ELSEVIER

PDMA Success Measurement Project: Recommended Measures for Product Development Success and Failure

Abbie Griffin and Albert L. Page

Success is not just elusive; it is also multifaceted and difficult to measure. A firm can assess the success or failure of a development project in any (or all) of many terms, including customer satisfaction, financial return, and technical advantage. To complicate matters, success may be measured not only at the level of the individual project, but also at the program level. With so many variables to consider and so many stakeholders involved, managers face a difficult challenge just deciding which measures are useful for measuring product development success.

Recognizing that no single measure suffices for gauging the success of every product development project, Abbie Griffin and Albert L. Page hypothesize that the most appropriate set of measures for assessing project-level success depends on the project strategy. For example, the objectives (and thus, the success criteria) for a new product that creates an entirely new market will differ from those of a project that extends an existing product line. Similarly, they hypothesize that the appropriate measures of a product development program's overall success depend on the firm's innovation strategy. For example, a firm that values being first to market will measure success in different terms from those used by a firm that focuses on maintaining a secure market niche.

To test these hypotheses, product development professionals were presented with six project strategy scenarios and four business strategy scenarios. For each project strategy scenario, participants were asked to select the four most useful measures of project success. For each business strategy scenario, participants were asked to choose the set of four measures that would provide the most useful overall assessment of product development success.

The responses strongly support the idea that the most appropriate measures of project-level and program-level success depend on the firm's project strategy and business strategy, respectively. For example, customer satisfaction and customer acceptance were among the most useful customer-based measures of success for several project strategies, but market share was cited as the most useful customer-based measure for projects involving new-to-the-company products or line extensions. At the program level, firms with a business strategy that places little emphasis on innovation need to focus on measuring the efficiency of their product development program, while innovative firms need to assess the program's contribution to company growth.

Address correspondence to Abbie Griffin, Associate Professor of Marketing and Production Management, University of Chicago, Graduate School of Business, 1101 East 58th Street, Chicago, IL 60637.

J PROD INNOV MANAG 1996;13:478–496

655 Avenue of the Americas, New York, NY 10010

0737-6782/96/$15.00
PII S0737-6782(96)00052-5

J PROD INNOV MANAG
1996;13:478–496

Difficulties Associated with Measuring Product Development Success

Key to maintaining a competitive position in the marketplace is the ability to repeatedly commercialize successful new products.[1] Since the Industrial Conference Board's first report on preventing product failures in 1968 [4], an enormous amount of research has gone into studying the factors that lead to product development success. At least 61 research studies resulting in 77 articles were published on the subject prior to 1993 [16]. *JPIM* alone has published 15 articles investigating some aspect of factors associated with product development success in 1993 and 1994. See Montoya-Weiss and Calantone [28] for a review and meta-analysis of this stream of research.

Even with all the research which has been done in this area, it is still difficult for a firm to define whether in fact a new product is successful [28]. Firms and academics use over 75 distinct measures of product development success, with little consensus across either group as to the measures which are the most useful [16]

Some measurement confusion arises because firms can measure product development success at two levels: at the overall product development program level and for individual products that make up the project portfolio. Further compounding the issue is that whereas most firms' ultimate objective is financial success, different product development projects may have different measurement needs than just financial due to the portfolio nature of the projects that make up development programs. Thus, although one might expect that at the overall [12] program level, measures of overall financial success derived from the program would be a primary focus, financial outcome is not necessarily the principal focus of any particular project.

Indeed, the largest problem in determining the success of individual products arises because of the multidimensionality of product development outcomes [13,19]. Previous research has determined that project success consists of three independent dimensions: consumer-based, financial, and technical or process-based success [16]. Achieving success with consumers is unrelated to whether a product produces profit for a firm. The perfect product (a silver bullet) is wildly sought after by customers who are delighted with it, provides enormous financial return to the firm, and in addition, is technically elegant, provides a performance advantage to the firm, or was commercialized efficiently.

Unfortunately, the perfect product development project does not exist. Firms frequently must sacrifice some level of success on one dimension to achieve success on another. For example, each of the new products in Exhibit 1 has been a success. However, as described in detail, each of these products is also a failure along at least one of the three dimensions.

The examples in Exhibit 1 illustrate a firm's need to measure product development success and failure (SF) along the three distinct dimensions of consumer, financial, and technical performance and separate project success expectations by outcome dimension. Across the firm's total set of product development projects, success will need to be measured and achieved on all three dimensions. However, expectations for each success dimension will vary by individual project, depending on the strategy undertaken for each project.

We provide recommendations for three questions:

- What specific measures should firms consider using to determine the success of individual product development projects, depending upon project strategy?
- Does the emphasis on different dimensions change, depending upon project strategy?

[1] "Products" refers to both physical goods and services.

BIOGRAPHICAL SKETCHES

Abbie Griffin is Associate Professor of Marketing and Production Management at the University of Chicago's Graduate School of Business. Her research interests in measuring and improving product development arose from participating in several new product commercialization failures in the years she worked as a plant engineer and business development manager prior to returning to academia. She is an avid quilter.

Albert L. Page is a Professor of Marketing in the College of Business Administration at the University of Illinois Chicago. He earned an M.B.A. and Ph.D. from Northwestern University. His research and teaching interests span the fields of product development, business-to-business marketing, and marketing management. He has published articles on these topics which have appeared in many of the leading journals in these areas including five earlier articles in the Journal of Product Innovation Management. He has also been a consultant to corporate clients on many occasions. Dr. Page is a long-time member of the Product Development & Management Association and has held several offices within the Association. He is currently its immediate Past President.

Exhibit 1. Examples of Simultaneous Product Success and Failure

The *Ford Taurus* was a technical failure that has been commercially successful. In this case the product failure was the very high rates of long-term defects (defects that do not appear until after the car is 3 years old) in the early production years of the model, even though initial product quality was as high as other Ford products. The Taurus is the first vehicle in which Ford used concurrent engineering, where the product and manufacturing process are designed simultaneously. Changing the product development process radically can have unexpected deleterious side effects, even though product development speed is improved [14]. In Ford's case, moving to concurrent engineering created the highest long-term defect rate in 20 years. Even though customers liked the styling and driving performance of the product, resulting in a commercially successful product with sales which were higher than forecast, many of the early purchasers were disappointed in the number of repairs needed as their cars aged and the low resale value of their cars. Ford has corrected the problem, and the Taurus is still well received by the market.

The *Xerox Mouse* is an interesting situation. It is a technical and customer success, but a financial failure. Xerox invented the mouse at their Palo Alto Research Corporation laboratories in the mid-1970s. The product, like Post-it Notes™, is now almost ubiquitous. Nearly everywhere there is a personal computer, there is a mouse. However, the mouse on your desk does not say Xerox. Apple, Microsoft, and a number of other firms have all profited from Xerox's development, although Xerox has not. Xerox did not commercialize the mouse—for them the product is a failure because it resulted in no financial return on the investment.

The final example of the difficulty of assessing product success is epitomized by *Kodak's instant picture* experience. If success had been measured 1 to 2 years after Kodak's market introduction, the conclusion would have been favorable: the product had achieved nearly a 35% share as a second entrant while simultaneously expanding significantly the volume of the whole category. However, when success is measured in the long-run, the product is generally classified as a failure for Kodak because of the large financial cost of infringing on Polaroid's patents. The time at which success is measured after introduction can effect whether a product is seen as successful or not.

- What measures should firms consider using to determine product development program success?

Our recommendations are derived from responses of knowledgeable product developers about the measures they find most useful in assessing product development SF across different project types and innovation strategies.

Firm Strategy, Product Strategy, and Product Development Differences

Over time, in every company, product development projects are undertaken for different reasons [15,23,24]. In a hotly competitive market, product development may have to be undertaken just to retain current customers or arrest margin erosion. When revenue growth is desired, product development may be used as the vehicle to attract a new customer or market segment. Because outcome goals vary for projects started for different reasons, each project's success objectives can be expected to vary. In this research we take this logic to the next step and hypothesize that the most appropriate measures of success vary by project strategy. We test this hypothesis by investigating the most useful success measures across distinct strategic categories of product development projects.

Interactions between project strategy and success have been extensively researched [2,3,5–9,20,22–24,29,33,34]. In general, this research shows:

- the factors producing project success differ by project strategy [2,3,5–8,20,29,33,34]
- different strategies produce different kinds of success [9]
- the project strategy mix pursued differs across more and less successful firms [23,24].

Probably the most complete delineation and study of product innovation strategy impact on success has been done by Cooper [9]. His analysis produced 20 separate dimensions, measured by a total of 66 variables, which make up a new product strategy. Although comprehensive because of the number of dimensions included, Cooper's explication of strategy components is not categorically simple enough for companies to use to help them measure or manage strategically dissimilar projects. However, since technological innovativeness, newness to the market and the proactiveness of the program were the strongest strategic drivers across success dimensions, Cooper's results suggest that a categorization scheme should at least differentiate along these strategic aspects of product development [9].

One simpler project typology was developed by Clark and Wheelwright in their automotive industry study [3,20]. Because car development is heavily engineering driven, their framework focuses only on technology (product and process) differentiators in

J PROD INNOV MANAG
1996;13:478–496

projects [3]. Because their framework ignores the market aspects of strategy, it is not suitable for this study.

A broader framework explicitly incorporating market aspects of strategy and implicitly including technology aspects was introduced by Booz, Allen and Hamilton (BAH) in the early 1980s [2] and has been used repeatedly since then in product development research [23,24,33]. As illustrated in Figure 1, this framework, which is derived from Ansoff's original product/market matrix [1], arrays projects based on newness to the market and newness to the company, grouping projects into six distinct categories:

- *New to the World* (NTW). New products that create an entirely new market.
- *New to the Company* (NTC). New products that, for the first time, allow a company to enter an established market.
- *Additions to Existing Product Lines* (AEL). New products that supplement a company's established product lines.
- *Improvements in/Revisions to Existing Products* (IM). New products that provide improved performance or greater perceived value and replace existing products.
- *Repositionings* (RP). Existing products targeted to new markets or market segments.
- *Cost Reductions* (CR). New products that provide similar performance at lower cost.

This framework provides a good compromise between the complexity of Cooper's set of strategic variables [9] and Clark and Wheelwright's overly technology-focused categories [3]. The strongest drivers of the three different dimensions of success investigated in Cooper [9] are incorporated into this typology. It explicitly positions the project's market strategy along the horizontal axis, addressing that important strategic aspect directly. Links to technology aspects of strategy (product and process) are more implicitly captured in the vertical positioning of projects. Although not as direct a link as the market tie, projects newer to the company most likely will require more technology development. Respondents and researchers also seem able to slot products into the categories without much difficulty. It seems to follow industry semantics describing types of projects. For these reasons, we adopted the market/company categorization to differentially describe projects in this study.

This market/company framework only provides a basis for project-level analysis of useful SF measures. However, we are also interested in recommending measures of overall firm effectiveness in product development as well as project-level success measures.

In reality, not all firms operate under the same strategy. Different strategies produce different levels of dependence upon new product development. This in turn means it is unlikely that one set of measures of overall success is suitable across firms with different strategies. An hypothesis in this research is that the mix of projects commercialized will differ by firm strat-

Figure 1. Project strategy typology.

Newness to the Market

Newness to the Firm	**Low**		**High**
High	New-to-the-Company		New-to-the-World
	Product Improvements	Add to Existing Lines	
Low	Cost Reductions	Repositionings	

egy. Firms following more innovative strategies will have a higher percentage of projects with higher levels of newness.

The final hypothesis arises from the effects of project mix varying by strategy: the most useful measures of product development program overall success vary with the strategy of the firm. We hypothesize that SF measures that focus on firm growth (recent and future) and more appropriate for more innovative strategies. SF measures that capture product development effectiveness will be more appropriate for moderately innovative firms, and SF measures that capture product development efficiency will be more appropriate for less innovative firms.

One widely used business strategy typology developed by Miles and Snow divides firms into four categories [27]. The key dimension underlying their typology is the speed with which an organization responds to changing environmental conditions by changing its products and markets [26]. Their four categories are:

- *Prospectors:* Value being "first" with new products, markets, and technologies even though not all efforts prove to be profitable. They respond rapidly to early signals concerning areas of opportunity. In the worldwide automobile industry, Honda and Chrysler are the prospectors.
- *Analyzers:* Seldom are first to market with new products. However, by carefully monitoring the actions of major competitors, they can frequently be a fast follower, bringing a more cost-efficient or innovative product into the market very rapidly. Toyota and Ford are analyzer companies.
- *Defenders:* Attempt to locate and maintain a secure niche in a relatively stable product or service area. They protect their domain by offering higher quality, superior service or lower prices. These firms ignore industry changes that have no direct influence on current operations. General Motors, Nissan, and Mazda are the defender companies.
- *Reactors:* Are not as aggressive in maintaining established products and markets as competitors. They respond only when forced to by strong environmental pressures. Subaru is a reactor.

Significant research has demonstrated that the focus of product development differs across these four categories [31], supporting our hypothesis that different strategies require different measures of overall product development success.

Growth through developing new products is more important for prospectors and analyzers than for defenders and reactors [31]. Prospectors, being pioneers, will more frequently seek to develop more innovative products, even at the expense of short-term profitability [25]. Analyzers are more imitative rather than innovative, developing business processes that allow them to rapidly add well-conceived products to their portfolio. Defenders place significantly less emphasis on product development overall [26,30], emphasizing line extensions that provide additional market penetration. Reactors are more likely to have an inconsistent strategy over time, with the emphasis on product development varying in response to environmental pressures [26,31]. Most researchers ignore the actions and needs of reactors in their investigations because of the variation in the strategies followed by these firms.

Research Methods

The purpose of this study is to suggest the most appropriate sets of SF measures for determining the individual success of different types of product development projects and for judging the overall success of product development programs at firms with particular business strategies. Previous research had found that there was little correlation between the measures firms currently used and the measures product developers would like to use to judge product development SF [16]. Over one-third of the reasons given for why firms did not use the measures believed to be most useful were because there were no systems in place to obtain the most desired numbers. Another one-third of the reasons given were associated with a lack of supporting culture in the firm for measuring product development performance. These responses led us to believe that surveying what firms actually measure for particular types of projects would not answer the research questions, because it would be an impossible task to find a large enough sample of firms with the appropriate culture and systems in place for the most useful measures of SF to demonstrate significant differences across project types.

The set of recommended measures was obtained from two simulations that placed experienced product developers in different scenarios. In the first, they were asked to assume the role of a product develop-

ment project manager; in the second, a CEO. In these simulations, they became responsible for assessing post hoc the multidimensional success of prototypical projects and firm-level programs for the respective strategies investigated. The SF measures recommended in this article are based on their responses for what they found most useful in assessing the success of each project or program. The results we report are not what the respondents' companies actually measure. By eliminating any reference to the firm in which product development had taken place we obtain assessments of what measures are most useful independent of whether they could or would be measured in the respondent's firm.

Research Instrument

To determine recommended project-level success measures, respondents were presented with six different project strategy scenarios for which they completed identical tasks. Appendix 1 presents the scenario describing the new-to-the world project scenario and respondent task. The scenarios depicting the other five project strategies differ only in the description of the prototypical projects. For example, the new-to-the-company project is "a product or service that is new to the company but already available in the marketplace from others. As an example, imagine that your company makes and distributes movies, but has now decided to add to the business by developing and managing amusement parks based on entertainment themes from those movies." A review of the six scenarios by academics knowledgeable in the BAH typology ensured congruency between them and the project types they described.

The number of measures that respondents were asked to select and distribution of those measures across the success dimensions was determined from previous research [16]. Firms on average currently use four separate measures to determine the success of projects. Two of these measures are measures of consumer-based success, one measures financial success and one measures technical performance. Practitioners also have indicated that neither the total number of measures nor the way in which those measures are apportioned across the dimensions would change, if they could measure what they wanted to measure rather than what they were currently measuring. They would prefer to use different measures within the same overall dimensional structure.

Based on the results from this previous research, respondents were asked to select the four measures for each strategy that provide them with "the most useful overall assessment" of each project's success, consisting of two measures of marketplace (customer-based) success, one measure of financial success, and one measure of product performance level success. They then rated the relative usefulness of the four measures by dividing 100 chips among the measures. The more chips allocated to a measure, the more important is the measure compared with the other three chosen.[2]

The seven customer-based, four financial, and seven technical performance measures from which respondents chose are a subset of the 75 measures identified by Griffin and Page in the interim report of this research effort [16]. This subset combines the 16 "core" measures identified previously (those measures that academics use, firms use, and firms continue to want to use in the future) with all other measures that at least 10% of the practitioner respondents from the survey in [16] indicated that they either do use or would like to use in the future.

To determine recommended firm-level success measures, respondents were presented with four business strategy scenarios for which they completed identical tasks as the president of the firm. Appendix 2 presents the scenario describing the prospector strategy situation and the respondent task. The other three scenarios differ only in the description of the strategy. A review of these four scenarios by academics knowledgeable regarding the Miles and Snow typology established the congruency between them and the strategy types they described.

Respondents were asked to choose up to four measures that would provide them, as president of the firm, with "the most useful overall assessment of product development success." As before, they indicated the relative usefulness of each measure by allocating 100 chips across their selections.[3] The number of measures from which they made their selections

[2] Constant sum scales have been found difficult for respondents to use when chips must be allocated across more than five items and when the education level of the respondents is not high [18]. Our respondents, who generally were highly educated, followed the directions to choose exactly four project-level success measures without error. No respondent allocated chips to more or less than four measures, and all numbers in each scenario for each respondent added to 100.

[3] Respondents were instructed to select no more than four program-level success measures. When fewer than four measures were chosen by a respondent, the allocations they provided were reduced during the analysis phase by the ratio of number of measures they chose over four so that the average allocation per measure was 25, regardless of how many measures a respondent actually chose.

combined the core firm-level measures in [16] with all those which at least 10% of the respondents indicated that they do use or would like to use.

The survey also collected demographic data about the respondent and their firm.

Data Collection Methods and Sample

The sample upon which our recommendations are based was purposely biased to include only product development practitioners with significant (at least 5 years) experience. Respondents were members and active participants of either the Product Development and Management Association or the American Productivity and Quality Center International Benchmarking Clearinghouse New Product Development Common Interest Group (IBCH). This purposive sample was used because people who are both knowledgeable about and actively involved with product development were expected to provide data that are more likely to reflect desired practice. A random sampling plan to find these knowledgeable respondents was not feasible.

The survey was delivered to 162 respondents prescreened for knowledge of and experience with product development practices (Table 1). Because of the difficulty of finding people who met the prescreening criteria, several sources of respondents and two different survey distribution techniques had to be used. Of the surveys distributed, 80 usable (and one unusable) responses were obtained for an overall usable response rate of 49.4%. However, response rates differed across two subpopulations. One group of 51 PDMA-member potential respondents were able to personally return their responses to the researchers at any time over a 3-day period after the instruments were distributed. Forty-five of them (88.2%) returned completed responses. The responses from this group constituted a pretest of the instrument. When it was determined this group had no difficulties completing the instrument, it was next distributed by mail to 111 members of the second subpopulation.

Table 1. Responses by Membership and Method Returned

Return Method: Membership:	Hand PDMA	Mail PDMA	Mail IBCH	Total
# Distributed	51	80	31	162
# Returned	45	25	10	80
% Returned	88.2%	31.2%	32.3%	49.4%

A total of 35 (31.5%) usable responses were received by mail, less than half the response rate obtained from personally obtained returns. The average returned-by-mail response rate is equal across both the remainder of the PDMA sample and the IBCH sample (Table 1). In addition, none of the demographics of the respondents differ depending upon the way in which the responses were returned ($\chi^2 > .05$). Therefore, the hand-returned and mail-returned responses are pooled in all analyses.

Demographic information about the sample is provided in Table 2. None of the demographic variables differ significantly across respondents from the PDMA and IBCH samples ($\chi^2 > .05$). Although quite heterogeneous, the sample is weighted somewhat toward high technology and business-to-business respondents. It is heavily weighted toward producers of physical goods rather than services. Very few of the respondents indicated that their firm followed a reactor strategy and very few competed in markets with slow-moving technology. Producers of slowly changing consumer goods (e.g., appliances) or services (e.g., home cleaning services) may want to apply the rec-

Table 2. Sample Demographic Information ($n = 80$)

	Number	% Total
Market in which the firm competes		
Business-to-business	44	55%
Both	15	19%
Consumer	21	26%
Type of products offered		
Physical goods	61	76%
Mixture of goods/services	15	19%
Services	4	5%
Functional driver of firm		
Marketing-driven	30	37%
Balanced functions	28	35%
Technology-driven	22	28%
Technology level of products		
High tech	32	40%
Both high and low tech	38	48%
Low tech	9	11%
Overall business strategy		
Prospector	30	38%
Analyzer	22	27%
Defender	22	27%
Reactor	5	6%
Respondent function		
R&D/development	45	56%
Marketing	15	19%
Management	12	15%
Manufacturing	5	6%
Other	3	4%

ommendations here with caution, because responses by firms of these types are underrepresented in the sample.

The profiles of the projects commercialized in the last 5 years by the firms represented in the two sample groups are presented in Table 3. Although there was no statistically significant difference in the emphasis on a particular strategy by the PDMA and IBCH subgroups, IBCH firms commercialized a higher percentage of cost reduction projects than did PDMA firms ($F < .01$). None of the other differences across these two respondent groups were statistically significant. Because of the difference in commercialization rates for cost reduction projects across the sample, potential differences in recommended measures for this project type and for cost reduction–emphasizing business strategies will be investigated in our analysis. Responses will be pooled across the two membership groups for the remainder of the analyses.

We had hypothesized that the mix of product development projects would differ depending upon the business strategy of the firm. This hypothesis is partially supported by the data. Table 4 presents the mix of product development projects by business strategy for the 78 respondents answering these two demographic questions. The project mix for prospectors differs statistically from analyzers and defenders, but there are no statistical differences between the project mix for analyzers and defenders. The project portfolios of prospectors contain a more innovative mix of projects, with much more emphasis on new-to-the world projects and less emphasis on additions to existing lines. Although reactors have far fewer NTW and NTC projects than the other strategies, these averages may not be representative of a boarder population due to the small sample size of reactors in this research. Based on these results, the measures for overall success at firms might be expected to be similar for analyzers and defenders, with those for both prospectors and reactors different from each of the other sets.

Table 3. Project Strategy Profile by Sample

	PDMA % of Total	IBCH % of Total
New-to-the-world	16%	12%
New-to-the-company	16%	8%
Additions to existing lines	11%	19%
Improvements	34%	33%
Cost reductions	14%[a]	25%[a]
Repositionings	9%	4%

[a] Statistically significantly different (ANOVA; $p < .01$).

Table 4. Project Mix by Firm Strategy

	Business strategy			
Project strategy	Prospector	Analyzer	Defender	Reactor
New-to-the-world	30%[a]	6%	7%	0%[a]
New-to-the-firm	15%	16%	17%	8%[a]
Add to existing lines	22%[a]	42%	40%	48%
Improvements	11%	16%	11%	13%
Repositionings	8%	8%	9%	11%
Cost reductions	15%	17%	21%	12%
Sample size	30	22	22	4

[a] Differs from means for other business strategies (t-tests, $p < .05$).

Project-Level Success Measures by Project Strategy

The basic hypothesis behind this research, that different project strategies require different measures of success, is confirmed by the data presented in Tables 5A and 5B. Even though the set of most useful measures differs somewhat by strategy, for most projects "degree to which the project met profit goals" is an appropriate indicator of financial success, and "degree to which the project provides a competitive advantage" is the most useful indicator of performance success. "Customer satisfaction" and "customer acceptance" are two of the best measures of customer-based success. As discussed later, there are special cases in which each of these measures is less useful than another measure of the same dimension of success.

Success Measures for New-to-the-World Projects

New-to-the-world (NTW) goods and services provide consumers with solutions to problems they have never been able to solve previously. The customer-based measures most appropriate for NTW projects are the most clearly defined across the six project types. For NTW projects, success can be most usefully measured in terms of the degree to which the products are accepted by customers and satisfy them after use. Acceptance is most useful in the NTW situation, where the firm has commercialized something never before available in the marketplace. If customers do not accept the product in the first place, no sales result. NTW projects must commercialize radically new products

Table 5A. Project-Level Success Measures: Frequency with Which Each Measure Was Selected by the Respondents for Each Project Strategy

Project-Level Measure	Project Strategy					
	New-to-the World	New-to-the Company	Product Improvement	Line Extensions	Repositionings	Cost Reductions
Customer-based success						
Customer satisfaction	**36**	**33**	**48**	26	**30**	**43**
Customer acceptance	**47**	20	14	26	**38**	**35**
Market share goals	11	**50**	**34**	**32**	**27**	11
Revenue goals	25	**26**	16	20	16	23
Revenue growth goals	10	12	**28**	24	12	20
Unit volume goals	10	6	10	18	16	19
# of customers	18	7	3	8	17	1
Financial success						
Met profit goals	**22**	**35**	**35**	**32**	**33**	21
Met margin goals	15	11	18	16	21	**36**
IRR or ROI	**26**	20	14	22	12	13
Break-even time	16	11	10	7	12	8
Technical performance success						
Competitive advantage	**34**	**47**	**40**	**41**	**33**	11
Met performance specs	19	7	16	11	14	**19**
Speed to market	8	9	10	11	8	9
Development cost	5	7	3	6	7	14
Met quality speces	3	5	3	1	5	**19**
Launch on time	6	1	4	3	5	6
Innovativeness	5	1	2	4	6	1

Note: The numbers in this table are the number of respondents (out of a total of 80) who selected each measure. Within each dimension of measures, the measures are listed in order of descending frequency of selection across all 6 project types. Measures in bold indicate the top selections by the sample for each project strategy.

that nonetheless must also be accepted by customers. Then those that use the NTW product must also be satisfied to spur product adoption by others.

Whereas competitive advantage is a useful measure for new-to-the-world projects, in some firms these highly innovative projects may require a more sophisticated financial measure than profits, for example one that takes into account the time value of money. Although profits statistically are more useful NTW success measures than ROI or IRR, according to respondents from low technology firms, profits and ROI/IRR measures are equally useful for respondents from high or mixed technology firms. Not one low tech respondent selected ROI/IRR as the most useful financial measure for NTW projects. When low tech firms commercialize NTW projects (13% versus 23% in high tech firms), they just do not see the utility such a sophisticated financial measure as do some higher tech firms. No other demographic variable differentiated between those higher-tech firms that find profits more useful and those that find measures of the time value of money useful.

Success Measures for New-to-the-Company Projects

New-to-the-company projects lead firms into new product lines and new markets. The most useful success measures for these situations are profits, producing a competitive advantage, and market share achieved by the new product. Because other firms already market products to these customers, share is a better measure of customer-based success than customer acceptance, and the most important measure overall. The importance of share is indicated by the magnitude of the average utility in Table 5B. The second useful customer-based success measure is either customer satisfaction or the product's ability to meet revenue goals. Respondents from firms that are balanced in their emphasis between marketing and technology find customer satisfaction a more useful measure than revenue goals.

Success Measures for Product Improvements

Product improvement projects create the next-generation performance modification for currently sold

Table 5B. Project-Level Success Measures: Average Utility of Success Measures for Each Project Strategy

Project-Level Measure	Project Strategy					
	New-to-the World	New-to-the Company	Product Improvement	Line Extensions	Repositionings	Cost Reductions
Customer-based success						
Customer satisfaction	**0.12**	**0.10**	**0.16**	0.08	**0.10**	**0.12**
Customer acceptance	**0.18**	0.06	0.04	0.08	**0.14**	**0.10**
Market share goals	0.03	**0.19**	**0.11**	**0.11**	**0.10**	0.03
Revenue goals	0.06	**0.08**	0.04	0.07	0.05	**0.09**
Revenue growth goals	0.03	0.04	**0.10**	0.09	0.04	0.06
Unit volume goals	0.03	0.02	0.03	0.06	0.05	0.04
# of customers	0.06	0.02	0.01	0.02	0.05	0.00
Financial success						
Met profit goals	**0.08**	**0.13**	**0.12**	**0.12**	**0.11**	0.08
Met margin goals	0.04	0.03	0.05	0.05	0.05	**0.15**
IRR or ROI	**0.08**	0.07	0.04	0.06	0.03	0.04
Break-even time	0.04	0.03	0.03	0.03	0.03	0.03
Technical performance success						
Competitive advantage	**0.11**	**0.16**	**0.15**	**0.12**	**0.12**	0.04
Met performance specs	0.06	0.02	0.05	0.04	0.04	**0.06**
Speed to market	0.03	0.02	0.03	0.03	0.02	0.03
Development cost	0.01	0.02	0.01	0.01	0.02	0.04
Met quality specs	0.01	0.01	0.01	0.00	0.01	**0.06**
Launch on time	0.02	0.01	0.01	0.01	0.01	0.02
Innovativeness	0.02	0.00	0.01	0.01	0.02	0.00

Note: The numbers in this table are the average fraction of the chips apportioned to this measure for each project strategy. Within each dimension of measures, the measures are listed in order of descending utility across all six project types. Measures in bold indicate the measures with statistically significantly higher utilities than the next most useful measure within each strategy (t-test, $p < .05$).

goods and services. The most appropriate financial and technical performance success measures for product improvements are profits and competitive advantage. Customer satisfaction with the improvements made is the most useful customer-based measure. If a firm has improved product performance but customer satisfaction is unchanged, perhaps the firm has wasted development dollars that could have been spent more effectively elsewhere. The sample is divided as to whether the second useful customer measure is share or meeting revenue growth goals. None of the demographic variables collected suggest which types of firms might be more likely to prefer one or the other measure. In a stagnant or highly competitive slow-growing market, share may be more important. However, in a growing market, particularly one in the early stages of the product life cycle, meeting revenue growth goals may be a more useful indicator of the customer-based success for product improvements.

Success Measures for Line Extensions

Line extensions are commercialized with a number of different purposes, including to tap specific subsegments of the market, defend the product line from competitive attack, increase the frequency of use by providing increased variety (e.g., new flavors), or widen the product's overall appeal [32]. Useful financial and performance success measures for line extensions again are those most generally useful—profits and competitive advantage. Market share is marginally more useful than any other customer measure (t-test, $p < .05$). However, in general, the customer-based measures are the least well defined for line extensions of all the project types. One reason for the lack of preference for a success measure may be because line extensions serve so many purposes at firms. The result is that this research finds that four other measures are nearly as useful as market share and are indistinguishable from each other in their utility: meeting revenue growth goals, customer satisfaction, customer acceptance, and meeting revenue goals.

Whereas none of the demographic variables significantly differentiate between which or these are more useful, there are interesting trends. Respondents from service-providing firms are more likely to find customer acceptance a useful second measure, whereas those from firms that sell only goods find customer

satisfaction more useful. Respondents who are general managers find revenue growth a more useful second measure, whereas respondents from the marketing function find customer acceptance more useful. The most useful measure may thus depend upon why the project was undertaken, for example whether the firm is commercializing these additions to product lines to increase the size of the market their products serve or to consolidate their position and more deeply penetrate products into a particular market.

Success Measures for Product Repositionings

Repositionings are undertaken primarily to rejuvenate a declining good or service [32]. The success of repositionings is most usefully measured in terms of profits and competitive advantage provided. Whether the customer accepts the new positioning is the most useful indicator of customer-based success. The second-level customer measure is then either satisfaction after using the product or the market share obtained. Again, the most appropriate of these two measures depends on something other than the strategy, like the purpose for which the project was commercialized. One differentiating demographic was whether the respondent's firm produced only goods, or both goods and services. Respondents from goods producers found customer satisfaction a more useful measure (t-tests, $p < .05$).

Success Measures for Cost Reduction Projects

Cost reduction (CR) projects can be undertaken both in the early stages of the life of a product, when firms are learning to manufacture more efficiently or at the mature stage, when cost must be eliminated in the face of stiffer competitive pressures. The success measures most useful for cost reduction projects differ the most from those generally useful across project strategy types. Financially, tracking margin changes in cost reduction projects is useful—the objective, after all, of these projects is to take cost out. The most direct way to measure whether that has been achieved is by margin, because many times overhead and other costs out of the project's control can influence profit.

Satisfaction is the more useful of the two customer-based measures for CR projects. CR projects need to maintain customer satisfaction even though cost has been eliminated—hopefully not at the expense of performance which is visible to the consumer. The second useful customer-based measure is either acceptance or meeting revenue goals. Marketing respondents indicated that customer acceptance was significantly more useful as this second measure than respondents from other functional areas.

Providing a competitive (performance) advantage is not the purpose of a cost reduction project. For assessing the technical performance of cost reduction projects, it is most useful to determine whether in taking cost out of producing the product, the firm has retained expected performance levels, rather than improved them. The average usefulness of "degree to which the project met performance specifications" and "degree to which the project met quality specifications" is statistically equal and higher than for the other measures. For respondents from low technology firms, meeting the project's quality specifications is a less useful measure than it is for those from higher technology firms.

Summary of Project-Level Results

Our results, summarized in Figure 2, strongly support the hypothesis of this research that the most appropriate measures for project-level product development success vary by project strategy. This research provides statistically based recommendations for three of the four measures needed for assessing success across the three dimensions of project-level success for each strategy situation. Between two and four additional measures are identified as being useful, from which the most appropriate may be selected based on other factors.

For most project strategies, "degree to which the project met profit goals" is the most useful measure of financial success. The exceptions to these recommendations are for new-to-the-world and cost reduction projects because as the level of market and firm innovation increases, the financial yardstick that is most useful shifts from a less to a more sophisticated measure. For the four somewhat innovative project types (new-to-the-company, improvements, additions to existing lines, and repositionings), measuring overall profit levels is most useful. Overhead and other indirect costs associated with commercializing the product need to be taken into account when determining the financial success of somewhat innovative projects, where goals for the project frequently are more customer driven than financially driven. The appropriate financial measure will be "margin," a less sophisticated measure, for cost reductions. In some firms, a

Newness to the Firm	Low	Newness to the Market	High
High	**New-to-the-Company** Market Share Revenue or Satisfaction Met Profit Goal Compteitive Advantage		**New-to-the-World** Customer Acceptance Customer Satisfaction Met Profit Goal or IRR/ROI Competitive Advantage
	Product Improvements Customer Satisfaction Market Share or Revenue Growth Met Profit Goal Comptitive Advantage	**Additions to Exitisting Lines** Market Share Rev./Rev. Growth/Satis./Accept. Met Profit Goal Competitive Advantage	**LEGEND:**
Low	**Cost Reductions** Customer Satisfaction Acceptance or Revenue Met Margin Goal Preformance or Quality	**Product Repositionings** Customer Acceptance Satisfaction or Share Met Profit Goal Competitive Advantage	**Project Strategy** Customer Measture #1 Second Customer Measure Financial Measure Performance Measure

Figure 2. Most useful success measures by project strategy.

more sophisticated financial measure that takes into account investment and the time value of money may be more appropriate for NTW projects.

"Degree to which the project provides a competitive advantage" is generally the most useful indicator of project performance-based success. The only project strategy exception for this rule of thumb is cost reduction projects where the objective is not to provide the firm a competitive advantage but to retain previous product performance levels (feature or quality) despite reducing the product's cost.

Previous research [16] found that firms use two different measures of the customer-based dimension of success and that they continue to want to use two in the future. Project strategy determines the most useful customer-based measure, which always had a higher average usefulness than the second most useful measure (t-test, $p < .05$). For NTW projects, recommendations for both of the most useful measures can be made. NTW projects can best be assessed by using customer acceptance and then satisfaction. Customer satisfaction is also the most useful measure for product improvement and cost reduction projects, whereas customer acceptance is most useful for product repositionings. Market share is the most useful customer-based measure for new-to-the-company and line extension projects.

The second most useful measure is generally not clear cut. With the exception of NTW projects, it depends upon factors other than project strategy. One way to select which to use is to consider the purpose behind undertaking the strategy (enter new markets versus penetrate more deeply into your own customers, in the case of additions to existing line projects, for example) and use the measure that seems to best deliver against that purpose.

Recommended Firm-Level Product Development Success Measures by Business Strategy

We hypothesized that the mix of product development projects commercialized would vary by firm strategy.

In part because project mixes varied, we expect the most useful measures of overall product development success to also vary by firm strategy. As illustrated earlier, the descriptive results in Table 4 confirm that for three of the four business strategies, the mix of projects commercialized over the past 5 years varies by innovation strategy. Thus, we still expect different success measures to be most useful assessing the firm's overall product development program depending upon the firm's approach to innovation. That hypothesis is confirmed by the data presented in Tables 6A and 6B, which show the frequency and utility results for the 10 firm-level success measures across the four innovation strategies.

Table 7 summarizes the most useful success measures for assessing overall product development performance for each business strategy that constitute our measurement recommendations. The measures are listed in order of usefulness, with the most useful at the top of each list. Previous research did not provide any evidence of how many firm-level measures of success firms want to use. Thus, the number of measures listed in Table 7 for each strategy are determined based upon statistically significant differences. The measures in each list are statistically more useful than the remaining measures that were presented to the respondents ($p < .05$). For the reactor strategy, the usefulness of development program ROI is statistically greater than for the other three measures shown in Table 7, and the usefulness of those three is also statistically greater than the remaining six listed in Tables 6A and 6B.

The results in Tables 6 and 7 illustrate clearly that different sets of success measures are most useful across the four different business strategies. The three measures for prospectors show an orientation toward measuring the firm's current and future growth from its product development program. On the other hand, the four measures for reactors show an orientation toward measuring the efficiency of the firm's program as could seem appropriate for the least innovative business strategy. Between these two extremes in strategy the two most useful measures of overall success for analyzers and defenders are similar, as expected based on the similarity in the distribution of development projects for the firms with these two strategies.

Prospectors

The three measures most useful for a prospector firm are all associated with growth, both past and future, as expected. Two measures look at current results of past program effects, whereas the third assesses how yesterday's efforts to develop today's products position the firm for continued growth in the future. Understanding the effectiveness of the product development program is statistically less useful to innovating firms than quantifying the growth derived from the program. These recommended measures are the same regardless of whether they are derived from the subpopulation of respondents from prospector firms or from the entire sample.

Analyzers

Analyzers are concerned with growth due to product development as well as the efficiency and effectiveness of the development program. The two most useful

Table 6A. Firm-Level Success Measures: Frequency with Which Each Measure Was Selected by the Respondents for Each Firm Strategy

Overall Success Measure	Prospector	Analyzer	Defender	Reactor
Development program ROI	25	**47**	**50**	**54**
New products fit business strategy	39	**55**	32	**44**
Success/failure rate	38	**43**	33	**46**
% Profits from new products	**44**	**46**	23	27
% Sales from new products	**45**	31	20	19
Program hit 5-year objectives	24	26	37	27
Products lead to future opportunities	**51**	21	18	16
Overall program success	16	27	26	**31**
% Sales under patent protection	18	3	14	5
% Profits under patent protection	11	6	15	7

Note. The numbers in this table are the number of respondents (out of a total of 80) who selected each measure. The measures are listed in order of descending frequency of selection across all 4 firm strategies. Measures in bold indicate the top selections by the sample for each firm strategy.

Table 6B. Firm-Level Success Measures: Average Utility of Success Measures by Business Strategy

Overall Success Measure	Prospector	Analyzer	Defender	Reactor
Development program ROI	0.08	**0.17**	**0.19**	**0.20**
New products fit business strategy	0.11	**0.17**	**0.18**	**0.13**
% Profits from new products	**0.17**	**0.16**	0.07	0.08
Success/Failure rate	0.10	**0.14**	0.09	**0.14**
% Sales from new products	**0.15**	0.10	0.06	0.06
Overall program success	0.05	0.08	0.09	**0.13**
Program hit 5-year objectives	0.07	0.06	0.12	0.08
Products lead to future opportunities	**0.15**	0.05	0.05	0.05
% Sales under patent protection	0.05	0.01	0.05	0.02
% Profits under patent protection	0.03	0.02	0.05	0.02

Note: The numbers in this table are the average fraction of the chips apportioned to this measure for each firm strategy. The measures are listed in order of descending utility across all four strategy types. Measures in bold indicate the measures with statistically significantly higher utilities than the next most useful measure within each strategy (t-test, $p < .05$).

measures for analyzers, the degree to which this year's new products fit our business strategy and the return on the investment in new products, are indicators of effectiveness and efficiency, respectively. The third measure brings growth into the assessment. The last measure, the success/failure rate, is another measure of program effectiveness. The recommended measures are the same regardless of whether they are derived from the subpopulation of respondents from analyzer firms or from the entire sample.

Defenders

The most useful overall success measures for defenders are identical to the two most useful measures for analyzers. However, growth from product development is not statistically significantly useful for them. Defenders only find measures useful that focus on the effectiveness and efficiency of their product development program. If the data are analyzed for the respondents from firms with defender strategies, the two most useful measures are identical. However, respondents from defender firms would also measure the degree to which the development program hit the firm's 5-year new product objectives as a third indicator of overall product development success.

Reactors

The top measurement priority for reactor firms, return on product development program investment, relates to measuring the efficiency and financial performance. The usefulness of this measure is statistically higher than the other three measures listed, which all related to the effectiveness of the development program. Because the sample contains only four respondents from reactor firms, their responses were not analyzed separately.

Summary of Recommended Firm-Level Success Measure Results

The trends of the most useful overall success measures across the strategies provide support for our expecta-

Table 7. Most Useful Overall Success Measures by Business Strategy

Prospector	Analyzer	Defender	Reactor
% Profits from products < "*n*" years old	Degree products fit business strategy	Development programs ROI	Development program ROI[a]
Degree today's products lead to future opportunities	Development program ROI	Degree products to fit business strategy	Success/failure rate
% Sales from products < "*n*" years old	% Profits from products < "*n*" years old		Degree products fit business strategy
	Success/failure rate		Subjective overall program success

Note: Measures listed in order of usefulness, with most useful at top of list. All measures on each list statistically more useful than those not listed (t-test, $p < .05$).

[a] Statistically more useful than the other measures for this business strategy (t-test, $p < .05$).

tions about what will be most useful to measure as the level of firm innovativeness changes. Firms with the least innovative strategies find it useful to focus on measuring the efficiency of their product development program. Firms with moderately innovative strategies find that measures that provide information about both the efficiency and the effectiveness of their programs are the most useful. Firms with more innovative strategies need to measure how product development has contributed to growth.

We have suggested useful firm-level success measures based upon the firm's strategic approach toward innovation. As was found for the project-level measures, multiple firm-level measures are needed to capture the different effects of an overall product development program. However, each of the four sets of success measures contain one or two measures of the financial performance of the program; either the percent of profits from new products, or the ROI of the development program. Given that the firm's ultimate objective is financial success, the inclusion of at least one financial measure of firm-level product development success is necessary to provide a link between product development and achieving this objective.

Discussion

This research into recommended measures of new product success/failure emerged from recognition of the many and diverse measures used in academic research. An earlier article [16] brought structure to that chaos by identifying a logical grouping of all the reported measures into those appropriate at the firm or program level and those relevant at the project level where three distinct groups of measures were revealed. In this study we have attempted to develop a method that would allow us to make recommendations about the appropriate measures to use in different product development situations.

Before adopting the measures recommended in Figure 2 and Table 7, it is necessary to recognize the methodological shortcomings of our study. Whereas the respondents are experienced new product professionals, they represent a small, purposive, and intentionally biased sample with all the problems inherent in such a sample. Furthermore, there is no guarantee that these respondents would actually measure success as they said they would in responding to the simulated scenarios. Many structural impediments exist at firms that could prevent using these recommended measures.

Another possible matter of concern is that we treated the three types of project-level measures as equal in importance to the firm. It is possible that there is a hierarchy of success measures at the project level that our research design would not pick up, although such a hierarchy would not invalidate our findings regarding project level measures.

For these reasons the ability to generalize from these results is naturally open to question. Nonetheless, we feel the results from our scenarios and the experienced practitioners represent a worthwhile contribution to the emerging body of knowledge on success/failure measurement for new products. They also set out a potential set of benchmarks for companies to use if they feel comfortable basing their measurement practices upon what our experienced practitioners say they would do in the 10 different situations we examined.

It is widely recognized that structure follows strategy. Our research results support our hypothesis that success measurement should follow strategy also. They show that practitioners recognize the different measurement needs posed by different types of development projects and by different types of business strategies. Thus, the two typologies we apply here appear to be useful for helping practitioners and researchers think through their measurement needs. A logical approach for a firm to take would be to determine which type of project or firm strategy situation needs to be measured and then use the appropriate set of measures in Figure 2 and/or Table 7 as their measurement benchmarks. In the absence of other compelling reasons to measure differently, we suggest firms follow this approach.

Many of the measures of success we recommend in different situations seem to make sense, giving them face validity. However, several of them fly in the face of measurement practices and even the capabilities at many companies.

Customer satisfaction is a recommended project-level measure that appears under every project strategy type in Figure 2 and which 44% of the firms surveyed in previous research say they would like to use to measure success [16]. However, only 10% of the firms actually do measure customer satisfaction. Measuring customer satisfaction incurs out-of-pocket cost, because customers must actually be surveyed to obtain the data. Because costs are incurred, customer satisfaction data are most likely to be obtained for new-to-the-company and new-to-the-world projects rather than product improvement projects [17].

Obtaining reasonably accurate profit- and investment-related measures of financial success will also be difficult. Appropriate financial measures are difficult to obtain accurately because most accounting systems at firms are designed to report the required numbers to the IRS, shareholders, and the financial community, not to help manage the product development process [17]. Whereas engineering and manufacturing personnel cost and out-of-pocket costs are carefully tabulated, marketing and especially management costs associated with product development are uncontrolled and frequently ignored in financial numbers [17]. Thus, most of the more sophisticated financial success measures are incomplete or only rough estimates of actual outcomes.

The measures of project performance used by firms have always been the most idiosyncratic [16]. This research suggests that the best performance measures will remain project specific and thus may appear on the surface rather idiosyncratic. For almost all project strategies, the recommended measure is "degree to which the product provides a competitive advantage." The appropriate performance dimension(s) in which the competitive advantage must be achieved will most likely be specific to each product. For a computer chip manufacturer, these might be chip speed and heat generation. For a producer of drugs, the dimensions may be efficacy and shelf life. Thus in quantifying this measure, the appropriate dimension(s) must first be defined and then the relative performance determined. A misspecification of the best dimension could lead to an inaccurate assessment of product performance.

At the firm level, only two of the recommended measures are currently used by firms, although several more have been used by academics investigating the factors that lead to successful product development. For those measures not currently used by a firm, standard protocols will have to be developed that can be applied invariantly over time. In addition, firms will have to define the period of "newness' which is most appropriate for their business.

One of the pleasant surprises we encountered in this research was just how stable the results were across demographic subpopulations in the sample. Although we tested the results for differences across several sets of subgroups, very few significant differences were found. This stability suggests that these recommendations are homogeneous across different kinds of firms and respondent backgrounds.

The implications of this research and recommendations for academic research are indirect but nonetheless powerful. The product development community needs to bring some order to the variety and disorder of measures in both practice and academic SF research. To do this, practitioners in concert will have to begin using some sets of measures. Researchers then may want to conform more closely to the measurement practices of practitioners. Researchers will be able to move more easily toward using these measures of performance in their studies as practitioners adopt the recommendations of this PDMA-sponsored research project.

In summary, this research recommends multidimensional sets of measures that firms find useful to consider in determining product development success. As Exhibit 2 indicates, the measures vary depending upon the project and business strategy. No one measure is useful for all projects, nor across all firms. Usefully measuring product development success requires a certain flexibility, within multidimensional guidelines.

Future Research

Several different research directions could provide additional useful information both to firms measuring product development success as well as to academics performing research in the area. The first research opportunity exists in tracking the adoption and diffusion of these recommendations for SF measurement. This would be useful to do over the longer term both among the community of PDMA member companies and through academic research to determine the impact of this research on both practice and research.

A major issue still unresolved is the timing of measuring product development success. This research was not able to recommend the period of time a product should be considered "new." 3M defines products in their first 4 years as "new." Other firms define "new" as the first 5 years a product is on the market. A method that can be applied across industries with different product life cycles to recommend appropriate time periods must be developed. One number is not appropriate for all situations.

A related timing issue has to do with when success at the project level should be measured. In other research, the measures that respondents considered important one-quarter of the way through the product life cycle differed somewhat from those more important three-quarters of the way through the life cycle [21]. Measuring aspects of product performance were more important in the short term (at one-quarter of the life

Exhibit 2. Summary of Recommendations for Success and Failure Measurement

Based upon the responses of the 80 experienced product development professionals to 10 scenarios that simulate success/failure measurement situations at the project and program levels, we have identified their measurement preferences. We present their preferences as measurement benchmarks and, in the absence of any other situations-specific reasons to the contrary, recommend they be given strong considerations when decisions are made regarding how to measure product development performance at the project and program levels.

At the project level our recommendations are:

- *New-to-the-World Projects:* Consider using some combination of customer acceptance, customer satisfaction, competitive advantage and met profit goals or ROI or IRR.
- *New-to-the-Company Projects:* Consider using some combination or market share goals, competitive advantage, met profit goals, and customer satisfaction or revenue goals.
- *Product Improvement Projects:* Consider using some combination of customer satisfaction, competitive advantage, met profit goals, and market share goals or revenue growth goals.
- *Additions to Existing Product Lines Projects:* Consider using some combination of competitive advantage, met profit goals, market share goals and revenue growth goals, or customer acceptance or customer satisfaction or revenue goals.
- *Repositioning Projects:* Consider using some combination of customer acceptance, competitive advantage, met profit goals, and customer satisfaction or market share goals.
- *Cost Reduction Projects:* Consider using some combination of met margin goals, customer satisfaction and customer acceptance or revenue goals and met performance specifications or met quality specifications.

At the level of the overall product development program or recommendations are:

- *Prospector Firms:* Consider using some combination of: the percent of profits from new products less than "*n*" years old, the degree today's new products lead to future opportunities, and the percent of sales from new products less than "*n*" years old.
- *Analyzer Firms:* Consider using some combination of: the degree the new products fit the business strategy, the development program ROI, the percent of profits from new products less than "*n*" years old, and the success/failure rate.
- *Defender Firms:* Consider using one or both of: development program ROI and the degree the new products fit the business strategy.

Exhibit 2. Continued.

- *Reactor Firms:* Consider using some combination of: development program ROI, the success/failure rate, the degree new products fit the business strategy, and subjective appraisal of the overall program success.

NOTE: In all 10 situations itemized above, the recommended measures are listed in descending order of utility to the experienced product developers as indicated in Tables 5 and 7. Therefore, the measures with higher utility are the ones we feel are more important to include when assembling a combination of measures of success/failure for a specific project or program situation.

cycle), whereas measuring customer and financial impacts were more important in the long-term.

Respondents in this research were asked to assess measures useful for project success half-way through the product's life cycle, without specifying how long the life cycle was. At half-way through the product life cycle, product performance and financial measures were equally useful, whereas customer success measures were twice as useful in the overall mix. Comparing these results, one might conclude that either the most useful measures change over the life cycle of the product, which would complicate the entire measurement issue further, or that different measures need to be obtained at different points in time. Only additional research can determine which of these two hypotheses holds.

Another major issue not at all addressed by this research is the appropriate *predictors* of success. With one exception ("degree today's products lead to future opportunities" for prospectors), all the measures identified here are *post hoc* measures of success. Measuring them leads to an understanding of how well a firm has developed products in the past but does not help forecast whether any particular product will succeed or whether the firm will continue developing a stream of successful products in the future. Although one model has been used for both diagnosing project weaknesses and predicting project success in the marketplace [10,11], no means for predicting whether the firm will remain successful overall has been developed.

The final issue that still needs clarification is what measures academics should be using to investigate factors that lead to improved product development. This is the question that initiated this whole line of research. Whereas we have provided indirect clues as to what might be useful to measure (that which firms find useful), we have not investigated the subject from

the researcher's point of view. Other factors and constraints (e.g., data timing, availability, accessibility, and comparability across industries) may override the usefulness of the measures recommended to firms.

References

1. Ansoff, H. Igor. Strategies for diversification. *Harvard Business Review* (September-October 1957).
2. Booz, Allen and Hamilton. *New Product Management for the 1980's.* New York: Booz, Allen, and Hamilton, Inc., 1982.
3. Clark, Kim B. and Wheelwright, Steven C. *Managing New Product and Process Development.* New York: The Free Press, 1993.
4. Cochran, Betty and Thompson, G. Why New Products Fail. *The National Industrial Conference Board Record* 11–18 (October 1964).
5. Cooper, Robert G. Project new product: Factors in new product success. *European Journal of Marketing* 14(5/6):277–292 (1980).
6. Cooper, Robert G. New product strategies: What distinguishes the top performers. *Journal of Product Innovation Management* 2:151–164 (1984).
7. Cooper, Robert G. The performance impact of product innovation strategies. *European Journal of Marketing* 18(5):5–54 (1984).
8. Cooper, Robert G. How new product strategies impact on performance. *Journal of Product Innovation Management* 1:5–18 (1984).
9. Cooper, Robert G. Industrial firms' new product strategies. *Journal of Business Research* 13:107–121 (1985).
10. Cooper, Robert G. Selecting winning new product projects: Using the NewProd system. *Journal of Product Innovation Management* 2:34–44 (1985).
11. Cooper, Robert G. and Kleinschmidt, E. J. *New Products: The Key Factors in Success.* Chicago, IL: American Marketing Association, 1990.
12. Corey, Raymond E. Key options in market selection and product planning. *Harvard Business Review* 53:119–128 (September-October 1975).
13. Craig, Angie and Hart, Susan. Dimensions of success in new product development. In: *Perspectives on Marketing Management,* Volume 3, Chapter 10, M. J. Baker (ed.). London: John M. Wiley & Sons, Ltd., 1993, pp. 207–243.
14. Crawford, C. Merle. The hidden costs of accelerated product development. *Journal of Product Innovation Management* 9(3):188–199 (September 1992).
15. Crawford, C. Merle. Defining the charter for product innovation. *Sloan Management Review* 22:3–12 (Fall 1980).
16. Griffin, Abbie and Page, Albert L. An interim report on measuring product development success and failure. *Journal of Product Innovation Management* 10:291–308 (1993).
17. Griffin, Abbie. Measuring product development time to improve the development process. In: *Field Studies in Quality,* New York: Kluwer Press, 1996, in press.
18. Griffin, Abbie. Functionally integrating new product development. Unpublished Ph.D. thesis, Massachusetts Institute of Technology, Sloan School of Management, June 1989.
19. Hart, Susan. Dimensions of Success in new product development: An exploratory investigation. *Journal of Marketing Management* 9:23–41 (1993).
20. Hayes, Robert H., Wheelwright, Steven C. and Clark, Kim B. *Dynamic Manufacturing.* New York: The Free Press, 1988.
21. Hultink, Erik Jan and Robben, Henry S. J. Measuring new product successs: The difference that time perspective makes. *Journal of Product Innovation Management* 12(5):392–405 (November 1995).
22. Kleinschmidt, Elko J. and Cooper, Robert G. The impact of product innovativeness on performance. *Journal of Product Innovation Management* 8(4):240–251 (December 1991).
23. Kuczmarski & Associates, Inc. *Winning New Product and Service Practices for the 1990's.* Chicago, IL, 1994.
24. Kuczmarski, Thomas D. *Managing New Products: The Power of Innovation.* Englewood Cliffs, NJ: Prentice Hall, 1992.
25. Lambkin, M. Order of entry and performance in new markets. *Strategic Management Journal* 9:127–140 (1988).
26. McDaniel, Stephen W. and Kolari, James W. Marketing strategy implications of the Miles and Snow strategic typology. *Journal of Marketing* 51:19–30 (October 1987).
27. Miles, R. E. and Snow, C. C. *Organizational Strategy, Structure, and Process.* New York: McGraw-Hill, 1978.
28. Montoya-Weiss, Mitzi M. and Calantone, Roger. Determinants of new product performance: A review and meta-analysis. *Journal of Product Innovation Management* 11(5):397–417 (November 1994).
29. Roberts, Edward B. and Meyer, Marc H. Product strategy and corporate success. Working paper #30-91. International Center for the Management of Technology, Massachusetts Institute of Technology, January 1991.
30. Shortell, S. M. and Zajac E. J. Perceptual and archival measures of Miles and Snow's strategic types: A comprehensive assessment of reliability and validity. *Academy of Management Journal* 33(4):817–832 (1990).
31. Slater, Stanley F. and Narver, John C. Product-Market strategy and performance: An analysis of the Miles and Snow strategy types. *European Journal of Marketing* 27(10):33–51 (1993).
32. Urban, Glen and Hauser, John R. *Design and Marketing New Products,* 2nd edition. Englewood Cliffs, NJ: Prentice Hall, 1993.
33. Yoon, Eunsang and Lilien, Gary L. New industrial product performance: The effect of market characteristics and strategy. *Journal of Product Innovation Management* 2(3):134–144 (September 1985).
34. Zahra, S. A. and Pearce, II, J. A. Research evidence on the Miles and Snow typology. *Journal of Management* 16(4):751–768 (1990).

Appendix 1. Instrument and Task for Project-Level Success Measures

Project Situation: Success Measures for New-to-the-World Projects

You are the team leader for a project team that has developed and taken to market a new-to-the-world product or service. Neither potential customers in the market nor your firm had any experience with this new-to-the-world product or service before you commercialized it. One example of this type of product might be the first matter energizing and transporting device (as in "beam me up Scotty"), or a service that instantly transports people and things from place to place using one of these devices. It is now about one-half of the way through the life cycle of this product, and you must judge the overall success of the project. Please select the four measures that will provide you with the most useful overall assessment of this project's success.

# of Chips

Place an "X" in the left-hand column to select two of the following measures of marketplace success:

___ Degree to which the project met market share goals ..... ___
___ Degree to which the project met revenue goals..... ___
___ Degree to which the project met revenue growth goals.. ___
___ Degree to which the project met unit volume goals..... ___
___ Level of customer acceptance..... ___
___ Level of customer satisfaction ..... ___
___ Number of customers ..... ___

Place an "X" in the left-hand column to select one of the following measures of financial success:

___ Break-even time..... ___
___ Degree to which the project met margin goals..... ___
___ Degree to which the project met profit goals ..... ___
___ IRR or ROI..... ___

Place an "X" in the left-hand column to select one of the following measures of product-level success:

___ Degree to which the project met the performance specifications..... ___
___ Degree to which the project met the quality specifications..... ___
___ Development cost of the project..... ___
___ Degree the project provides a competitive advantage ..... ___
___ Level of innovativeness of the project ..... ___
___ Project's ability to launch on time..... ___
___ Speed to market; development length ..... ___

Total: 100

Now please divide 100 chips among the four measures you selected to indicate the relative utility of each of these four measures in determining overall product development success. Allocate the most chips to the most useful measure and the least chips to the least useful of these measures in assessing overall project success. Use the spaces provided on the right to record your chip allocation. Please make sure you only allocate chips to those measures you have selected by placing an "X" in the left column. Please check to make sure that the sum of the chips adds to 100.

Appendix 2. Instrument and Task for Firm-Level Success Measures

Innovation Strategy: Prospector

You are the president of a firm that values being "first" with new products, markets, and technologies, even though not all efforts prove to be profitable. Your firm responds rapidly to early signals concerning areas of opportunity.

You must judge the overall success of product development and its contributions to the firm. Please select no more than four measures that will provide you with the most useful overall assessment of product development success given that your firm is continually trying to lead the competition in new products, markets and technologies.

# of Chips

Place an "X" in the left-hand column to select no more than 4 of the following measures of success:

___ Degree to which this year's new products fit the business strategy..... ___
___ Degree to which the program hit our 5-year new product objectives ..... ___
___ Degree to which today's products lead to future opportunities ..... ___
___ Overall success of the product development program (subjective)..... ___
___ % of profits provided by products less than "*n*" years old..... ___
___ % of profits under patent protection..... ___
___ % of sales provided by products less than "*n*" years old..... ___
___ % of sales under patent protection ..... ___
___ ROI for the new product development program..... ___
___ Success/failure rate (# successes/total projects)..... ___

Total: 100

Now please divide 100 chips among the measures you have selected to indicate the relative utility of each of these measures in determining overall product development success. Allocate the most chips to the most useful measure and the least chips to the least useful of these measures in assessing overall project success. Use the spaces provided on the right to record your chip allocation. Please make sure you only allocate chips to those measures you have selected by placing an "X" in the left column. Please check to make sure that the sum of the chips adds to 100.