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Performance Measures and Management Control in New Product Development

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SYNOPSIS: An exploratory study was conducted to examine management control issues in new product development (NPD). The study focused on three management control aspects that NPD managers considered important: (1) position of NPD in the firm's organizational structure; (2) NPD process; and (3) NPD performance measures. Primary data were collected from NPD managers via interviews, workshops, and a questionnaire. For each management-control aspect studied, we examined current practice, recent changes, and how the control links to strategy.

The NPD function reported fairly high in the organization. The need to integrate NPD and strategy encouraged higher reporting levels, and shifts in reporting from engineering to marketing. The need to integrate NPD and strategy also drove the addition of NPD/strategy steps into already well-defined, phased NPD processes. However, NPD/strategy integration was not well reflected in performance measures. The firms studied used varied financial and nonfinancial performance measures, yet relatively few firms reported that their performance measures reflected key aspects of their strategies. NPD managers generally expressed dissatisfaction with the performance measurements, and firms appeared to be searching for more effective alternatives.

Data Availability: Available upon request from authors.

INTRODUCTION

The new product development (NPD) process transforms concepts into commercially viable products; it is thus critical for strategy implementation and should be closely linked to business strategy. NPD is a key *upstream* activity in manufacturing businesses,

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preceding *downstream* manufacturing, sales, and distribution activities. As the following example suggests, NPD is critically important to a firm's financial success.

Yokogawa Electric is a \$1.7 billion-a-year manufacturer of industrial testing and measuring equipment headquartered near Tokyo. Facing difficulties, the company was forced to improve its financial performance. They scrutinized their products, including an industrial recorder used to track temperature, pressure, and flow rates in process industries such as oil refineries. Product designers found that redesigning the cover enabled them to use a new die-casting method to make the cover in a single piece; before, it required 31 pieces. They also redesigned the recorder's knobs, cutting the cost of materials 90% and assembly time by 96%. Overall, production costs fell 45%. (Henkoff 1995)

The Yokogawa Electric example illustrates how NPD can reduce product cost and improve the firm's financial performance. Yokogawa Electric's experience is not unique; it has been widely reported that 75–90 percent of product costs are determined when product design is finished (Berliner and Brimson 1988; Shields and Young 1991). Thus, a firm seeking to control product costs might be expected to focus on upstream NPD activities. Astonishingly, this is often not the case, as the following example shows.

Managers at General Electric's Aircraft Engines operations failed to make dramatic productivity breakthroughs despite many "work-out" (reengineering) projects. That may have been because engineers looked only at how the engines were *built*, not how they were *designed*. Admits William Vareschi, vice president of finance: "We never, shamefully, even discussed that. We thought manufacturing productivity was just a manufacturing problem." When they changed their approach to focus on product design, the NPD team redesigned the CF6 engine, eliminating 24 brackets, five valves, 33 feet of cable, 24 tubes, and 70 fasteners. The new CF6 was 81 pounds lighter, which cut the cost of flying a Boeing 767 by about \$150 an hour. (Henkoff 1995) (emphasis in the original)

This example shows that NPD not only influences the manufacturer's product costs and financial performance, but also that NPD can improve the customer's financial performance. This can increase demand and further improve the manufacturer's financial performance.

Since upstream NPD activities have a significant impact on attaining the firm's strategic and financial goals, NPD activities require management control¹ just as manufacturing, distribution, and other downstream activities do. However, extant management control system (MCS) literature has not directly addressed this important issue.

Research Questions on NPD, Strategy, and Management Control

In this study, we focus on three questions about each of three management control system (MCS) mechanisms. Early in the preliminary phase of this research, NPD managers identified these questions and mechanisms as key concerns requiring attention at their firms. The three management controls include: (1) positioning NPD within the firm's organizational structure; (2) the NPD process; and (3) performance measurement.

Strategy was highlighted not only early, but also throughout the study as a key influence on MCS for NPD. NPD was viewed as critical for strategy implementation;

¹ "Management control is the process by which managers influence other members of the organization to implement the organization's strategies" (Anthony and Govindarajan 1998, 6).

in addition, NPD managers viewed NPD as potentially contributing to strategy formation although this potential was not being fully realized. In order for NPD to make these strategic contributions, management controls had to be structured to effectively link NPD to strategy. Each of the three mechanisms above can potentially enhance the NPD/strategy link. Locating the NPD function correctly in the organization facilitates the flow of strategic information to NPD for strategy implementation and from NPD for strategy formation. Structuring the NPD process appropriately enables strategic goals to be used to select and guide NPD projects. Finally, effective performance measures can signal strategically important goals that the NPD team must address, and measure their success in achieving these goals. To the extent these MCS mechanisms are not effectively linked with strategy, NPD outcomes will not be consistent with the firm's strategic goals. Thus, for each MCS mechanism studied, we asked:

1. What is the current practice?
2. How, if at all, has this control mechanism changed recently?
3. How, if at all, has strategy influenced this control mechanism, or changes to it?

Summary of Key Findings

Our findings are based on interactions with over 75 industrial design managers involved with NPD over three research phases. These managers work in firms that are above average or superior with respect to product design and development. The sample firms primarily manufacture goods representing 14 industries including computer hardware and peripherals, automotive components, durable consumer products, consumer electronics, other manufactured consumer goods, telecommunication products, and office furniture and equipment.

Position of NPD in the Organization

We find that NPD managers generally report to a vice president, typically in the marketing or engineering (R&D) function. The position of NPD is changing; NPD managers are reporting to higher-level executives, and moving to marketing from engineering. Managers state that the need to link strategy and NPD motivates these changes; for example, reporting at higher organization levels allows NPD managers to participate in strategy formation.

NPD Process

All firms studied use a stage-gateTM NPD process (Cooper 1993) in which projects proceed through specified, sequential stages; at the end of each stage, senior management makes "go" or "no-go" decisions about continuing the project's development. Many firms in the study report recently revising, formalizing, and documenting the NPD process, often adding explicit steps to link NPD to the firm's strategy.

Performance Measurement

Many firms in the study do not measure NPD performance explicitly; however, those that do use both financial and nonfinancial measures. Many firms were changing NPD performance measures. The link between performance measures and strategy appears weak, although NPD managers want increased emphasis on measuring NPD's alignment with strategy. NPD managers are generally dissatisfied with NPD performance measurement.

Motivation for Change

Among the firms studied, NPD management controls are dynamic; changes are occurring in all three management control system mechanisms examined. Numerous firms' managers indicate changes were made to better integrate NPD and the firm's strategy. Other changes may result from a general concern with how to control NPD more effectively.

In the next section, we discuss the prior management control research related to strategy and NPD that framed our investigation and set our expectations. We then present our three-phased methodology, followed by results and discussion. Finally, we develop tentative conclusions from this research and identify future research opportunities.

BACKGROUND LITERATURE

A review of relevant MCS and NPD literature shaped our expectation for two of the three management control mechanisms identified by NPD managers: (1) the NPD process and (2) performance measurement. However, our search of the literature revealed nothing on the third management control mechanism that NPD managers indicated was important, specifically, NPD's position in the organization (level and functional group).² Thus, we have no explicit expectations regarding the NPD functions' formal position in the firm.

NPD Process

NPD typically follows a well-defined process where new product concepts evolve through several stages before products reach commercial production. Cooper (1993) identifies 13 distinct NPD stages of what he calls the stage-gate™ process with senior management making go or no-go decisions between each stage. Griffin (1997) reports that just over 60 percent of surveyed manufacturing firms use a cross-functional stage-gate™ NPD process. Several studies have shown that use of a repeatable NPD process is related to successful new product outcomes (Cooper and Edgett 1996; Cooper and Kleinschmidt 1995; Rochford and Rudelius 1997). Further, firms that include an explicit strategy step in their NPD process are more likely to produce successful new products (Griffin 1997).

Given the consistent findings about the value of a repeatable NPD process, we expect firms to use a well-defined stage-gate™ process. We further expect firms engaged in leading-edge design to include a specific stage that links strategy to product development opportunities. The research on NPD process and its effects on new product outcomes addresses current practice. It is not clear what NPD process changes to anticipate, as this is a new area of exploration.

Performance Measurement

Performance measures are a common control mechanism. They communicate desired outcomes or behavior to employees and are used to evaluate success in achieving goals. It is generally believed that the best performance measures are those linked to a firm's strategy (Kaplan and Norton 1992, 1993; Nanni et al. 1992; Langfield-Smith 1997). In an experimental setting, Griffin and Page (1996) find that subjects rate NPD

² While there is literature discussing the preferred or optimal structure of NPD teams (Souder 1987; Larson and Gobeli 1988; Griffin 1997), there was nothing to inform our discussion of the organizational structural position of NPD within the firm.

performance measures as most appropriate when they are related to strategy. However, there is little empirical evidence that strategy guides the selection of NPD performance measures in practice.

Several studies report that about half of surveyed firms measure NPD performance (Griffin 1997; *R&D Magazine* 1995). Most firms that measure performance use a combination of financial and nonfinancial measures (Griffin and Page 1996). Such combinations are used in a variety of settings and are generally agreed to be most appropriate for performance measurement (Abernethy and Lillis 1995; Cooper 1996; Govindarajan 1988; Hertenstein and Platt 1998; Kaplan and Norton 1992, 1993; Simons 1987).

Certain functions such as NPD and R&D are critical to the success of innovative firms.³ The performance of these functions is difficult to measure financially because of the long-term nature of the work and the lag between NPD or R&D work and financial performance in the market (Hertenstein and Platt 1997; Langfield-Smith 1997). In an empirical study of R&D management controls, Rockness and Shields (1988) found that financial measures were less useful in evaluation and in determining rewards than in planning and monitoring activities. Additionally, identifying individual members' contributions to NPD team financial outcomes is difficult (Milgrom and Roberts 1992). These factors may partially explain why NPD managers prefer nonfinancial performance measures that more directly assess critical strategic dimensions such as customer satisfaction, time to market, and product quality (Hertenstein and Platt 1997).

We expect NPD results to be assessed in both financial and nonfinancial terms. However, we expect NPD managers to want increased emphasis on nonfinancial measures and decreased emphasis on financial measures due to the lag between NPD work and product launch and to the difficulty in separating NPD financial results from those of other functions such as marketing or manufacturing. Further, because Cooper (1984a, 1984b) and more recently Griffin (1997) report that strategic guidance is an important determinant of success for NPD projects, we expect NPD managers to perceive a fit between the firm's strategy and the performance measures that the firm emphasizes.

METHODOLOGY

We obtained the data for this study over an 18-month period from industrial design managers involved with NPD. We focused on industrial design managers because of their distinctive skills and contributions to NPD teams. Industrial designers focus on the user's interaction with the product—for example, its ease of use—but they bring more to NPD than user-product interaction. Their cross-functional training enables them to view NPD from multiple perspectives,⁴ to facilitate group decision making by providing concrete drawings and models of the team's conceptual designs, and to help the team find a consensus and build on it (Fujimoto 1991). Thus, industrial design managers are good subjects for a study of NPD management controls because they not only participate on NPD teams, but also their expertise places them in a unique position to understand and appreciate contributions and perspectives of other team members.

³ NPD overlaps with the development phase of R&D; however, NPD is distinct from R&D, as employees from numerous business functions, not just R&D, collaborate to plan, design, develop, and launch new products.

⁴ This cross-functional training includes marketing, manufacturing, process engineering, product engineering, and human factors as well as color theory, graphic composition theory, and visual principles of design (Industrial Designers Society of America 1997).

The study's methodology was evolutionary, proceeding through three sequential phases: preliminary interviews, an expert panel workshop, and a performance measurement survey. Each phase addressed issues identified as important in the prior phase. The preliminary interview phase identified three key MCS mechanisms that design managers and senior managers currently consider critical to NPD. These three mechanisms were then explored in detail in the expert panel workshop. Finally, performance measurement was investigated further in the last phase due to industrial design managers' dissatisfaction with this MCS mechanism. During all three phases, we addressed the three basic research questions of current practice, recent changes and links to strategy. In addition, following each phase, we discussed findings with industrial design managers to interpret results and clarify information.

Our goal in selecting firms for various study phases was to examine firms considered above average, if not superior, in industrial design to reveal practices of leading-edge firms in design and NPD. Firms in the first two phases were hand chosen with this criterion in mind. Firms in the performance measurement survey were also likely to be above average because they were members of an organization focused on effective design management practice.

Phase I: Preliminary Interviews

To shape our research agenda, we conducted preliminary research with knowledgeable practitioners to identify and understand management control issues critical to NPD. The unstructured preliminary interviews focused on management control issues that the firms represented considered important. During this phase, we led a roundtable discussion with six industrial design managers from manufacturing firms, service firms, and design consultancies. We next interviewed in-depth the senior design manager at a large high-tech manufacturing company and a principal in a design consultancy. Finally, we held an executive workshop with 11 industrial design managers attending a design management conference.

Phase II: Expert Panel Workshop

Three management control mechanisms that concerned design managers emerged from the preliminary interviews. We chose to investigate these mechanisms in greater depth with firms that had leading-edge industrial design functions. We composed an expert panel by identifying eight such firms⁵ that represented a variety of product manufacturing industries.⁶ We invited their industrial design managers to participate in a workshop focused on the three management control mechanisms identified in the preliminary interviews. Each expert panel member presented his or her firm's current practice on the three control mechanisms, recent changes to these controls, and how each was linked to strategy.

Phase III: Performance Measurement Survey

Managers in the preliminary interviews and the expert panel indicated dissatisfaction with and need for improvement in performance measurement. The third phase of this study extended our description of NPD performance measures begun in the expert panel.

⁵ The Design Management Institute was instrumental in identifying the leading-edge product design firms.

⁶ The eight firms were Bissell, Black & Decker, IBM, Kodak, Prince, Steelcase, Thomson/RCA, and Whirlpool.

At a design management conference,⁷ we administered a performance measurement survey to conference attendees.⁸ The survey was designed to determine the range and number of performance measures used, the design manager's assessment of actual and desired emphasis placed on the performance measures, and the extent to which the firm's performance measures were related to strategy. The survey included 43 performance measures derived largely from the expert panel presentations. We modified the list of measures based on the preliminary interviews and our literature review (Potter et al. 1991; Kaplan and Norton 1996). To help survey respondents, we grouped the 43 measures into financial (16) and nonfinancial measures (27), with the latter divided into eight categories (see Exhibit 1).⁹

We explored not only the measures the firms used, but also the emphasis placed on them. We examined the degree to which each measure was actually emphasized to understand its practical importance, since it is possible that a measure could be calculated, but ignored. We also assessed how much emphasis industrial design managers believed *should* be placed on each measure; if they disagreed with the actual emphasis, that could cause the dissatisfaction with performance measures observed in earlier phases.

In the survey, we also wanted to explore issues expert panelists raised about linking strategy and NPD. We developed three questions to explore the relationship between performance measures and strategy: (1) whether measures the firm emphasized reflected critical aspects of the firm's strategy, (2) whether the firm measured achievement of specific strategic goals, and (3) whether the firm assessed the alignment of design with company strategy. If performance measures are not linked to strategy, this may partially explain design managers' dissatisfaction with performance measurement.

RESULTS AND DISCUSSION

Phase I: Preliminary Interviews

Three distinct control mechanisms emerged as common concerns across the various firms, including industrial design's position within the firm's organizational structure, the NPD process, and NPD performance measurement.

Position of NPD in the Organization

Preliminary interviews indicated that the level of industrial design's reporting relationship is being debated in the firm. According to the design manager at a high-tech manufacturing company, the firm moved industrial design to a higher reporting level due to its strategic importance.

The [design function] developed a common design language [set of characteristics] that enabled designers to develop a wide range of products clearly imprinted with [the company's] brand image. [Company name] came to view design as a strategic advantage or core competency. Recognizing the increased importance, [design function] has recently received greater visibility at [company name]; it was moved to report to [an EVP]—a higher level than previously.

⁷ The 21st Annual International Design Management Conference, Chatham, MA, October 1996, sponsored by the Design Management Institute.

⁸ These individuals represented all facets of design, including product design, graphics design, package design, and corporate image design.

⁹ This set of measures appears reasonably comprehensive, as respondents added no measures when they were asked to list any financial or nonfinancial measures used by their firm that were not included in the survey.

EXHIBIT 1
Financial and Nonfinancial Measures of Design Performance in Questionnaire

Financial Measures	Nonfinancial Measures	
<ul style="list-style-type: none"> ♦ Revenue/Sales ♦ Product cost ♦ Development process cost—total ♦ Development process cost—phase ♦ Gross Profit—total ♦ Gross Profit—new products ♦ Cash flow ♦ Net income/Profit ♦ Economic value added (EVA®) ♦ Stock Price ♦ Market share—product ♦ Percent sales—new products ♦ Percent sales—new customers ♦ Percent sales—repeat customers ♦ Percent sales—proprietary products ♦ Sales to break even 	<p style="text-align: center;">Timing Measures</p> <ul style="list-style-type: none"> ♦ Time to market ♦ Cycle time, by phase ♦ Time to revision ♦ Time to break even <p style="text-align: center;">Design Effectiveness Measures</p> <ul style="list-style-type: none"> ♦ Percent first designs meet needs ♦ Team assessment of design effectiveness ♦ Percent projects that reach production ♦ Assessment of CAD use <p style="text-align: center;">Design Efficiency Measures</p> <ul style="list-style-type: none"> ♦ Number of design modifications ♦ Frequency of specification changes 	<p style="text-align: center;">Customer Satisfaction Measures</p> <ul style="list-style-type: none"> ♦ Satisfaction—product ♦ Satisfaction—style/appearance ♦ Satisfaction—ease of use <p style="text-align: center;">Employee-Rated Measures</p> <ul style="list-style-type: none"> ♦ Employee morale ♦ Team assessment of individual contribution ♦ Ratio: # designers/# employees <p style="text-align: center;">Strategic Measures</p> <ul style="list-style-type: none"> ♦ Alignment: design with company strategy ♦ Achievement of specific strategic goals <p style="text-align: center;">Volume Measures</p> <ul style="list-style-type: none"> ♦ Number of products in pipeline ♦ Number of products started ♦ Number of products completed
	<p style="text-align: center;">Innovation Measures</p> <ul style="list-style-type: none"> ♦ Number of patents ♦ Number of new products developed ♦ Number of new products introduced ♦ Number of design awards ♦ Peer evaluation of design work ♦ Percent new features 	

NPD Process

Design managers describe fairly well-defined NPD processes. Descriptions from different firms are similar; for example, they indicate that teams, with representatives from marketing, design, manufacturing, engineering, and others, as needed, develop new product designs. Many tasks appear routinized and cross-functional, for example, "The marketing folks, with the finance folks, estimate what the competitive selling price will be when the product is released." Yet, despite typical, well-defined processes, design managers are not fully satisfied and continue to seek further process improvements.

Performance Measurement

Design managers voice dissatisfaction with design performance measures, particularly financial measures such as revenue and net income. These managers express concern that financial measures alone do not adequately reflect the nature and depth of contributions that designers make to NPD outcomes. Since financial results such as sales or product profitability are not realized until after product launch, they do not reflect designers' current performance. Related to their dissatisfaction with performance measures, design managers express frustration that they can not effectively communicate design contributions and accomplishments to senior management. They ask:

How do we show the value of design?

In analyzing the benefits from NPD, how much is due to design [not other functions]?

The question is not whether design is good or bad; rather, is the design appropriate for the firm's [strategy and markets]?

The salience of these issues was heightened at several firms that were downsizing, where senior managers were asking design managers to justify industrial design's value to the firm.

Changing NPD Controls

Throughout the preliminary interviews, managers indicated that these three mechanisms used to control NPD are changing. Because change is difficult, and employees typically resist it, the fact that firms are changing these control mechanisms suggests the firms consider them important to achieving their goals. This prompted us to focus explicitly on changes to NPD control mechanisms in later phases of the study. The NPD managers also pointed out that while the link between NPD and strategy is important, it is often weak in practice. Moreover, they suggest that the desire to strengthen the connection between NPD and strategy often motivates changes to the firm's MCS. These observations motivated us to focus directly on links between strategy and the controls we were investigating.

Phase II: Expert Panel

We asked the eight expert panelists to make presentations focused on three management controls: position of NPD within the organizational structure, NPD process, and NPD performance measurement. For each management control, they presented their firm's current practice, recent changes, and integration with firm strategy.

Position of NPD in the Organization

Expert panel members indicate that the head of industrial design reports fairly high, with most reporting to a vice president or higher. They also state that at several firms, industrial design recently was assigned to report at a higher level.¹⁰ Another organizational change, seen in three firms, moved the industrial design group from engineering to marketing.

Participants tie their discussion of these organizational changes to the need for close integration between industrial design and strategy, arguing that NPD teams play a key role in strategy implementation by interpreting strategic concepts and shaping them into products.¹¹ Participants indicate the primary reason for changes in reporting relationships is the need to better integrate design and strategy, where reporting higher in the organization increases design's access to and knowledge of strategy. The shift to reporting to marketing rather than engineering is also viewed as enabling product design to be better aligned with corporate strategy.

Expert panelists indicate that industrial design not only implements strategy, but it can also contribute to strategy formation, although they believe this potential is not being realized. All agree that industrial design managers are more likely to participate in strategy implementation than strategy formation; only two panel members actually participate in strategy formation.

NPD Process

Exhibit 2 describes the NPD process typical among these firms. As shown there, advanced concept discussions informed by strategy generate product concepts that cross-functional teams design and develop into the final product prototype in stages. At stage-gates™ between stages, senior managers reevaluate the project and decide whether to proceed with development.¹²

All expert panelists indicate their firms have recently changed the NPD process, generally in two key areas. First, many firms have recently formally documented their NPD process. Several panelists observe that formal documentation enables consistent replication of the process, and helps management monitor and control the process and improve it when needed.

Second, although the link between the advanced concept stage and strategy is represented in Exhibit 2 as standard, it reflects a recent change for some firms. Managers report their firms are introducing explicit steps linking strategy and NPD early in the advanced concept stage to guide new product ideation and conceivably the rest of the NPD process. This finding is consistent with Griffin's (1997) results that strategy-setting activity in the NPD process is one factor that significantly distinguished the best performing firms in NPD.

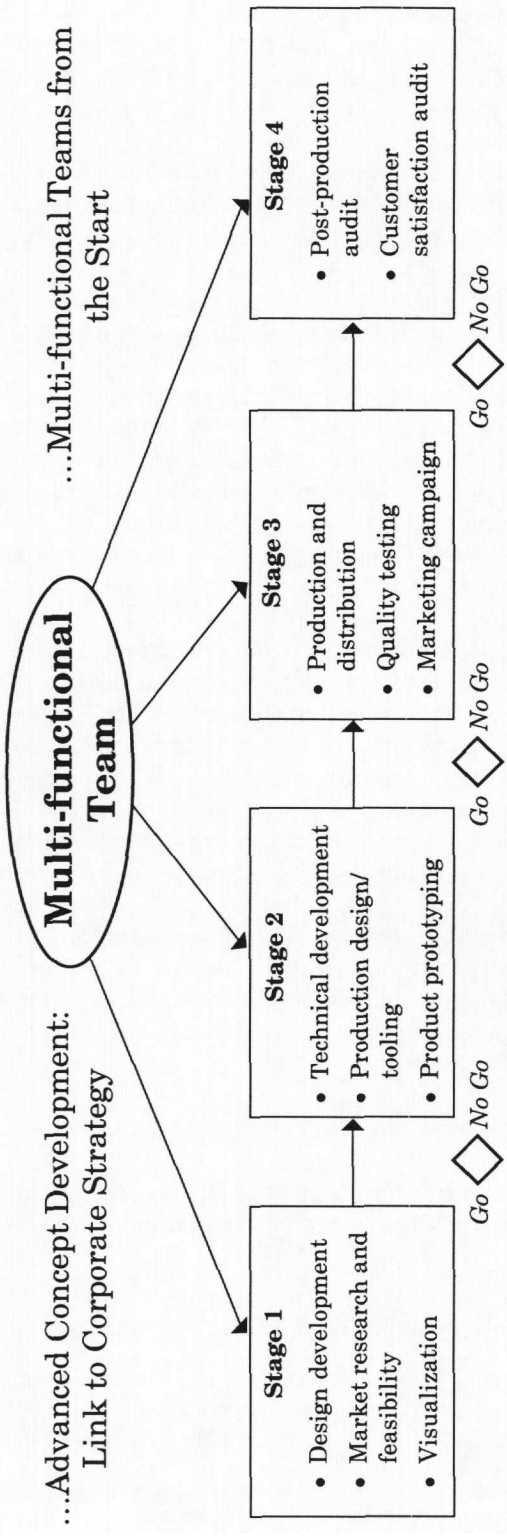
The panel presentations also suggest that despite these changes, and despite progress in linking NPD and strategy, more work is needed. NPD teams do not always have access to needed strategic information, especially in later stages. Panelists indicate they sometimes lack sufficient information on corporate or product strategy

¹⁰ In one instance, industrial design had been moved down a level.

¹¹ The firms in the expert panel were predominantly single-business firms; thus, their "corporate strategy" was what others might refer to as a business-unit strategy.

¹² This type of process is characteristic of the more advanced processes used to develop products and of the most successful firms engaged in NPD (Griffin 1997).

EXHIBIT 2
The New Style/New Product Development Process...



...Stage-gate™ Process: Go/No Go Decisions

to facilitate design. They describe how NPD teams attempt to access needed strategic information; when those efforts fail, "we make up the strategy to design the product." Thus, they anticipate further changes—and progress—in this area.

Performance Measurement

Participants indicate their firms use both financial and nonfinancial measures to assess industrial design performance. Each expert panelist discussed between one and six financial performance measures and between four and seventeen nonfinancial performance measures.¹³

Most expert panelists indicate that product cost and process cost (the cost to develop the new product) are the key *financial* measures of industrial design performance, while customer satisfaction measures are the key *nonfinancial* measures. In measuring product cost, they typically first develop a target cost, then use the target cost to evaluate product cost estimated during NPD.¹⁴ In only one instance, however, did an expert panelist state that design performance measures are related to the firm's strategy.¹⁵ In fact, strategy was rarely mentioned during presentations on performance measurement, in sharp contrast with presentations on the other two controls, where the desire to link NPD to strategy was a key reason cited for recent changes.

Despite numerous and varied performance measures, these managers, like those in the preliminary interviews, are dissatisfied with performance measurement. Expert panel members indicate their search for effective measures to communicate industrial design's performance and contribution to product and firm success is ongoing. They indicate that objective performance measures are crucial and are receiving increased scrutiny from senior management.

Some firms are making explicit changes in their design performance measures. Two firms had implemented new design performance measures within the past two years; another three of the eight firms are considering or developing new design performance measures.

To explicitly address the expert panelists' clear dissatisfaction with NPD performance measurement, we designed a survey questionnaire to explore current use of design performance measures, design managers' assessment of actual and desired emphasis placed on the various performance measures, and the extent to which performance measures are linked to strategy.

Phase III: Performance Measurement Survey

Overall Survey

The survey was administered to attendees at a design management conference. Out of 107 companies represented at the conference, 46 usable surveys were completed,

¹³ Presentations typically emphasized new measures their firms had adopted; they did not necessarily enumerate every measure used.

¹⁴ Target costing begins with establishing a target price based upon analysis of what the market will bear and future customer preferences (Cooper and Chew 1996). Target costing works back from market-based pricing and subtracts a standard or expected return-on-sales percentage to yield an allowable cost for new products (Kaplan 1990).

¹⁵ It is possible that some measures presented by others might have been related to key strategic goals—for example, product cost—but the presenter did not designate them as such.

EXHIBIT 3
Descriptive Statistics: Overall Sample^a

Type of Company	67%: Company/company division 33%: Design consultancy
Company Size	26%: Small (fewer than 50 employees) 6%: Medium (50 to 499 employees) 60%: Large (more than 500 employees)
Design Group Size	44 employees, on average
Percent Work Completed In-House	65%
Measure Design Performance?	39%: Yes 61%: No
Considering New Performance Measures?	41%: Yes 39%: No 15%: Don't know

^a All statistics presented are based on all survey respondents, $n = 46$. In some cases, the breakdown of the sample does not add to 100 percent due to nonresponse.

a 43 percent response rate.¹⁶ Descriptive statistics about companies in the overall sample are presented in Exhibit 3. Only 39 percent respond that their firm currently measures design performance.

Forty-one percent of the respondents indicate their firm is considering new design performance measures, while 39 percent are not considering new measures and the remainder do not know. Interestingly, a majority (57 percent) of those considering new measures *do not* currently measure design performance. Just over 60 percent of all respondents are either currently measuring or are considering measuring design performance at their company. As we found in earlier phases, design performance measurement is receiving considerable attention.

Product Firms That Measure Design Performance

To extend expert panel findings on design performance measurement, we focused on firms who measured design performance *and* produced products, thus eliminating industrial design consultancies, service firms, and firms that produced products but did not measure design. Focusing the analysis on this subgroup reduces the sample to eight respondents; however, it enables us to concentrate on a set of designers of particular interest because they work in NPD and it extends our understanding of similar companies from the expert panel.

These respondents work in somewhat larger firms than in the overall sample, with 88 percent responding they work in a firm with "500 or more" employees, and the remainder in a firm with "50 to 499" employees. The design group is smaller, with about

¹⁶ Only one respondent was accepted for the sample from each firm at the conference. In the case of multiple respondents from one firm, one respondent was selected randomly to be part of the sample.

EXHIBIT 4
Currently Used Design Performance Measures: Frequency and Percentage

	<u>Frequency^a</u>	<u>Percentage Frequency</u>
Financial Measures		
Revenue/Sales	7	88
Product Cost	6	75
Development Process Cost—Total	5	63
Nonfinancial Measures		
Satisfaction—product	7	88
Satisfaction—style	7	88
Satisfaction—ease of use	7	88
Number of patents	7	88
Number of new products developed	7	88
Team assessment: design effectiveness	6	75
Achievement of specific strategic goals	6	75
Time to market	5	63
Number of products started	5	63
Number of design modifications	5	63
Number of products completed	5	63

^a Percent of respondents reporting current use of measure at their firm. Only those measures used by a majority (63 percent) or more of the firms are shown.

23 people, on average. As with the overall sample, 65 percent of the design work is done in-house. Two of the eight firms are considering new design performance measures.¹⁷ Again, the results that follow are for the eight firms that measured design performance and manufacture products.

Performance Measurement

Usage. All but one of the 43 measures in the survey was checked as currently used by at least one respondent firm.¹⁸ Consistent with findings from the expert panel, respondent companies, on average, use about 5 financial measures and about 11 nonfinancial measures to evaluate design performance.

Exhibit 4 shows design performance measures that a majority of firms use. Revenue, product cost, and total development process cost are the most frequently checked financial measures. This rank order is about what we expected based on expert panel discussions and on business' traditional use of revenue and cost to evaluate financial strength. Customer satisfaction and innovation measures are the most frequently used nonfinancial metrics. Moreover, firms use a diverse set of nonfinancial measures; at least one measure from seven of the eight categories of nonfinancial measures appears in this list of frequently used nonfinancial measures.¹⁹

¹⁷ This result is comparable to that found for the expert panel firms, where three of the eight firms reported active consideration of new performance measures.

¹⁸ The one measure not checked as currently used was number of designers/number of employees.

¹⁹ Individual measures from the employee-related performance measure category were *not* frequently used.

EXHIBIT 5
Financial Measures: Mean Ratings and Rank Order of
Actual Emphasis Given and Desired Emphasis

Measure	Actual Emphasis			Desired Emphasis		
	n	Mean Rating	Rank Order	n	Mean Rating	Rank Order
Product cost	6	7.0	1	6	7.5	1
Revenue/Sales	7	6.7	2	7	7.0	4
% Sales—new products	5	4.4	3	5	5.2	12.5
Market share of product	6	4.3	4.5	6	6.7	7
Sales to break even	4	4.3	4.5	4	6.3	9
Development process cost—total	5	4.2	6	5	7.4	2
New income/Profit	5	3.8	7	5	6.8	5.5
% Sales—new customers	5	3.4	8.5	5	5.4	10
% Sales—repeat customers	5	3.4	8.5	5	6.8	5.5
Cash flow	5	3.0	10.5	5	5.2	12.5
Gross profit—new products	7	3.0	10.5	7	5.3	11
Development process cost w/phase	5	2.8	12	5	6.6	8
Gross profit—total	5	2.4	13	5	4.4	14.5
EVA [®]	6	2.2	14.5	6	7.2	3
% Sales—proprietary products	5	2.2	14.5	5	4.4	14.5
Stock price	5	0.8	16	5	1.8	16
Mean rating		3.5			5.9	

Actual vs. desired emphasis. To gauge the importance of various performance measures, we asked respondents to indicate how much emphasis is placed on each measure (*actual emphasis*), as well as how much emphasis should be placed on each measure (*desired emphasis*), using a ten-point scale ranging from 1 = no emphasis to 10 = heavy emphasis. Exhibits 5 and 6 contain the mean ratings of actual emphasis and desired emphasis for the financial measures and nonfinancial measures, respectively. In addition, the rank order of the measures, based on the mean ratings, is shown.

As Exhibit 5 shows, the average actual emphasis rating for the financial measures (3.5) is less than that for desired emphasis (5.9). This finding is true, also, for each financial measure considered separately. A sign test was performed on respondent's pairs of ratings comparing actual to desired values across the 16 financial measures. Because the sample size varies from four to eight respondents, a sign test was conducted rather than paired t-tests to increase the power of the test. The test was based on $n = 57$ pairs for which 3 signs were positive and 54 signs were negative. These results indicate that the desired ratings are significantly higher than actual ratings at the .01 level of significance.

Thus, industrial design managers in this survey desire greater emphasis on all financial measures in the survey, even those they rate as actually having minimal emphasis. We expected the opposite—that industrial design managers would want to reduce the emphasis on financial measures due to their concerns about the ability of financial measures to capture important aspects of design performance, and to their preference for nonfinancial performance measures. The higher desired emphasis may

EXHIBIT 6
Nonfinancial Measures: Mean Ratings and Rank Order of
Actual Emphasis Given and Desired Emphasis

Measure	Actual Emphasis			Desired Emphasis		
	n	Mean Rating	Rank Order	n	Mean Rating	Rank Order
Satisfaction—product	6	7.7	1	5	9.8	1
Satisfaction—ease of use	6	7.2	2	5	9.0	4
Time to market	6	6.7	3	5	9.0	4
Satisfaction—style	6	6.3	4	5	7.8	9.5
Employee morale/satisfaction	5	6.0	6.5	5	8.4	7.5
Number new products developed	6	6.0	6.5	6	7.7	11
Number design modifications	5	6.0	6.5	5	7.4	12.5
Cycle time within phase	6	6.0	6.5	5	6.8	18
Number new products introduced	6	5.8	9	6	7.8	9.5
% products—1st design meets needs	4	5.5	11.5	4	9.0	4
Team assessment—design effect	6	5.5	11.5	6	8.5	6
Peer evaluation	6	5.5	11.5	6	6.8	18
Frequency of changes in specs	4	5.5	11.5	4	7.3	14.5
Achievement of strategic goals	5	5.4	14	5	8.4	7.5
Number products completed	5	5.2	15	5	7.2	16
Number patents	6	5.0	16	6	6.3	20.5
% new features	5	4.6	17	5	7.4	12.5
Team assessment—individual's contribution	5	4.4	18	5	6.8	18
Alignment of design w/strategy	4	3.8	20	4	9.3	2
Number products started	5	3.8	20	5	6.0	22
Number products in pipeline	5	3.8	20	5	5.8	24
Assessment—CAD use	5	3.4	22	4	5.8	24
% design projects go to production	5	3.2	23	4	6.3	20.5
Time to revision	5	2.8	25	4	7.3	14.5
Time until product breaks even	5	2.8	25	5	5.8	24
Number design awards	6	2.8	25	6	5.7	26
# designers/# employees	3	1.0	27	3	1.7	27
Mean rating		4.9			7.2	

suggest that these design managers realize that it is critical to express results in financial terms to communicate to senior management.

As Exhibit 6 shows, analysis of nonfinancial performance measures yields similar results to those reported above for financial measures. Again, industrial design managers indicate they want the measures to be emphasized more than they actually are. A sign test similar to that described above was conducted for nonfinancial measures. The test was based on $n = 80$ paired comparisons across the 27 measures, for which 5 signs were positive and 75 were negative, yielding a significant difference at the .01 level. These results are as expected, based on earlier research findings. Moreover, design managers in earlier phases indicated that nonfinancial measures correspond better to their assessment of design's contribution to NPD. Therefore, it is consistent that they want greater emphasis placed on these measures.

Further analysis of the rank order data in Exhibits 5 and 6 shows there is a significant, positive rank order correlation between actual and desired emphasis on financial measures ($r = .55$, $p < .05$, $n = 16$) and on nonfinancial measures ($r = .70$, $p < .00001$, $n = 27$). For each type of measure, those rated high (low) in actual emphasis are those that design managers rate high (low) in terms of desired emphasis, producing a similar ordering of the measures for actual ratings and desired ratings. This result suggests that, on average, industrial design managers in the sample basically agree with the firm on emphasis given to performance measures within financial and nonfinancial categories, and that they consider the measures emphasized by the firms to be the "right" measures.

A final observation from Exhibit 6 concerns nonfinancial measures with high desired emphasis ratings. While design managers agree that customer satisfaction and time to market should be heavily emphasized, they also rate highly the two strategic measures, especially the extent to which design is aligned with corporate strategy, the measure with the greatest difference between actual (20) and desired (2) rank. This again highlights a theme raised earlier, the importance of linking strategy and design.

The Connection of Design Measurement to Strategy

Pursuing the interesting finding that product design managers want greater emphasis placed on the extent to which design is aligned with corporate strategy, we further stratified our subgroup of firms that produce products *and* measure design performance to focus on respondents who indicate performance measures currently used by their company reflect critical aspects of their corporate strategy. Five of the eight respondents fall into this category. We looked at these five respondents' use of the strategic measures and the degree of importance attached to them.

All five firms currently measure achievement of specific strategic goals; further, the managers generally agree with their firm's emphasis on this performance measure. These results suggest these industrial design managers acknowledge the importance of achieving strategic goals, an outcome consistent with their recognition of the importance of NPD for strategy implementation. However, while three of the five respondents say that their firm uses the strategic alignment measure, a far greater disparity exists between the ratings for actual and desired emphasis, with desired much greater than actual. These results are consistent with expert panel findings that firms are striving to align NPD with strategy, but have not fully achieved this goal.

Summary of Performance Measurement Survey

Consistent with expert panel findings, the survey results show that for companies that make products *and* measure design performance, the firms use a variety of financial and nonfinancial design performance measures. Industrial design managers consider product cost the number one financial measure in terms of its actual emphasis, and also its desired emphasis. This suggests these managers understand NPD's significant impact on product cost, and product cost's importance to the firm. Indeed, they indicate that even more emphasis should be placed on product cost than is currently placed on it. And, contrary to our prior expectations, these industrial design managers want greater emphasis, not reduced emphasis, on financial measures in general. However, consistent with our expectations, design managers desire greater emphasis on nonfinancial performance measures. Moreover, the ordering of both financial and nonfinancial measures with respect to actual emphasis compared to desired emphasis is similar, indicating that these managers generally agree with the relative weighting of these performance measures.

The results also indicate that achievement of strategic goals is an important design performance measure, and that performance measurement should place more emphasis on the alignment between design and competitive strategy.²⁰

CONCLUSIONS AND FUTURE RESEARCH

This study addressed three management control mechanisms that practicing industrial design and NPD managers consider critical to their success: design's position in the firm's organization structure, the NPD process, and performance measures. The results of this study are descriptive and exploratory. The findings cannot be generalized to the population of all firms engaged in NPD or all industrial design managers, but should be interpreted as representing the practices and opinions of the firms and managers participating in the study.²¹

Position of NPD in the Organization

The position of the NPD function was a new area for MCS research. We find that the head of most industrial design functions reports to the vice president level or above. Recent changes involve reporting higher within the organization and reporting to marketing rather than engineering. A primary motivation for these changes is to link NPD and strategy.

NPD Process

As expected, we find that study firms have a well-defined NPD process, and some firms have explicitly incorporated strategy into the NPD process, often early in the advanced concept stage. However, extending beyond earlier findings, we find that firms want more explicit links between strategy and the NPD process, especially to guide later stages of NPD.

Performance Measurement

Consistent with earlier studies, many firms in this study do not use performance measures to evaluate design performance. Firms that do measure design performance use a variety of financial and nonfinancial performance metrics. Product cost is the most important financial measure used; customer satisfaction and timing measures are the most important nonfinancial measures.

As expected, industrial design managers want more emphasis on nonfinancial measures. Contrary to expectation, these managers want more emphasis on financial measures, as well. This result may suggest that industrial design managers realize that both types of measures are important to effectively communicate performance to senior management.

Further, in contrast with our expectations, we failed to find that NPD managers perceived a fit between the firm's strategy and the firm's performance measures. First, many firms engaged in NPD do not measure industrial design performance at all.

²⁰ Product cost itself is an example of a measure that could be considered a "specific strategic goal." That is, product cost plays an important role in many competitive strategies, especially for those firms that pursue the low cost producer strategy (Porter 1980).

²¹ We focused on one participant in the NPD process, industrial design managers. Other NPD participants, such as representatives from marketing, engineering, or production, may have different responses to issues pertaining to management control of NPD.

Further, although five firms in the survey report that performance measures do reflect critical aspects of their corporate strategy, three firms indicate that their performance measures *do not*, a troubling result suggesting these firms may be encouraging behavior *inconsistent* with their strategies. Even those who felt performance measures reflected corporate strategy report that the firm's actual emphasis on strategic measures was less than desired. Respondents rate the two strategic measures among the highest in terms of the emphasis they want placed on them. They suggest that the link between strategy and performance measures could be much stronger.

Throughout the study, managers were dissatisfied with performance measurement. Firms were struggling to find more effective measures, as many firms had recently implemented new design performance measures, and many are considering new measures.

Linking NPD Management Controls to Strategy

Changing management controls for NPD is a consistent theme, affecting all three management control mechanisms examined. Managers in this study often link "change" with "strategy." Their increasing recognition that strategy must guide NPD, and that NPD is key to strategy implementation has led to changes in management controls to increase the availability and use of strategic information during NPD.

Other changes may result from the sheer difficulty of controlling the creative, innovative NPD function. They may simply reflect companies conducting live experiments as they struggle with a challenging issue, especially since managers lack guidance to support choices they must make, as little academic research on management control of NPD has been conducted.

Future Research

This exploratory study raises important issues warranting further study, especially about performance measures where managers report considerable dissatisfaction.

Some firms in this study indicate that their performance measures reflect critical aspects of their strategy; others indicate that they do not. Research needs to address whether firms whose performance measures reflect critical aspects of their strategy perform better, are more profitable, are able to more effectively implement their strategy.

In particular, since the highest rated performance measure is product cost, research should examine the relationship between product cost and strategy. Of particular interest is whether NPD outcomes related to product cost differ depending on firm strategy, and whether the firm's strategy affects the development and use of product cost information during NPD.

Although industrial design managers are generally dissatisfied with performance measurement, the survey indicates that they do not want to deemphasize financial measures and that the relative emphasis among the financial measures and among the nonfinancial measures is about right. However, the data suggest²²—although we cannot definitively say—that these managers may want more emphasis on nonfinancial than financial measures. We need to examine this issue and whether their dissatisfaction stems from an alternative explanation offered by some managers in the study.

²² The mean desired emphasis rating for nonfinancial measures (7.2) was higher than that for financial measures (5.9).

Specifically, they indicated that existing financial measures do not capture the "right" data, because accounting systems do not provide a "full" picture of an NPD project since product development costs are expensed as incurred, and cumulative revenues and costs are not recorded. Thus, future research should examine what financial information is most useful to measure and manage NPD.

NPD is a strategically important activity. It influences the firm's operating and financial success. Better understanding what controls, especially performance measures, are effective for NPD will contribute to our understanding of management control and will provide helpful guidance to firms.

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