Redesigning the Firm

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New York Oxford
OXFORD UNIVERSITY PRESS
1995

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How Control Systems Can Support Organization Flexibility

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Ronald Dore, a sociologist at Cambridge University, once posed the question of why Japan should evidence a paradox of "flexible rigidities." Despite being a country marked by rigid restrictions on the lay off of workers and on the mobility of capital, the economic record of Japan shows a remarkable flexibility in coping with the major economic shocks of the 1970s. In comparison, the economic adjustment of the major Western countries progressed more slowly.

We are puzzled by the converse problem: why do firms find it so difficult to become more flexible? The advantages of flexibility are clear, ranging from the capability to tailor products and services for customers to the facility to expand rapidly when market opportunities suddenly open up. The creation of new information technologies and manufacturing systems has created the potential to achieve dramatically higher degrees of flexibility. The impact of these technologies is felt not only on the plant floor, but also in the way financial and retail services are provided and supply chains are managed.

The flexibility possible with current technologies is a qualitative change from past practice. Unfortunately, these technological investments, when implemented in isolation from organizational changes, have proven to be woefully inadequate. Here is the dilemma that makes flexiblity so difficult to achieve. Firms have long been described as designing mechanisms by which to buffer uncertainty in order to minimize risk.[1] Yet the development of flexible capabilities implies a contradiction of this learning. The value of flexibility lies in increasing an organization's ability to respond to changing and uncertain environments. Designing an organization that does not shield itself from this uncertainty requires fundamental organizational changes.

o Shimada and John Paul MacDuffie, for example, have contrasted " concept of organizational design prevalent among Western manu-th the "fragile" concept of their Japanese counterparts. A "robust" system attempts to "buffer" itself against the uncertainties of sales , supply interruptions, and equipment breakdowns through re-ventory stocks, large repair areas, and other forms of organizational agile" system, in contrast, attempts to avoid buffers in order to stay nsive to environmental changes. With no buffers to shield the fragile n uncertainty, flexible capabilities are required to permit rapid re-npredictable production contingencies and demand changes. These are embedded not only in hardware such as flexible manufacturing t also in the organization's employees, or what they call "human-pter five in this book on cross-functional teams and chapter six on iety provide examples of some of the methods available to increase lexibility.

apter is intended to show why changes in the desired capabilities of n require an alteration in control systems and the metrics by which e is evaluated. Attempts to develop flexible organizations without ing the way objectives are set and performance is measured are tile (Voss 1988 and Lim 1988). To examine why, we conducted with three American firms in three industries: pharmaceutical, au-oduction, and telecommunicatons. (The research design is summa-ble 7.1) Each of these industries currently faces challenges to in-bility in order to respond to rapid changes in customer demands, nvironments, and product markets. The inferences from these in-re checked against the extant literature and against interviews with om a European and a Japanese firm in each of the industries in order the robustness of our findings.[2] Finally, we interviewed managers at ere cited as being industry leaders in particular control practices, or esults from an interview required validation—as was the case with s of capital budgeting in Japanese firms.

rk shows that existing control systems, many of which were devel-port the mass production strategies of the past, frequently provide

TABLE 7.1. Summary of Field Research Design

Use of Flexibility	*Industry*
Flexible manufacturing	Automobiles
Research and development	Pharmaceutical
Strategic planning and joint ventures	Telecommunications

incentives that are inconsistent with the adoption of the organizational capabilities needed to meet today's strategic challenges. Some of the firms that we investigated were in the midst of major transformations, but had not thought through the consequences for their control systems. Other firms had instigated major changes in control systems by moving toward single financial measures of performance, even though their stated strategies contained multiple, often nonfinancial, objectives.

There were fundamental differences in whether companies viewed measurements as "incentives" to be used in performance evaluation or as "signals" to highlight the desired strategic direction of the firm. In reality, performance measures are both. Yet, the signals sent by the organizations' control systems often contradicted the firms' strategies; the concern with incentives dominated the internal discussion of many corporations, overlooking the role control systems can play in signaling the new skills and capabilities that must be acquired to achieve the organizations' strategic objectives. In times of change, a control system supports not only efficiency, but also exploration and experimentation.

Our recommendation is that the development of flexible capabilities requires performance measures that explicitly recognize the specific capabilities that the firm hopes to acquire. In doing so, companies must remember that control systems serve two related purposes—evaluating performance and signaling the actions and experiments that management considers desirable. To rephrase an old saying, you get what you signal. If the development of a specific capability requires actions that are incompatible with existing performance measures, it is unlikely that the capability will be acquired.

Since many strategic investments in the development of organizational capabilities resemble research and development (R&D) projects, they should be treated as such; they are risky on an individual basis but even when they fail, they contribute to the accumulation of experience and new skills that ultimately lead to organizational success. Individual investments in flexibility should therefore be measured in the same way as individual research projects, with greater emphasis placed on nonfinancial measures that reflect the extent to which the desired capabilities and learning are being achieved. Evaluating the achievement of overall strategic and financial goals should be performed at higher levels in the organization, much as a basic R&D laboratory limits financial measurements to broad research areas. By placing greater emphasis on nonfinancial criteria in the evaluation of individual projects, companies avoid penalizing managers for undertaking inherently risky investments that lead to the acquisition of valuable capabilities.

Our recommendation should be clear: we suggest multiple criteria and a change in the relative weights placed on financial and nonfinancial measures, not the elimination of financial objectives. Companies must recognize that control systems are an important signaling device. Managers are busy; their attention is limited. A control system provides powerful symbols with which to focus attention on strategic goals and the development of organizational capabilities.

Control Systems and Organizational Experimentation

One way to understand how control systems influence an organization's capabilities is to recognize that control mechanisms guide what is done in a firm by directing the behavior of people toward organizational objectives. Control mechanisms can take a variety of forms, including personal supervision, job descriptions, work rules, standard operating procedures, performance appraisals, budgets, incentive compensation schemes, and planning systems, as well as informal norms and expectations.

Formal control systems represent not only what information management will be evaluated on, but also signal *what is important* to the organization. Consequently, control systems have a strong influence on the priorities placed on alternate courses of action. For example, efficiency and effectiveness—that is, "doing things right" vs. "doing the right things"—represent two very different, and possibly contradictory, goals (Hrebeniak and Joyce 1984). A company that rewards performance based solely on efficiency measures will see greater emphasis placed on improving resource utilization than on determining whether the organization is producing the correct product mix or serving the appropriate markets.

The message that a control system sends regarding what an organization values is not isolated from how things are done. For example, the adoption of mass production strategies using Taylorist principles was accompanied by the implementation of standard costing systems which specified exactly how much labor and material should be expended for each product (Johnson and Kaplan 1987). The goal of these systems was to determine the "best" way to perform a task and to formalize these practices in labor and material standards, Performance was subsequently measured based on variance from standard. Standard costing systems allowed companies to use the accounting system to signal that good performance meant maximizing labor and material efficiency. This measurement made sense for the strategy of standardized mass production, where the control system's emphasis was on signalling the most efficient production techniques—that is "doing things right". However, in rapidly changing environments where opportunities for long production runs of standardized products are rare, "doing things right" no longer assures competitive success if the company is not "doing the right things" by quickly responding to changes in customer demands.

As this example illustrates, a company's articulated strategy and control systems send strong messages regarding the appropriate actions to consider and the appropriate lessons to be learned. A performance evaluation system that emphasizes efficiency over flexibility tells managers that short-term productivity takes precedence over building organizational capabilities, regardless of the organization's espoused long-term direction.

The danger is that a control system's value as a signaling device is easy to underestimate. Control and flexibility sound contradictory. They are not, once it is recognized that a control system can serve as a powerful guidance mechanism to support a company's development of organizational capabilities.

Firms are Rule Based

A simple reason why firms do not build or exploit flexible capabilities is the fact that management behavior is constrained by the "rules of the game" that are found in any organization. These rules appear not only in the policies, procedures, and measurements that make up the formal control system, but also in the informal norms, expectations, and "rules of thumb" that emerge over time.

In many cases, organizational rules are functional. They are the intelligence of a firm, much like the knowledge embedded in algebraic rules, which, if applied correctly, increase the knowledge and competence of a student. Rules have a bad reputation because their existence is typically acknowledged only when they do not work. but they are the backbone of all firms. Good rules and good firms are synonymous expressions.

Both formal and informal rules are the collected wisdom of experience and, occasionally, analysis. They work, and they frequently work well. Ned Bowman studied whether managers did better when they stuck to rules or when they tried to tailor their responses to the circumstance (Bowman 1963). Consistent rules produced better results, even though they were not optimal or "best" in a global sense.

But rules can also be dysfunctional. They are based on the repetition of learned behavior of individuals and coordination in and between groups. As learned behavior, they do not change easily. They become "believed" and are embedded in the distribution of power and authority. Rational responses from managers who view their behavior as consistent with objectives can be radically irrational in their consequences.

For example, a team of researchers in France analyzed the procurement activities of a large industrial firm. This firm established an inflation forecast for the year that set a precise target for permitted increases in the prices of procured parts. As this forecast never matched the actual inflation rate, the management responsible for procurement developed a policy that relied upon two suppliers for identical parts. The price paid to one supplier was 30 percent greater that that paid to the other. The inflation target, consequently, could be realized by changing the proportion purchased from the two suppliers, depending upon whether the inflation forecast was too high or too low. In many years, the firm wound up paying more than necessary for the parts due to the influence of the control system on the employees' actions (de Pourvourville 1981; Berry 1983).

Very often, the dysfunctionality of decision rules is not even noticed. Companies that have been successful in the past frequently believe that applying the same "formula" will ensure success in the future. All too often, however, the competitive environment requires a new set of capabilities that are not incorporated in the firm's current decision rules. By clinging to existing formulas, companies often lose the ability to compete in new environments.

Decision Cues and Performance Measurement

One problem with rules is that people do not make judgments based on all available information. Instead, individuals respond to what they consider "salient" or to how a problem is framed (Tversky and Kahneman 1973). By providing the framework that will be used to evaluate performance, control systems provide signals or cues for managers to follow when making decisions.

Japanese manufacturers, for example, typically allocate overhead expenses based on the amount of direct labor used in a department or product. This policy is enacted to drive plants towards further labor-reducing automation in order to avoid anticipated labor shortages (Hiromoto 1988). By allocating overhead based on direct labor content, the accounting system sends the message that reducing direct labor leads to significant reductions in overhead costs as well. The allocated expenses are clearly not an accurate measure of an operation's use of overhead resources, but do provide an important cue by which to direct managerial attention toward the goal of lower labor content.

The trick in designing an effective control system is providing cues that direct managers to take the appropriate action or apply the appropriate decision rule. The selected performance measures or cues, consequently, should be supportive of the strategy of the business and the corporation. Though simple in theory, developing the required linkages between strategy, performance measures, and decision rules can be extremely difficult.

Changes in performance measures may make obsolete the decision rules by which managers have learned to play. Japanese managers, for example, have traditionally ranked other goals ahead of profitability and shareholder value, a sensible choice in expanding, profitable markets (Kagono et al 1985). However, our interviews with Japanese firms indicated that there is currently increasing interest in profitability and return on capital measures. This interest is not surprising given the state of the Japanese economy. Capital costs more than before; profits are negative. For Japanese managers who have emphasized market share growth in their decisions, the change to financially oriented performance measures requires a fundamentally different set of decision rules for strategic decision making.[3]

Even more problematic is the difficulty in specifying the appropriate "benchmark" against which to compare performance. An easy solution is to measure performance based on financial results, such as profits or return on capital. But financial measures may not be appropriate or feasible in all cases. The short-term profit impact of a basic research laboratory, for example, may be impossible to ascertain. Consequently, the performance of scientific staff is typically evaluated based on nonfinancial measures such as the number of patents issued, the number of papers published, or the ability to meet project milestones. Similarly, long-term investments such as joint ventures typically produce poor financial results during their early years. Yet the investment may be making satisfactory progress toward longer-term goals, or meeting short-term goals that are not financial in nature. Evaluating the investment using financial indicators will in the short-term understate its performance. Moreover, emphasizing financial results sends the message that managers should focus on maximizing short-term accounting returns rather than experimenting with longer term organizational capabilities.

William Ouchi distinguishes two types of performance measures that can be used to provide the appropriate decision cues to managers (Ouchi 1979). Output measures are indicators of results and include financial measures, such as profitability and return on capital. Input measures, in contrast, represent variables that should determine or create measurable results, such as the number of new products introduced or the percentage of employees trained in quality improvement techniques. Input measures, which are frequently nonfinancial in nature, are not themselves measures of the results that a company establishes as its ultimate goals, but rather are indicators of longer term health and vitality.

Erin Anderson provides a framework to guide the selection of input and output measures.[4] As shown in Figure 7.1, the two dimensions in the framework are the extent to which managers understand the transformation process (that is, how inputs become outputs) and the ability of the firm to assess, measure, and judge outputs or results.

Dimension 1:
How well do you know the "transformation process"?
Do you know how inputs get transformed into outputs?
Do you know what people should do?

		Understood Poorly	Understood Well
Dimension 2: How thoroughly and accurately can you assess outputs (results)?	Poorly	Evaluation performed informally, implicitly, seldom	Input measures heavily weighted Output measures lightly weighted
	Well	Output measures heavily weighted Input measures lightly weighted	Either inputs or outputs are valid Use both, weighting outputs more heavily

Figure 7.1. Should Evaluation Be Weighted Toward Inputs, Outputs, or Neither? (*Source:* Anderson 1990, adapted from Ouchi 1979.)

In cases where the process is well understood but results are difficult to assess, input measures should be more heavily weighted. This situation occurs in basic research, where a manager may be able to assess whether a scientist followed the right scientific and project management practices, but is not able to judge the potential financial returns from a new discovery.

Output measures should be more heavily weighted when a firm can measure results but the transformation process is not well understood. This case arises when top management is able to evaluate the profitability of a division but does not have the necessary, intimate knowledge of the division's operations to assess exactly what strategic moves the unit should have made.

Finally, when the transformation process is well understood and results can be accurately assessed, either input or output measures are valid indicators of performance. As we will discuss later in the chapter, the continuum of input and output measures provided in this framework can assist in selecting control mechanisms that support the development of organizational capabilities.

Cues for Flexibility?

The preceding discussion indicates that flexible capabilities cannot be built without putting in place the appropriate decision cues. To do so, a company must first identify the forms of flexibility needed to accomplish the organization's strategic objectives. Broadly defined, flexibility is a capability that gives managers the ability to respond appropriately to different contingencies.[5] A natural way to think about flexibility is in relative terms. A firm is more flexible if it outperforms another when the environment changes more rapidly.

Of course, if the environment is not especially volatile, then flexibility might be at best a useless capability; at worse, it raises the costs of the firm with no benefit. It is as though one has a set of serving china with no occasion for its use.

The specific form of flexibility adopted by a company will depend upon the capability or uses it provides. Sometimes its use is clearly known at the time of implementation. For example, a manufacturer might design a manufacturing process to have the flexibility to produce a car with five basic option packages. At the time the process is developed, the company does not know the exact mix of packages that customers will order, but it can resolve this uncertainty when the orders arrive at the factory. As long as customer orders are limited to the five option packages that the equipment is capable of producing, any mix of products can be accommodated by the system. Switching production between known options is an example of *static flexibility*.

Occasionally, however, we lose sight of Say's law that supply creates demand: having the capability to be flexible may generate new ways to capitalize on its use. Flexible capabilities may allow a firm to experiment with new production methods, to pick up experience in new technologies that provide a competitive advantage in the future, and to move into unanticipated market segments. If the investment in flexibility proves beneficial, it can be expanded. If not, then no further investment is required.

The ability to expand the use of new capabilities over time is an example of *dynamic flexibility*. In the static case, management knows that it can produce five kinds of options; the question at any given point in time is *which* mix of options will be manufactured. In the dynamic case, the issue is when or if to take advantage of existing flexible capabilities. For example, a company may decide to expand previous investments in flexibility because the capability has created opportunities to improve its position in new or expanding markets or provided experience in emerging technologies or products. At the same time, the company has the option not to expand and may even decide to abandon the investment altogether. The central question in the dynamic case is therefore *when* to make a decision to abandon, maintain, or expand an investment in flexibility.

The reader has the right to smile at our attempt to define flexibility as contingent upon knowing what capabilities or uses it provides. A rather "flexible" definition. Yet, knowing the potential uses of flexibility is a fundamental element in the design of the appropriate control systems.

The following three cases show how control systems can hinder or support the development and use of flexible capabilities, the first in a flexible manufacturing operation, the second in R&D planning for a pharmaceutical company, and the third in a telecommunications joint venture.

Static Flexibility and Mix Variances

Manufacturing plants increasingly look like restaurants. Customers place their orders, waiters transmit the specifications by computer to the kitchen, and a team of cooks rushes to assemble the product. And if the tomato sauce for the spaghetti is similar to that for the lasagna, we indeed can speak of a "modularized" production process that assembles and reassembles components to create variety.

A restaurant is an example of *static* flexibility. The menu is already printed and the hours of production are fixed. As in the automobile options example discussed above, the primary question in the restaurant is what to produce during a given period.

An interesting question is why manufacturers that have purchased flexible machinery have limited the "menu" that they offer to customers. Ramchandran Jaikumar, for example, found that "the average number of parts made by an FMS (flexible manufacturing system) in the United States was 10; in Japan the average was 93" (Jaikumar 1986). The U.S. systems were flexible technologically, but rigid in practice.

A team of researchers at Wharton has found that the decision cues provided by control systems are a major reason why high levels of flexibility are not being achieved at many U.S. manufacturing sites.[6] The Wharton team is investigating the interaction between control systems and capital investments in one of the American big three automakers. The company has recently established a manufacturing strategy that places significant emphasis on the development of flexible capabilities that will allow more rapid introduction of new products and the production of multiple models on the same assembly line. Even though this strategy focuses on the *effective* use of flexible automation, the primary plant-level performance measure continues to be direct labor utilization rates, an *efficiency* measure.

This measurement system has had two significant effects on the adoption and utilization of flexible machinery. First, some plant managers are wary of the training costs and teething delays involved in moving from traditional hard automation to robots, as well as of the additional ongoing maintenance requirements of the new technology. Because performance is evaluated based on direct labor utilization, these managers prefer to use technologies that maximize direct labor productivity, regardless of the stated manufacturing strategy of the company.

More important, direct labor measurement provides no incentive to *use* the flexibility once the new equipment is purchased. As one manager stated, "We focus on direct labor utilization because once you buy the equipment, you just depreciate it over time. But labor you have to deal with every day." It is not surprising that, unlike many Japanese automakers, none of the company's plants produces more than one platform on a production line. Plant managers view flexibility as the ability to reuse the same equipment after discontinuing the current model (with each product generation lasting roughly five years) and to adapt to minor, annual trim changes. Under the existing control system, assembly plants have no incentive to seek ways to take advantage of the robots' full capabilities, and consequently use flexible machinery in much the same way as existing hard automation. Taking advantage of the flexible equipment's capabilities will require a radical change in the measures that are used to evaluate plant-level performance.

One solution that has been suggested in the flexible manufacturing literature is the use of "flexible budgets." Traditional static budgets are developed based on the capital, labor, and material required to produce the forecasted product mix. As a result, static budgets indicate that productivity is poor when the inputs required to manufacture the actual product mix are greater than those required for the forecasted mix, even though the plant may be operating efficiently.

This false signal can be a significant problem in flexible manufacturing operations where the actual mix of products that will be manufactured is highly uncertain until orders are received. To alleviate this dilemma, the flexible manufacturing literature suggests that companies develop flexible budgets that are contingent on the mix of products actually produced. Flexible budgets are calculated *ex post* by multiplying the actual product mix by the standard costs for each type of model produced. A "mix variance" is then calculated to account for any differences between actual costs and the original static budget that are due to disparities between the forecasted and actual product mixes.

Does the flexible budget solve the control system problem? Clearly, comparing actual costs against a flexible budget has the virtue of capturing how well costs were managed, given that a certain level of flexibility was exercised. But it does not indicate whether the flexibility was exercised well, that is, whether the flexible *potential* was economically utilized.[7] In this respect, a performance measurement system using flexible budgets is no different from the control systems that are used to manage traditional manufacturing environments. Flexible budgets and mix variances do not measure the effectiveness of a flexible manufacturing system—only its efficiency. They provide no incentive for managers to do the things necessary to utilize the flexible machinery's potential (for example, to introduce new products or to make many products on the same machine).[8]

How, then, does a company develop performance measures that support the development and utilization of static flexibility in manufacturing? The answer depends upon the reasons for acquiring flexible capabilities in the first place. Robb Dixon and his colleagues (1990) identify four dimensions of flexibility that are available in manufacturing operations: quality-associated, product-associated, service-associated, and cost-associated. As shown in Table 7.2, each of these dimensions is characterized by an "ability" to be flexible in a certain area and each makes a different strategic contribution. To develop effective performance measures, companies must first determine which of these dimensions is required to support their organizational objectives.

While the need to develop capabilities that are consistent with overall business goals may seem obvious, S. H. Lim found that the types of manufacturing flexibility being implemented by most companies are incompatible with the strategic objectives of the firms (Lim 1988). For example, although most firms considered quick changeovers to new products to be an important use of their flexible equipment, few believed that the introduction of new products was an important strategy within their organizations. The incompatibility between the types of flexibility that companies implemented and their competitive strategies was due in large part to the fact that the firms' strategic and operational objectives were not linked.

TABLE 7.2. Dimensions of Manufacturing Flexibility

Quality-associated flexibility dimensions	
Material:	Ability to accommodate variation in the quality of purchased materials.
Output:	Ability to make products with different quality requirements.
Product-associated flexibility dimensions	
New Product:	Ability to introduce new products.
Modification:	Ability to modify existing products.
Service-associated flexibility dimensions	
Delivery:	Ability to change the current production and/or delivery schedule to accommodate unanticipated needs.
Volume:	Ability to vary aggregate production volume from period to period.
Cost-associated flexibility dimensions	
Factor:	Ability to modify the mix of resources (materials, labor, and capital) used in the production process.

Source: Dixon, Nanni, and Vollmaun (1990).

Once a company determines the means by which flexibility contributes to the achievement of strategic objectives, the appropriate performance measures can be developed to provide the required decision cues. For example, a strategy focused on being first to market with state-of-the-art products requires managers to develop and utilize the flexibility to rapidly introduce new products and modify existing products. Performance measures, such as the number of introductions of new products and the speed of new product start-ups, signal that success is achieved by building the capability to introduce new products quickly. Note that neither of these measures is a short-term financial measure. Instead, they are indicators of long-term success—that is, the capability to meet the manufacturing requirements of the strategic plan. Our emphasis on nonfinancial measures of manufacturing flexibility follows the framework in Figure 7.1. Because flexibility is a capability rather than a result, output-oriented financial measures do a poor job of evaluating its effectiveness. If a company knows what uses are desired from investments in flexibility, nonfinancial input-oriented measures can be used to specify and assess the actions managers are taking to build and utilize the desired capabilities.

Dynamic Flexibility and Goal Setting

Imagine you are to take a trip, but you are not told the destination. What would you pack? You do not want to take too much, as it is painful and costly to move the bags around. An umbrella is always good, as the old line on benefits of diversification tells us, whether it rains or shines. But first you have to buy and pack the umbrella and then remember not to lose it along the way. The other choices may be more difficult. Do you bring a dark suit or dress? The probability of its use on a pleasure trip is low, but it might be handy if the destinaton is the casino at Monte Carlo.

Of course, you could follow another strategy. you could pack a few things now and bring along a credit card. But you might reget the decision if you find you are stuck on an island with exorbitant prices; the clothes you left on your bed at home would look like a bargain.

The cost of buying late is not unlike the experience of one telecommunications firm that had to make an acquisition to enter a market after its competitors were already there. The company had previously carried out a pilot R&D project in the area, but had abandoned it at the time when the technology became marketable. The cost of commercialization seemed too large for such an uncertain market. In retrospect, keeping the R&D project alive seems like a small price to have paid to retain the option to commercialize the product, just in case the market looked good in the future. Other firms did commercialize the product, and the market later looked good enough to cost the telecommunications company several hundred millions of dollars to reenter.

Investments in new products, technologies, or markets that provide a company with the option to expand if the endeavors look promising are examples of *dynamic* flexibility. More generally, dynamic flexibility is the creation of a capability to act in response to opportunities as they develop over time. A simple response is to abandon the project; another is to expand the project into a business. The use of dynamic flexibility poses the question of when to act given that you already have the capability to respond.

One industry where dynamic flexibility is extremely valuable is pharmaceuticals, where investments in risky projects are routine. Only about 5 percent of drugs that enter development get to the market. From the time development begins until final market entry, a number of discrete steps must be followed. Roughly three years into the R&D process, a compound goes through synthesis examination and screening, in which its chemical and biological properties are assessed. This is followed by two years of preclinical tests on animals. If the compound passes this hurdle at year five, it enters clinical tests on humans. The Federal Drug Administration stipulates standardized trials (phases I, II, and III) that the compound must pass to be marketed. Since each stage involves the commitment of tens of millions of dollars, there is a strong incentive to evaluate the selection of drugs in light of the flexibility to discontinue further development, known as the abandonment option, or to commit additional resources.

The company that we studied is widely regarded as one of the leaders in the evaluation of investment and risk.[9] In the early 1980s, the company began to develop risk assessments of its portfolio of research projects through the application of Monte Carlo techniques. The Monte Carlo model evaluates the current portfolio of products and development projects in order to forecast company performance over a twenty-year horizon. Inputs to the model include assessments of the probabilities of development success by an expert panel of research directors, sales forecasts from the marketing group, and cost forecasts from manufacturing. Assessments of project success are generally in the form of 10 percent probability, 90 percent probability, and most likely. The results from the Monte Carlo model are used to identify gaps in the company's product portfolio and to estimate the firm's long-term value for comparison to the firm's stock price.

Despite the importance of this methodology to overall corporate planning, post-completion analyses do not tie these projections to an assessment of managerial performance. In fact, scientists in the laboratories described an R&D planning process that does not rely heavily on financial and marketing simulations, especially in basic research and the early stages of product development.

Instead, the choice of research projects is guided by commitments to long-term drug programs in targeted therapeutic areas.

Financial analysis is not critical to the determination of the research portfolio. The decision to continue or abandon a project is made on the basis of screening and clinical trials. Work on a substance is killed if toxicity is found, not on the basis of financial assessment of earnings. Since outcomes are so unpredictable, there is no financial justification for a product until a substance is registered with the government.

The high risk of projects not coming to market creates a demanding environment for the evaluation of managerial performance. Senior management recognizes that with a 5 percent industry success rate, any project is a high-risk bet. The probability of failure attached to any single project is mitigated by investing in a portfolio of projects within targeted long-term drug programs, rather than by betting the company on specific projects or drugs.

The logic of this planning leads to a policy of hiring the best scientists in any given area and then committing substantial resources to developing knowledge in basic research. Even if a particular drug fails, knowledge of the general science related to the drug is achieved. In a sense, investing in research programs increases the probability that future drug projects will succeed. Although individual projects may fail, they contribute to the future success of the firm.

It may be for this reason that strict financial measures are not used for project selection. Projects in areas that are considered strategic are not subject to financial evaluation because they represent the generation of future opportunities rather than investments in any particular market opportunity. The project portfolio approach of this company is not merely a method by which risk is diversified, but also a long-term investment in a set of skills and capabilities that are useful to many markets.

William Brown's and David Gobeli's (1992) study of performance measurement in R&D environments supports the pharmaceutical company's emphasis on nonfinancial measures at the project level. Their research identified three levels of activities within R&D, each of which requires a distinct set of measures. These levels are mapped against the input-output continuum of performance measures in Figure 7.2.

At the lowest level of the hierarchy are the individual activities and processes within R&D. Since the output of individual research activities may be a poor indicator of performance due to the inherent risk in R&D and the inability of output measures to capture the development of organizational capabilities, input measures such as the percentage of key skill areas learned by R&D personnel or the number of publications predominate at this level.

At the project management level, more specific input measures such as timeliness in meeting project milestones are emphasized. As the project moves

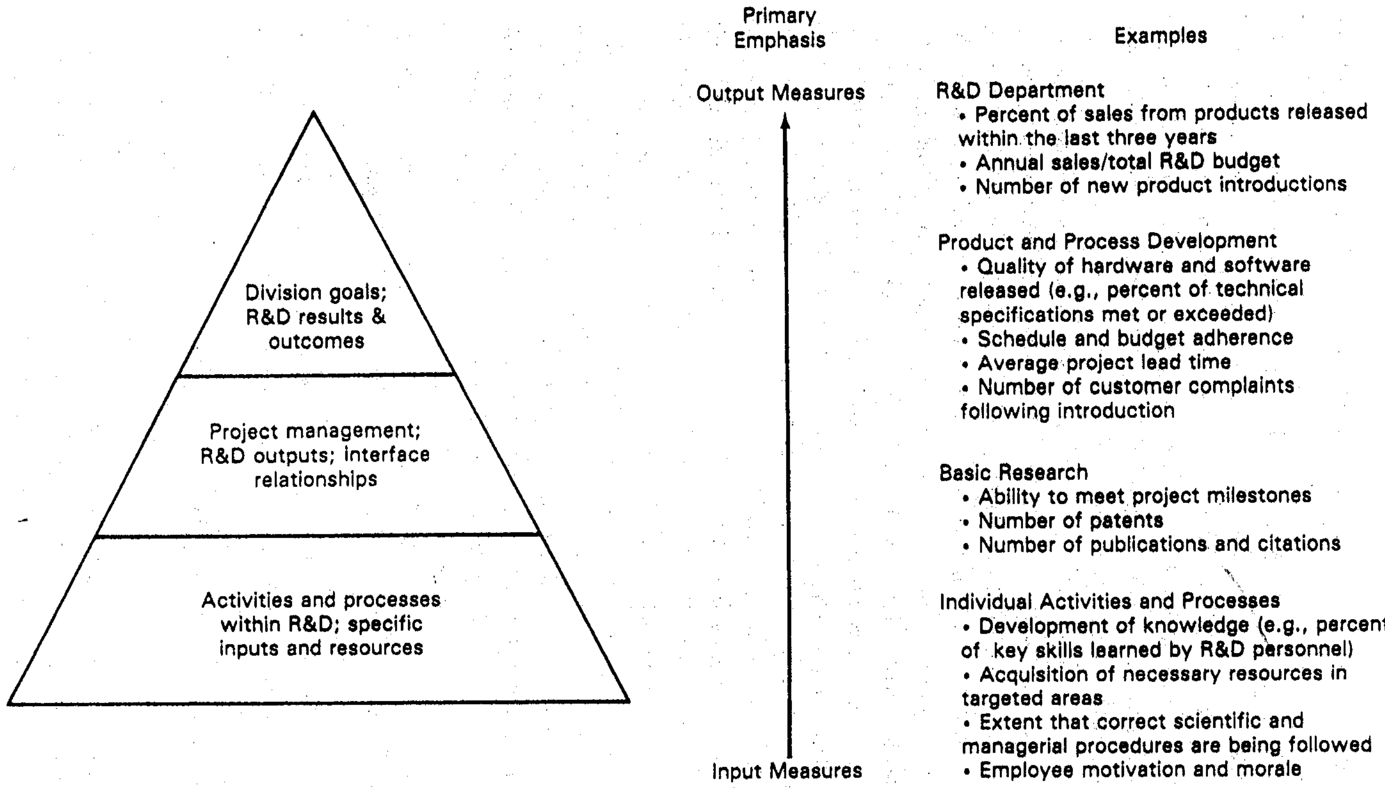

Figure 7.2. The R&D Performance Measurement Hierarchy. (*Source:* Adapted from Brown and Gobeli 1992.)

into the lower risk development stage, outcomes become easier to evaluate and performance measures move closer to the output end of the performance measurement continuum, focusing on factors such as project cost overruns, the number of engineering change orders caused by modifications to specifications, and the quality of the hardware or software released.

Finally, output measures move to center stage when evaluating the performance of the entire R&D organization. At this level, the risk inherent in individual projects is diversified away in the many projects that are ongoing at any point in time. Consequently, output measures become a valid measure of organizational success. Typical output measures for an R&D organization include the percent of sales from products released within the last three years, the contribution to gains in market share, and the ratio of annual sales to the R&D budget. By utilizing this performance measurement hierarchy, companies avoid penalizing managers for individual R&D projects that develop organizational capabilities but fail due to inherent risk.

The Case of Joint Ventures

The development of flexibility in high-risk environments is hard to value because performance is measured against a probabilistic and potential use, not an expected standard. But even in the case of flexible manufacturing, the measurement of performance using flexible budgets and mix variances only provides an illusion of control over the use of flexible capabilities. If the factory only solicits orders for one model, would we say that it has exploited its flexibility fully? A multibillion dollar investment in flexible machinery, yet there is no strategic use of the equipment.

If flexibility is an investment in a capability, then it must be evaluated in terms of its contribution to the development of the desired capability. Let us take a concrete example. One of the non-U.S. telecommunication firms in our study established a joint venture in the United States for the adaptation of its digital exchange switch. This switch serves to direct incoming and outgoing telephone calls and was to be expanded to handle both voice and data (for example, transfer of computer files). From the European firm's perspective, the primary reason for creating the joint venture was to utilize its partner's technological capabilities to adapt a product designed for the European market to unfamiliar American standards. The venture proved to be a technological success, but the product failed when the anticipated markets did not materialize. The joint venture was terminated within five years.

Normally, this business venture would be interpreted as a failure. The firm designed a tight functional plan; from a product design perspective, the joint venture ran perfectly. Yet the business strategy to enter the anticipated market leaked like a colander.

However, the termination of the joint venture does not end the story. The venture was not dissolved; it was acquired by the non-U.S. company, which had negotiated the right of first refusal should the operation be put up for sale. Although the venture was not profitable, it provided the European firm with two key capabilities: the technology required to meet U.S. specifications and knowledge of the U.S. market. These capabilities gave the company the flexibility to expand their U.S. presence beyond the market that had originally been anticipated. Since the joint venture was acquired, it has been expanded into one of the company's global research centers and has successfully supported the adaptation of the firm's larger and more profitable products to the U.S. market. The decision to acquire the joint venture is an example of exercising dynamic flexibility: the right to acquire (that is, to expand the investment) if the operation looked promising was built into the design of the venture. The venture failed, but the experiment succeeded.

Many joint ventures are established as trial investments in new markets for the purpose of learning, or establishing a foothold in, a technology or market. Often, a right-to-buy clause is attached, with the timing of a firm's decision to exercise the option influenced by changes in the market (Kogut 1991). Particularly during the early stages of a joint venture, short-term financial measures will fail to capture the value that the venture provides in terms of increased capabilities and the flexibility to move into new technologies and markets. In many ways, joint ventures, like many strategic investments, are similar to R&D projects in that seemingly unsuccessful investments can contribute to the achievement of corporate strategies through the learning and capabilities that the venture contributes. Consequently, their performance should be measured based, at least in part, on their contribution to the acquisition of the desired capabilities.

Erin Anderson uses the framework in Figure 7.1 to guide the evaluation of joint venture performance. Many ventures in basic research and experimental technologies fall in the upper left cell, where knowledge of the appropriate actions to take and the ability to judge outputs and inputs of the joint venture are both low. In these cases, evaluations should be less formal with a greater emphasis on qualitative assessments of progress and learning, including such factors as harmony among partners, morale, adaptiveness, innovativeness, and the acquisition of resources. At the other extreme are joint ventures that can be effectively evaluated using output measures, such as profitability. These ventures tend to be older, in familiar markets and products, and in mature industries. Between these extremes lie the joint ventures that are designed for a specific purpose, such as acquiring knowledge in a new product or market. In the early stages of these ventures, outputs are not good indicators of performance; output measures such as profitability and cash flow provide no information on whether the learning and capabilities required for long-term success are being built. However, since these ventures exist for definable reason (for example, knowledge acquisition, footholds in emerging markets, and so forth), certain activities or inputs can be prescribed. To the extent that organizations can identify the capabilities that are desired from a joint venture, the appropriate measures, which will typically be nonfinancial, can be implemented to direct managers toward the achievement of these goals.

Metrics and Incentives

Our recommendation that companies place greater emphasis on nonfinancial measures when evaluating flexibility stands in opposition to the view that if managers are to do the right thing, they must be under the appropriate financial incentives. Unless they bear risk, they will not be motivated to capitalize on flexibility.

A number of corporations, including one of our Japanese research sites, are rethinking their compensation package with an eye on promoting greater attention to financial returns. The proposals to use financial measures to motivate managers' incentive raise an intriguing issue: can control systems promote the development of flexibility through the creation of optionlike incentives? An optionlike incentive pays a manager more if the business does well but limits the penalty if it does badly, thereby eliminating any disincentive to invest in the development of flexible capabilities that are potentially risky. Moreover, if you cannot determine the potential uses of flexibility ahead of time, should not incentives be created to motivate managers to find them?

One of the common threads in our interviews was the belief that individual rewards should be tied to the fulfillment of the original capital plan. As one manager stated, "Capital is a sunk but not forgotten cost." A few companies that we interviewed for comparison purposes are adopting various techniques to transform accounting numbers into "economic values" in order to tie managerial pay to the economic value created by using an organization's capital and human resources.

For example, a number of the U.S. firms are experimenting with new bonus plans.[10] These proposals establish a pseudomarket price for divisions using techniques similar to those used to value acquisitions. Managers receive part of their compensation in the form of "stock" options on their divisions, with the exercise price set at a few percentage points higher than the division's current "market" price.[11] An increase in the division's value should be reflected n to the

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become more conservative in order to preserve the value of this wealth. This contradicts the needs of many organizations to provide incentives that encourage managers to make potentially risky investments in the development of flexible capabilities.

If effective measurements and incentives for top executives are hard to design when stock prices already exist, imagine the problem for lower levels of management. In some businesses, the separation of environmental influence and individual performance can be sorted out. There is a logic, after all, to the statistical interests of baseball fans because players bat individually and in fairly homogeneous circumstances. It is not surprising that optionlike incentives are common in these cases.

But in most businesses, individuals not only work in groups but also face very different competitive markets that differ in risk. Tying pay to economic value added generates large discrepancies in employee rewards as the variability in risk among businesses increases. These discrepancies may be attributable to risk differences or to simple luck, either of which creates the perception that the compensation system is not "equitable".

Optionlike incentives inside the corporation aggravate a tendency of people to believe that risk can be controlled. In a survey of corporate managers, James March and Zur Shapira (1986) found that managers see risk taking as good when the outcome is positive, but as a "foolish gamble" when the project fails, even though earlier it was recognized to be a bet. The fundamental quality of risk is that there will be winners and losers regardless of difference in ability or effort. Managers, and people in general, have a hard time acknowledging luck retrospectively.

The problem with optionlike financial incentives is not that it is wrong to tie payment to results. The problem is believing that a single output measure, no matter how sophisticated, can provide the incentives to develop the flexible capabilities required to achieve competitive success in today's increasingly volatile marketplace. As we noted at the start, the value of flexibility lies in increasing an organization's ability to respond to changing and, therefore, uncertain; environments. Developing an organization that does not shield itself from risk requires more than a new financial measurement system. It requires a commitment to experimentation that may not be captured in financial output measures. This, in turn, means that companies must implement control systems that promote the capabilities that are needed to achieve strategic objectives. In most cases, these control systems will emphasize nonfinancial input measures that more closely reflect the development of longer term organizational capabilities.

Conclusions

We began by asking why firms are less flexible than their potential. The simple answer, we suggested, is that organizational actions are based on rules—both formal and informal. Given the constraints of these rules, it is not surprising that the use of flexible capabilities falls short of their theoretic possibility. But the wide variance in corporate practices suggests that some firms are much more flexible that others. Part of the explanation for this difference rests on the extent to which these firms have created control systems to support flexibility.

There is an interesting difference of opinion on whether financial measures should play any role in providing incentives to develop organizational capabilities. One camp clearly believes that the necessary tonic lies in improving financial methodologies and tying performance measures to these numbers. Another camp, often more operations-oriented, is clearly skeptical of the value of financial measures. An extreme view is that the "new technology . . . will relegate accountants and finance staffs . . . to a minor role in the organization . . . New operating measures will be needed . . . (Kaplan and Atkinson 1989). A more moderate view reflects a displeasure with financial criteria, proposing that, in addition to new measures, financial measures will remain important in evaluating heavy capital investments, despite their "many drawbacks" (Bennet et al 1987).

As in all debates of this nature, there is a middle ground. The findings in this chapter indicate that wisdom depends not only on where you sit, but also in what hole you have dug for yourself. For example, many of the Japanese corporations appear to be overcapitalized. This, coupled with the rising cost of capital, is awaking an interest in the cost of capital estimations. Including capital charges in managers' measurements provides a strong signal to avoid the tendency to overinvest and to introduce new generations of products too rapidly, problems that have been ascribed to Japanese companies. U.S. and European firms seem divided in their attitudes, with a number of firms increasing their reliance on financial measures, while others resist the use of financial methodologies.

What we have suggested is that the control system should be treated as a tool to guide the evolution of the corporation; performance measurement should be subsidiary to long-term objectives. The case of the pharmaceutical R&D laboratory may be the right vision for a corporation seeking to develop new organizational capabilities. The focus is on building capabilities in certain chemical compounds by investing in a portfolio of related experiment projects; expert scientists make informed judgements to continue or to abandon, to invest more or to withdraw. The philosophy is evolutionary and the emphasis is placed on broad strategic objectives; individual failures, although inevitable, contribute to the buildup of knowledge in the desired area of competence.

Of course, pharmaceutical R&D is unusually risky. Many businesses enjoy substantially more tranquil markets and technologies. If environments are stationary, then financial measures probably work well for companies at the frontier of best practice. For the majority of firms that operate in a less than stationary world, however, control systems should be seen as a powerful way to direct the attention of managers toward experimentation and the building of the long-term organizational flexibilities that are necessary to compete in today's increasingly uncertain marketplaces.

Notes

We would like to acknowledge the comments of Jim Allison and Blaine Davis of AT&T, Ned Bowman, and two reviewers on earlier drafts, as well as the excellent research assistance of Vipin Gupta. The research has been supported by funding from KPMG Peat Marwick and the Reginald H. Jones Center.

1. One of the foundational texts in economic risk, Frank Knight's (1921) *Risk, Uncertainty, and Profit,* devotes a chapter to how firms organize to reduce risk. The classic text in organizational theory, Richard Cyert's and James March's (1963) *A behavioral theory of the firm,* regards "uncertainty avoidance" as one of the hallmark features of an organization. James Thompson's (1967) *Organizations in Action* describes the various ways "organizations seek to buffer environmental influences" by maintaining inventories, using joint ventures, or acquiring competitors.
2. We did not interview a Japanese pharmaceutical company.
3. Increasing emphasis on financial results has already forced some Japanese companies to change their decision rules. Nissan, for example, proliferated products during the 1980s in an attempt to gain market share. The decision cue produced by the control system was that market share was desired regardless of cost. As a result, model variations exploded to more than 2,200. Poor financial results have now forced Nissan to shift its emphasis to cost control, leading to reductions in the number of models offered and greater use of common parts. See Chandler and Williams (1993) for details.
4. Anderson's (1990) framework is adapted from Ouchi (1979).
5. Similar distinctions between static and dynamic flexibility are made in Carlsson (1988) and Cohendet and Llerena (1990). De Groot (forthcoming) shows why flexibility requires jointly understanding the technology and environmental diversity. We have cut our discussion showing how flexibility can be modeled and financially evaluated as an option. See Brealey and Myers (1991) for a general discussion, especially in reference to R&D; Kogut and Kulatilaka (1994) and Kogut (1991) show applications to manufacturing and joint ventures, respectively.

6. The study is under the joint coordination of Christopher Ittner and Marshall Fisher.
7. These observations would also apply to the measurement of flexibility achieved by coordination among global manufacturing plants. A multinational corporation has the potential to shift production among sites located in different countries, depending on exchange rates or changes in wages. See Kogut and Kulatilaka (1994) and Cohen and Huchzermeier (1991). This kind of flexibility can be measured ex post by looking at variances derived from a flexible budget. But these variances do not measure the extent to which the potential is realized.
8. Although the need to use different performance measures for traditional and flexible manufacturing operations may seem self-evident, studies indicate that many American firms have not done so. A study by Howell and his colleagues (1987), for example, found that 82 percent of U.S. manufacturers used the same performance measurement and control systems for both automated and nonautomated processes, despite the wide differences in the processes' capabilities.
9. The field study was aided by the ongoing research of Randy Case and by a preliminary summary of his extensive interviews prepared for his dissertation.
10. Two firms were trying out the proposal of Bennett Stewart and Joel Stern. See Stewart (1990).
11. Since no market prices or stock options actually exist for these divisions, the companies are developing proxies for these financial instruments.

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