and Hart's own work because, for them, the right of residual authority is synonymous with ownership. Within corporate organizations, however, we are dealing with the distribution of decision-making authority among organizational components, none of which actually owns the assets which it controls. The theory of internal organizational structure is thus purchased at the expense of a theory which explains the boundaries between the internal organization and the outside. This is also a problem in the production based theories discussed earlier.

The lack of a theory of the market is a serious problem for orthodox economics because of the importance of the market as a referent in the conventional analytical system. It does not need necessarily to be a problem in analyzing corporate reorganization if one could really take the corporation as a given. But as we have seen, one cannot. The precise limits of the disintegration of the classic corporation are not at all clear. It appears
that such limits do indeed exist, but in order to say what precisely they are, one would need a theory of why the market fails. And in this sense Williamson continues to be a model for an approach to theorizing even if the corporate reforms seem to render the theory itself inadequate.
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