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PDMA Research on New Product Development Practices: Updating Trends and Benchmarking Best Practices

Abbie Griffin

Product development professionals may have the feeling that yet another buzzword or magic bullet always lurks just around the corner. However, researchers have devoted considerable effort to helping practioners determine which tools, techniques, and methods really do offer a competitive edge. Starting 30 years ago, research efforts have aimed at understanding NPD practices and identifying those which are deemed "best practices." During the past five years, pursuit of this goal has produced numerous privately available reports and two research efforts sponsored by the PDMA.

Abbie Griffin summarizes the results of research efforts undertaken during the past five years and presents findings from the most recent PDMA survey on NPD best practices. This survey, conducted slightly more than five years after PDMA's first best-practices survey, updates trends in processes, organizations, and outcomes for NPD in the U.S., and determines which practices are more commonly associated with firms that are more successsful in developing new products. The survey has the following objectives: determining the current status of NPD practices and performance; understanding how product development has changed from five years ago; determining whether NPD practice and performance differ across industry segments; and, investigating process and product development tools that differentiate product development success.

The survey findings indicate that NPD processes continue to evolve and become more sophisticated. NPD changes continually on multiple fronts, and firms that fail to keep their NPD practices up to date will suffer an increasingly marked competitive disadvantage. Interestingly, although more than half of the respondents use a cross-functional stage-gate process for NPD, more than one-third of all firms in the study still use no formal process for managing NPD.

The findings suggest that firms are not adequately handling the issue of team-based rewards. Project-completion dinners are for the most frequently used NPD reward; they are also the only reward used more by best-practice firms than by the rest of the respondents. The best-practice firms participating in the study do not use financial rewards for NPD. Compared to the other firms in the study, best-practice firms use more multifunctional teams, are more likely to measure NPD processes and outcomes, and expect more from their NPD programs.

Address correspondence to Prof. Abbie Griffin, University of Illinois, Urbana-Champaign 350 Commerce West, Champaign, IL 61820, Phone: (217) 244-8549, E-mail: abbieg@uiuc.edu.

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Introduction: Why Track Product Development Practices

If the world was stable, there would be no need to change business operations and methods, nor to understand what has changed and what works well. However, firms operate in dynamic environments, not stable ones. Both the competitive and internal environments in which firms operate evolve over time. In response, management processes must also change over time so that firms can remain effective and profitable through the changing situation. Some of the changes in business with the potential to impact the ways in which new product[1] development (NPD) is practiced and managed over the last five years include:

- increased levels of competition (more firms competing for the same markets) [34,40,59]
- rapidly changing market environments [8,53]
- higher rates of technical obsolescence [49] and
- shorter product life cycles [3,58].

A primary impact of these environmental changes is to drive firms to implement changes which help speed products through development, and improve process efficiency and overall NPD effectiveness.

Over previous decades, and the last five years in particular, many new processes, techniques, and tools purporting to improve the practice of product development have been developed by academics, consultants and practitioners and implemented by a few or many firms. While the effectiveness of some of the ideas espoused as useful has been rigorously researched prior to general diffusion to the product development community [11,12,30,57], some have been presented to potential users as useful aids without definitive proof as to how they improve development or even that they improve development at all. One of the ways of differentiating between more and less useful NPD approaches is by tracking NPD management and performance over time and linking changes in outcome to practices which have been implemented.

Part of the Product Development & Management Association's (PDMA's) mission is to create and disseminate knowledge about managing and improving new product development. As one means of fulfilling this mission, the association developed a research agenda in 1989 to proactively aid in the process of product development knowledge creation [7]. This research agenda has resulted in several papers and many presentations of findings in three streams of research: profiles and compensation of new product professionals [25,26], measuring product development success [31,32], and tracking the practices of managing product development [36,50,51]. This article adds to the last stream of PDMA research.

This article presents results from the second PDMA survey on product development best practices fielded in the summer of 1995, just over five years after PDMA's first best practices survey [50,51]. The objectives of the second wave of best practices research were to:

- Determine the current status of product development practices and performance
- Understand how product development has changed from five years ago
- Determine whether differences exist in NPD practice or performance across industry segments
- Investigate process and product development tools which differentiate product development success.

A summary of the key findings is contained in Exhibit 1.

While parts of the survey instrument were kept identical to those used in 1989 so that direct longitudinal comparisons could be made, the instrument was vastly expanded in terms of topics covered and number of questions asked. In addition, the survey was sent to a much larger community than just PDMA members. Details about the survey instrument and research method are in the methods section.

This article is the first of a series of articles which are expected to be published from the PDMA 1995 best practices data. The purpose of this article is to describe how product development practices have changed, both relative to the results obtained five

[1] Throughout this article, "product" refers to both manufactured goods and services. When physical products are considered separately from services, they are referred to as manufactured goods.

BIOGRAPHICAL SKETCH

Abbie Griffin is a Professor of Marketing at the University of Illinois, Urbana-Champaign. Her research focuses on measuring and improving the process of new product development. Although *JPIM* is her preferred publication outlet, she also has published articles on product development in *Marketing Science, Management Science, Sloan Management Review,* and *Journal of Marketing Research.* Prior to becoming an academic, she worked as an engineer at Polaroid Corporation, in product development at Corning Glass Works, and as a technology strategy consultant at Booz, Allen and Hamilton. Her personal background includes a passion for quilting.

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Exhibit 1. Summary of Key Findings

1. The Best do not succeed by using just one NPD practice more extensively or better, but by using a number of them more effectively simultaneously.
2. NPD change is evolutionary, but unceasing. It moves forward simultaneously on multiple fronts.
3. NPD processes have continued to evolve and become more sophisticated over time.
   - While nearly 60% of US firms use a cross-functional stage gate process for NPD, 38.5% of all firms still use no formal process for managing NPD. Best practice firms have implemented stage gate processes to a greater extent than the Rest of the firms.
   - Best practice firms are more likely to drive product development efforts through specific NPD strategies at both the program and project level.
   - NPD processes used by Best practice firms are more likely to start with a strategy step and be more complex because they include more steps.
   - Processes for service firms are less complex than for manufactured goods firms.
4. Firms support NPD efforts in two separate locations of their organization, on average. No single or combination of structures relates to achieving best practice.
5. Project managers (61%) and champions (43%) are most likely to lead NPD projects. Management appoints NPD leaders over 70% of the time.
6. Firms have not grappled adequately with team-based rewards. Project completion dinners are the most frequently-used NPD reward, and the only reward used more by Best practice firms than the Rest (72% versus 54%). Best practice firms do not use financial rewards for NPD.
7. Over 84% of the more innovative projects use multi-functional teams. On average, however, multi-functional teams are used in only 40–50% of the less innovative projects. Best practice firms use multi-functional teams more extensively in these less innovative projects (50–60% of the time).
8. Best practice firms are more likely to measure NPD performance and expect more out of their NPD efforts. Best practice firms expect 45% of their sales to come from products commercialized in the last three years. In actuality, 49.2% of their sales did come from products commercialized over the last five years, about twice the rate of the Rest of the firms.
9. Even with all the NPD improvements implemented, the average outcomes have improved only slightly across many measures.
   - The success rate is stable at 59% of those products which make it to market.
   - It takes 6.6 ideas to generate one success, down from 7 in 1982. Firms are more efficient in weeding out less probable projects earlier in the NPD process.
   - The most progress has been made in reducing NPD cycle times, which average 23.8 months for more innovative projects, down approximately ⅓ from five years ago.

years ago and relative to what other investigations have said about product development practices. It also presents analyses of product development processes and organizations which are associated with higher performance.

The History of Tracking Product Development Practices

There is a long history of studies tracking product development management practices. Across these studies, several consistent themes emerge. Table 1 summarizes the studies presented in this section.

Issues in new product development practices were first investigated in the aggregate by Booz, Allen and Hamilton (BAH) in 1968, with the effort repeated in 1982. Their ground-breaking results were privately published in managerially-targeted brochures [4,5]. Booz, Allen and Hamilton's 1968 report, based on knowledge accrued from over 800 client assignments and data obtained from just over 49 firms, reported that almost ⅓ of all product development projects commercialized by firms were failures, with this rate essentially independent of industry [4]. Most of the commercialization failures occurred because the idea or its timing was wrong. This report presented the product development mortality curve, which showed that, on average, 58 ideas were considered for every successful new product commercialized. This report also delineated a common six-stage process for product development which they found most typically used by firms. Although aspects of the process were slightly modified by firm to cater to the needs of the industry, product type, and corporate culture, the basic process consists of exploration, screening, business analysis, development, testing, and commercialization. The authors of the report concluded that heavy attention should be focused on the first three stages of the process to minimize failure. They also found that new products departments, product teams, and a new product committee were organizational forms which, singly or in combination, were found in companies where more consistent NPD success had been achieved.

Booz, Allen and Hamilton's 1982 report is based on in-depth interviews with more than 150 NPD executives and survey responses from more than 700 US manufacturers [5]. From the analysis of these data, and based on the recommendations from research on the use of strategic planning techniques to guide NPD by Crawford [18], they recommended adding a seventh

Table 1. Summary of Prior Best Practice Studies

Year	Sponsor	Sample	Differentiating the Best	Findings (*Best Practice*)
1968	Booz, Allen and Hamilton [4]	50 firms	unspecified	• *Delineated a 6-stage process* • 58 ideas/success • NPD success rate = 67%
1982	Booz, Allen and Hamilton [5]	150 interviews 700 survey responses broad manufacturing cross-section	unspecified regression of factors against NP sales as a % of total sales	• *Add strategic planning step to NPD process* • 7 ideas/success • NPD success rate = 65%
1990	Page, PDMA [50,51]	189 survey responses broad industry cross-section 79% goods	unspecified	• *Measure NPD performance* • *Use multi-functional teams* • Best practice is context-specific • 11 ideas/success • NPD success rate = 58%
1991	Arthur D. Little [1]	701 survey responses 9 manufacturing industries		• *Use multi-functional teams* • *Provide top management attention* • *Early supplier involvement*
1993	Kuczmarski [37,38]	77 fax survey responses broad industry cross-section	rated NPD as "successful" or "very successful" (53% of total)	• *Tangible and visible top management support* • *Provide adequate resources* • *Spend more time on up-front steps* • *Focus on newer products*
1994	Mercer Management Consulting and R&D Management [46]	193 R&D managers broad industry cross-section	top ⅓ in cycle time, innovativeness, success rate and revenue contribution, combined	• *Use a customer-centered, disciplined NPD process* • *Cultivate a supportive NPD infrastructure* • *Manage the NPD portfolio* • *Use a planning stage*
1994	Product Development Consulting [45]	129 survey responses	top ⅓ based on financial, sales and market share performance	• *Distinguish between features and needs* • *NPD scope includes entire augmented product*
1995	Group EFO [33]	103 marketers from 83 firms consumer packaged goods	no Best practices specified	• 25 ideas/success • Lack of NPD commitment
1995	Mitchell Madison Group [47]	15 service firms	self-rated as better than the competition-top 27%	• *Actively manage the NPD portfolio* • *Provide adequate resources* • *Use an empowered team* • Dedicated NPD team members
1995	Pittiglio Rabin Todd & McGrath [52]	over 200 participants many high-tech industries	top 20% across 6 metrics	• *Measure both project performance and development effectiveness* • *Use multi-functional teams* • *Structured process, action-oriented phase reviews* • *Manage product strategy and the NPD pipeline* • 9.5% cycle time reduction
1996	Southwestern Bell [24]	134 respondents, 7 industries 32-item fax survey services and goods	no Best practices specified	• 57% use a formal NPD process • 58% have reduced cycle time • for 80%, team membership is a part-time responsibility

step to the front of the process delineated in their 1968 publication. This step has the NPD process beginning with identifying the new product strategy, then moving into exploration. In 1982, BAH claimed that 77% of the respondent firms used product strategy development as the first step in their product development process. They again found, in this round of research, that most firms used multiple organizational structures to guide NPD programs, with the structure used tied to product-specific requirements. In addition, they found that since the previous study more management attention and financial resources were being given to the early steps in the NPD process (as they had previously recommended), firms were becoming more efficient at product development (spending a larger percentage of their NPD expenditures on successes rather than failures), and needed only seven new products ideas to generate one success in the marketplace. However, the average success rate from NPD had not improved, even with these operational improvements which had been made.

Over the years since 1982, the results in these publications have been widely referenced in academic research on new product development [10,12,15,32,50]. Although BAH was the first to analyze changes in product development management over time, time lags between projects were long. This opened a research opportunity for more routine tracking of product development changes over time.

PDMA has accepted the challenge of periodically providing information about the process and management changes in product development through sponsoring regularly-scheduled research on this topic which is both managerially interesting and academically rigorous. They sponsored their first study of product development practices and norms in the fall of 1990 with a survey distributed only to PDMA members. This first PDMA research effort established norms describing product development changes since 1982 [50] and determined several best practices found in high impact new product programs [51].

This initial PDMA research found that over 76% of the firms responding to the 1990 survey used multidisciplinary product development teams [50]. Formal measurement of NPD programs had increased to 76% of the sample, from 66% in 1982. However, even with these improvements, the average efficiency (spending on successes rather than failures) and success rate were unchanged over the previous decade. The mortality rate of products proceeding through development had increased slightly—one successful product resulted from eleven new product ideas or concepts. In aggregate, it appeared that trends in managing NPD were changing, albeit more slowly than might have been expected.

Page [51] also identified several best practices for high-tech and low-tech product-producing companies which differentiated between NPD performance. For high-tech firms, these practices included having manufacturing devote at least 10% of their time to NPD, having "satisfies customer needs" as an explicit success criterion, including concept testing and market testing in the NPD process, and using non-financial rewards and incentives to motivate people. For low-tech firms, best practices include using product managers as part of the organization's new product development structure, and having "satisfies customer needs," "strategic fit or synergy," and "uniqueness of the new product" as explicit success criteria. In other words, Page found that although average performance and trends could be identified across the sample, at least some best practices were context-specific. One of the ways in which corporate context could be defined was by looking at the technology position of the firm.

Since the first PDMA survey was completed, a number of other organizations have investigated and reported on different aspects of product development best practices. The investigations have been published privately, but are publicly available with the results presented in open managerial forums.

In 1991, Arthur D. Little surveyed 701 companies in 9 manufacturing industries about their product innovation processes, focusing primarily on top management's concerns and improvement efforts [1]. They found major differences in concerns and approaches to overcome those concerns depending upon the geographic location of the responding firm: Japanese firms were developing new products in markedly different ways from US firms. The three top US product development concerns they found were improving product appeal, getting products out on time, and decreasing product development time. The approach which most frequently was found to lead to increased US success was "multifunctional teams with significant autonomy dedicated to a project." Other research has shown that top managers formally control the budgets and plans of these groups only loosely, but exert considerably tighter control over them informally by providing them with significant amount of top management attention and contact [2]. The next most successful approach to creating successful NPD was "early supplier selection and involvement," as

also recommended by the research of Clark and Fujimoto [9].

Kuczmarski & Associates published a study on product development best practices based on the results from 77 respondents from a broad cross-section of industries to a survey in 1993 [37,38]. They found that more successful companies (the 53% of their respondents who rated their NPD performance as "very successful" or "successful") were more likely to pursue NPD to gain or maintain a competitive advantage, fill a growth or profit gap, arrest margin erosion or utilize a new technology than less successful firms, who were more likely to use NPD to retain current and attract new customers. More successful firms had more tangible and visible signs of top management commitment to NPD, especially in terms of providing adequate funding and resources. They also focused more effort on new-to-the-world and new-to-the-company products, devoted a larger percentage of the product development process to concept screening and testing and rated themselves as being more effective in terminating projects during development.

Mercer Management Consulting, Inc., in conjunction with *R&D Magazine*, gathered survey responses from 193 R&D managers from a variety of industries and linked product development practices to NPD performance, which was defined as combined self-assessments of cycle time, innovativeness, success rate and revenue contribution [46]. They found that high performers (top third) were differentiated from lower performers (bottom third) in their execution of a commonly agreed to, customer-centered and disciplined NPD process, their cultivation of a supportive organization and infrastructure for NPD, and in setting the NPD agenda and managing the portfolio of projects in aggregate. Some of the practices contributing to success the most while differentiating between lower and higher performers included involving potential customers directly through numerous stages of product development, formulating product strategy early in the project, consistently following the project execution process from project to project, having top management visibly and tangibly committing to NPD and explicitly formulating and communicating the firm's NPD strategy.

Product Development Consulting, Inc., developed a description of best practices in product definition from 129 responses to a survey they administered in 1994 [45]. This research focused only on practices associated with the initial few stages of the product development process, rather than trying to understand best practices across the entire process. Responses in this survey indicate that marketers and engineers in best-in-class firms carefully distinguish between customer requirements (needs) and product features (solutions to customer needs) and have explicit documents which describe each separately. In-depth interviews with customers used to gain a deep understanding of the needs of a moderate number of customers (11) are market research best practices uncovered in this survey. Finally, the scope of product definitions is wider to include the entire augmented product—the sales process, packaging, installation, complementary products, support and service—at best practice firms.

Group EFO, in conjunction with *Brandweek*, conducts an annual poll on new manufactured goods in the consumer packaged goods area [33]. In the 1995 Innovation Survey of 103 marketers from 83 firms, they found that only 4 ideas out of 100 considered became commercial successes, or expressed in mortality curve language, 25 ideas were required to produce one marketplace success. Consumer packaged goods firms seem to be less effective in generating ideas, in turning ideas into products, or both, than the predominantly business-to-business samples in other surveys. These firms also indicated that their product development processes are only effective about half the time—and in no case is the process used effective more than 75% of the time. Only 60% of the managements were reported to have a clear point-of-view of the role of new products in their firms. Fully two-thirds of the respondents felt that their new product programs were under-resourced. EFO interprets that the survey responses indicate that there is a lack of commitment to new products in these firms, or that management does not understand what commitment to NPD entails.

Also in 1995, the Mitchell Madison Group released a study of NPD in a small sample (15) of service firms [47]. They found that while service firms differ from goods-producing firms, notably by the effect of 'intangibles' in the satisfaction equation and by the tight linkage between service delivery and service manufacturing—the production of the service is the delivery of the product [21]—many of the key success factors for service NPD are identical to those identified for manufacturing firms. Using formal processes for services NPD is a fairly recent circumstance—none of the firms had been using a process for more than five years, over 25% had been using a process for less than one year, and half had been using a process for between 1 and 4 years. The "best companies" (self-rated as better than the competition) more actively manage

the portfolio of projects under development, limit the number of projects underway at any one time to match the available resources and involve multi-functional teams early in the process. These firms also use different organizational structures for NPD depending upon the needs of the project, but allow the project team to fully "own" the process, with the ability to make virtually all the decisions within the team. One large difference between service firm teams and manufacturing NPD teams seems to be that virtually all the service core team members are dedicated to the team.

Pittiglio Rabin Todd & McGrath (PRTM) also used responses from over 200 organizations from 6 industry groups in 1995 to determine NPD best practices [52]. They defined the "best-in-class" as the top 20% against a set of six NPD metrics: time-to-market, time-to-profitability, project goal attainment, NPD revenue contribution, R&D Effectiveness Index [44] and wasted development project spending. The study identified several "best practices," although the methodology for arriving at these is not defined in this publication. At the project level best practices include using cross-functional teams, a structured development process with action-oriented stage reviews and an integrated set of development tools (such as QFD, rapid prototyping and simulation). Best practice firms also manage across projects with product strategy, pipeline management, and technology management processes.

In the summer of 1996, Southwestern Bell commissioned Fact Finders Inc. to perform a bench-marking study of NPD [24]. A 32-item fax-questionnaire was returned by 134 respondents from 7 industries spanning services and manufactured goods, as well as both consumer and business-to-business products. About 57% of the respondents used a formal NPD process, with 52% including test marketing as part of that process prior to launch. Just over half (56%) of the firms measure their product development processes, with 58% of the respondents reporting reductions in NPD cycle times in the last year. Processes in these respondent firms have been in place longer than in the service firms from the Mitchell Group study. Over 32% of the firms have had formal processes for five years or more, 54% have used a formal process for 1–4 years, and only 14% have just within the last year implemented a process. Another difference between NPD at these firms and those of the Mitchell study is that for 80% of the respondents, team membership is on a part-time basis rather than a full-time basis. Best practices were not determined in this study.

Summary of Findings from Tracking NPD Practices

Over these 11 studies, several themes consistently emerge. First, although NPD processes are a relatively recent phenomena [10,11,15,16], they consistently are seen as being necessary to effective NPD. Over the years, the focus on the NPD process has moved from defining an appropriate process, to assuring implementation, to better managing the up-front portion, to measuring the process better, to continue improving the process. Interestingly, mortality curves and overall success ratios seem to be stable, even with operational improvements being made in the process. The latest aspects of process which are receiving renewed attention are obtaining customer needs for product development and managing the resource allocation process across projects (portfolio and pipeline management).

Organizationally, there are two consistent themes. First, virtually every study claims that effectively implementing multi-functional teams is crucial to NPD success. Second, the studies consistently relate that NPD is melded into the firm's organization through multiple structures within each firm, and that no one structure seems to be associated with consistently higher performance. We have not yet been able to define the organization and infrastructure which best supports effective multi-functional teams over time and across projects [35].

Another consistent finding for producing successful NPD is the need for tangible and visible top management support of NPD, especially in terms of providing adequate funding and resources and explicit, consistent strategies. This includes having a rational process at firms for allocating resources across projects and a well-thought-out strategy for both NPD at the firm, and the particular project under way.

Finally, recent studies suggest that best practices may be somewhat context-specific, and some efforts are taking place to better define best practices within contexts rather than in aggregate. For example, Page [51] found different success differentiators depending upon the technology base of the firm (high- versus low-tech). The Mitchell Madison services study found that all teams were dedicated NPD teams, while the Southwestern Bell study, encompassing a number of industries, found only 20% of the respondents used dedicated teams. The processes used in the consumer packaged goods firms in the EFO Group seem much less effective than those found in more business-to-business-oriented surveys because of the differences

found in the numbers of ideas required to produce a commercial success in the marketplace. Future research in best practices, to be most useful, then, should also investigate best practices for specific contexts.

Research Method

Survey Development

In developing the PDMA research, a number of "best practice" surveys developed since 1982 were gathered. The PDMA 1995 Best Practices survey was developed by combining questions from several different sources: the 1990 PDMA [50,51], 1982 BAH [5], 1994 Mercer Management/*R&D Magazine* [45] and the Arthur D. Little surveys [1]. A multiplicity of sources was used because this research was to cover a broader set of issues than any one of these previous surveys covered.

Potential questions to be included in the survey were identified and formatted. This set of questions was then circulated to three academics and three practitioners who had previously been involved in best practices research. Changes were made in a number of questions to increase their clarity and several issues and questions were eliminated based on their suggestions. Another draft of the survey was developed and pretested with twelve knowledgeable product development practitioners for clarity and usefulness of issues addressed. Additional rewordings of the survey were made based on their suggestions to increase the clarity of a few questions.

The final survey consisted of 9 pages of questions and a 1-page cover letter. Questions covered issues surrounding the product development process, organizing for product development, tools supporting product development, measuring product development, product development outcomes, and background information on the respondents. The questions investigated in the analyses presented here come from the product development process, organization, measurement, outcomes, and respondent background sections.

The survey was a pre-addressed self-mailer. Respondents folded the finished survey in half, taped or stapled it shut, placed a stamp in the corner and dropped it in the mail. No incentives were provided to participants for filling out this long survey. However, if they stapled a business card to the form, we promised to send working papers derived from the research as they became available.

Variable Operationalizations

Success Outcome Variables. A total of 7 success criteria were included in the survey measuring overall, relative, market and financial success at the firm level [31,32]. Overall success is obtained from the single-item categoric measure, "position in your industry" (most successful, top 1/3, middle 1/3, bottom 1/3) [51]. Degree to which the NPD program met its objectives and degree to which the NPD program is a success allow the firm to assess how well they are doing relative to their program's objectives. These criteria, from [10], have been used extensively in NPD research. They are measured as the degree to which the respondent agrees with the relative success of the program on a 1 (completely disagree) to 9 (completely agree) scale (5 is neutral, neither agree nor disagree). These two items are highly correlated in the data ($\rho = .76$, $p < .01$) and a scale constructed by averaging the two items has an α of .86. The 4 criteria measuring market and financial success (% of products categorized as successes in the last five years, $ sales of products commercialized in the last five years as a % of total sales, $ profits of products commercialized in the last five years as a % of total profits, and % of products categorized as financial successes in the last five years) are linear in nature, measured as %'s, with a maximum range from 0% to 100%. These measures are from prior NPD best practices and success measurement research [31,32,50]. These four items are all statistically significantly correlated in the data. The scale constructed from the average of these four items has an α of .79. As Table 2 illustrates, overall industry, relative and market-financial success are significantly correlated in the data. However, the correlations account for only about 1/4 of the variability in the data (the square of the correlation coefficient). Although correlated, each multi-item measure represents a slightly different aspect of success.

Process and Organization Variables. The questions investigating strategy, product development process, and organization may be found in the Appendix. They covered whether strategies and processes had been used, and how long, of what steps the process

Table 2. Correlation Matrix for Success Variables (ρ)

	Overall Success	Relative Success
Relative Success	.50**	—
Market-Finance	.45**	.42**

** $p < .01$.

consists, product idea mortality, how NPD is organized and led, multi-functional team usage, and team and leader rewards for NPD.

Demographic Variables. The survey also gathered information on several pieces of demographic information. Respondents indicated whether their firm primarily provided manufactured goods or services to consumer or business purchasers, or to a mix of both types of purchasers. They indicated whether their firm is high-tech, low-tech, or a mix of both, and checked boxes according to industry participation and firm size.

Sample

The survey was sent out to over 14,500 potential U.S. respondents obtained from three separate sources as outlined in Table 3. The cover letter stressed the need for a respondent knowledgeable with the scope of NPD activities and requested that the recipient pass the survey to a more qualified person, should they not feel equipped to provide the breadth of information requested. Reminder postcards were mailed to all potential respondents two weeks after the initial survey was sent out. The overall response rates obtained are low for survey research. However, this is not unexpected due to the length of the questionnaire, complexity of some of the questions, and lack of incentives provided for taking the time to respond.

The PDMA members to whom the survey were sent are a sub-sample of the PDMA population. The surveys were sent out only to non-academics or service providers (consultants) to obtain data from people associated with firms actually involved in product development on an ongoing basis. In addition, random samples of two mailing lists were purchased from the American Marketing Association (AMA) and CorpTech to obtain a significant sample size of responses. The AMA sample came from those in the database who had checked off the "new product development" interest category. The CorpTech sample consisted of those with "business development," "product development," or "development" in their titles.

The mailing lists were chosen to maximize the sample diversity. Previous studies had shown that PDMA members are primarily manufactured goods producers in the business-to-business market, from somewhat larger firms [25,50]. Table 4 shows that the 1995 PDMA sample is similarly characterized. The percentage of manufactured goods has increased from 78.8% in the 1990 sample to 91.0% in the 1995 PDMA sample. The 1990 PDMA sample was 34.8% high-tech, 34.8% mixed, and 30.4% low-tech. Thus, the 1995 sample is slightly less high-tech than previously. The 1995 sample also consists of a somewhat smaller set of firms. The median sales for the sample is under $500 million, whereas in 1990 median sales were $1 billion. Because summary statistics are not available for the PDMA membership, it is not known if the respondent sample for this survey differs from the PDMA population in any meaningful way.

Because the goal was to get a broader understanding of NPD practices, lists were sought which would provide more consumer, service-providing, and smaller-firm respondents. Table 4 shows that the diversity of the sample was increased statistically significantly across four demographic variables by using the AMA and CorpTech lists in addition to surveying PDMA members. The AMA sample provided an increased number of consumer and service respondents. The CorpTech sample increased the number of high-tech and small firms in the sample. The sample is still more manufactured goods-oriented than service-oriented, with 80.6% of the respondents indicating that their firms primarily produce manufactured goods, and predominantly sell into the business-to-business market rather than directly to consumers. The CorpTech list helped increase the numbers of smaller firms in the sample.

Average success rates differed statistically across the three samples for one of the measures used, as Table 5 illustrates. Respondents from the CorpTech sample indicate that they achieve higher percentages of market and financial success in the products they commercialize than respondents from the other two groups. Importantly, even with this difference, all

Table 3. Sample and Response Rates

	PDMA Members	American Marketing Association	CorpTech List	Total
# Mailed Out	1,601	6,650	6,500	14,751
# Undelivered	0	225	57	252
# Usable Returns	159	86	138	383
Response Rate	9.9%	1.3%	2.1%	2.7%

Table 4. Demographics by Source of the Sample

		PDMA Members		AMA Sample		CorpTech		Total Sample	
		#	% PDMA	#	% AMA	#	% CorpTech	#	% Total
Technology Base[1]	High-Tech	43	27.7%	18	22.2%	67	49.3%	128	34.4%
	Mixed	64	41.3%	41	50.6%	48	35.3%	153	41.1%
	Low-Tech	48	31.0%	22	27.2%	21	15.4%	91	24.5%
Market[2]	Consumer	39	25.0%	20	24.7%	7	5.2%	66	17.8%
	Mixed	28	17.9%	14	17.3%	22	16.4%	64	17.3%
	Business	89	57.1%	47	58.0%	105	78.4%	241	65.0%
Product Type[3]	Goods	142	91.0%	39	48.8%	119	87.5%	300	80.6%
	Services	14	9.0%	41	51.3%	17	12.5%	72	19.4%
Sales[4]	<$10 M	6	4.0%	12	15.3%	44	33.6%	62	17.0%
	$10–$24 M	6	4.0%	7	9.0%	28	20.7%	41	11.2%
	$25–$99 M	18	11.8%	19	24.4%	43	31.9%	80	21.9%
	$100–$499 M	63	41.4%	22	28.2%	16	11.9%	101	27.7%
	$500–$999 M	18	11.8%	6	7.7%	2	1.5%	26	7.1%
	≥$1,000 M	41	27.0%	12	15.4%	2	1.5%	55	15.1%

[1] Anova test: $F = 11.1$, $p < .01$, $df = 371$.
[2] Anova test: $F = 12.4$, $p < .01$, $df = 370$.
[3] Anova test: $F = 40.5$, $p < .01$, $df = 371$.
[4] Anova test: $F = 79.1$, $p < .01$, $df = 364$.

three groups of respondents are undifferentiated in their average industry success level and with overall NPD program performance, relative to their programs' objectives. This means that while the CorpTech respondents have higher performance on one dimension, they also expect more in that dimension.

The statistically significant demographic differences of the different sample populations are predominantly captured in the market and manufactured good/service demographic variables, as shown in Table 6. The only demographic difference across manufactured goods and service producers is the percentage of consumer versus business-to-business firms in the sample. Over ⅔ of the manufactured goods producers serve only business-to-business customers, while less than half of the service firms serve only them. Service firms are more than twice as likely to serve both consumer and business-to-business customers than manufactured goods producers. For example, both telecommunications and financial services firms frequently serve both markets rather than just one or the other. However, NPD performance is independent of product type, as the last three lines of Table 6 show. This simplifies the analysis in identifying practices which are found to differ in achieving success across these two sub-samples.

Analysis

Best practice publications in the recent past have presented aggregate results for broad populations of firms, or for firms within one particular context. While analyzing aggregate results may suggest NPD practices associated with success independent of context, firms in different industries or managerial contexts may require additional or different practices to maximize the probability of success. For example, manufactured good producers differ from service providers,

Table 5. Average Success by Source of the Sample

	PMDA Members	AMA	CorpTech	Total Sample
Industry Success*	2.6	2.6	2.7	2.6
Relative Success†	5.5	5.3	5.7	5.5
Market-Financial Success[1]	40.1%	42.2%	50.5%	44.6%

* 4 = most successful in industry, 3 = top third, 2 = middle third, 1 = bottom third.
† 9 = completely agree, met criteria, 1 = completely disagree, met criteria (higher is better).
[1] Higher percentages are better. Anova test: $F = 7.1$, $p < .01$, $df = 267$.

Table 6. Descriptive Statistics of the Sample

		Service Firms		Manufactured Goods Firms		All Firms	
		#	% of Service	#	% of Product	#	% of Total
Technology Base	High-Tech	24	33.8%	103	35.3%	127	35.0%
	Mixed	33	46.5%	119	40.8%	152	41.9%
	Low-Tech	14	19.7%	77	26.4%	91	25.1%
Market[1]	Consumer	16	22.5%	50	17.1%	66	18.2%
	Mixed	22	31.0%	42	14.4%	64	17.6%
	Business	33	46.5%	206	70.6%	239	65.8%
Sales	<$10 M	16	22.5%	45	15.4%	61	16.8%
	$10–$24 M	4	5.6%	37	12.7%	41	11.3%
	$25–$99 M	14	19.7%	65	22.3%	79	21.8%
	$100–$499 M	15	21.1%	86	29.5%	101	27.8%
	$500–$999 M	6	8.4%	20	6.9%	26	7.2%
	≥$1,000 M	12	16.9%	42	14.4%	54	14.9%
	Sample Total	71	100%	292	100%	363	100%
Success[2]	Industry	2.5	—	2.7	—	2.6	—
	Relative	5.5	—	5.5	—	5.5	—
	Market-Financial	39.6%	—	45.8%	—	44.8%	—

[1] Statistically different percentages across cells by Anova. $F = 7.77$, $p < .01$, $df = 388$.
[2] A higher number is higher success.

at least in terms of the linkage between the manufacture and delivery of the service or good [47]. One might thus expect that service firms could be helped by slightly different practices than goods-producing firms.

This research purposely sought responses from firms across a broad set of industrial contexts so that contextual differences in NPD practices could be better understood. This article thus analyzes results, not just in the aggregate, but also across the manufactured good/service segments, when appropriate. Both descriptive trends and associations with higher and lower performance are included in the analysis.

For assessing "best practice," the sample was split into two groups based on success performance across multiple criteria. "The Best" are those firms who indicated that they were either the most successful or in the top third of their industry for NPD success, and also were above the mean on relative success and market-financial success for the entire sample. A total of 85 respondents, 22.2% of the sample, met all three of these criteria. "The Rest" are the other 298 responses in the sample, who fell short of the mean on at least one multi-item criteria or who were below the top third in their industry.

Table 7 shows how "The Best" responses are distributed across the product and market demographics. Although more of the goods-producing firms than service-delivering firms (both absolute and as a percentage of the total available) meet the three Best Practice, criteria, Anova tests of the distribution across these demographic variables show no statistical differences for the percentage of the total by product, market, or product and market together.

Table 7. Distribution of "The Best" by Market and Product Type

	Consumer Market		Mixed		Business-to-Business		Full Sample	
	#	% of Total	#	% of Total	#	% of Total	#	% of Total
Services	2	12.5%	3	13.6%	5	15.2%	10	14.1%
Goods	13	26.0%	9	21.4%	53	25.7%	75	25.2%
Full Sample	15	22.7%	12	18.8%	58	24.3%	85	22.2%

The data are analyzed using several methods. Means, means across sub-groups and Anova tests are used for continuous variables. Cross-tabulations and Chi-squared tests are used to analyze differences for discreet variables. These analyses investigate the relationship between individual variables and success. Interaction effects will be investigated in later analyses [41,42].

Results

Product Development Process Impact on NPD

Using a formal NPD process and not skipping steps in the process has long been a differentiating factor between successes and failures at the project level of analysis [10,15]. However, even though the effectiveness of product development processes has been well-proven, many firms still do not use a formal NPD process. Across the entire sample, 38.5% of the respondents (140) still either use no process at all, or use only an informal process. As Figure 1 shows, however, manufactured goods producers are statistically more likely than service providers to have and use a formal NPD process ($\chi^2 = 22.3$, $p < .01$, $df = 6$). Nearly 60% of the service firms responding to this survey do not use a formal process for NPD. In addition, very few firms now use a functional, sequential process. Those who use processes have migrated to some form of multi-functional stage gate approach.

Figure 2 shows that the extent of process use also differs statistically between best practice firms and the rest of the population ($\chi^2 = 14.4$, $p < .05$, $df = 6$). Multi-functional stage gate approaches are used by 69% of the best NPD firms, but only 52% of the rest. Differences in use across these two groups are especially apparent when looking at the use of facilitated and third generation (those with fuzzy and flexible gates [12]) stage gate processes. Mercer [46] found that 81% of the high performers in their sample used stage gate processes, but only 68% followed them consistently, a percentage very close to that found in this sample. Only 56% of the lower performers in Mercer's study used stage gate processes for NPD, and only 38% followed them consistently. Of the PDMA best practice firms, 22 of the 85 were able to achieve high NPD performance in spite of not following a formal NPD process. However, of those 22, only 4 had no process at all—the other 18 informally follow some procedure.

The firms in this sample using processes have been using them for longer periods of time than other studies have found, as shown in Figure 3. While the vast majority of firms have used their NPD processes for between 1 and 4 years, over 31% of the total sample has used their process for at least five years. Over 27% of the service firms in this sample have used a process for at least five years, which is a contrast to the Mitchell finding that none had used a process that long [47]. Of the best practice firms, over 40% have used their process for at least five years. This is consistent with the 1982 BAH findings for Best practice firms.

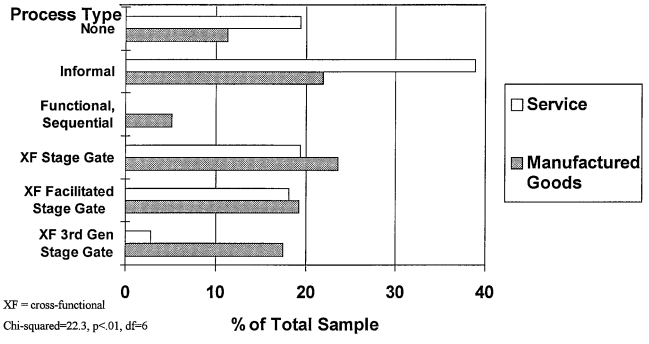

Figure 1. Product Development Processes: Services versus Manufactured Goods

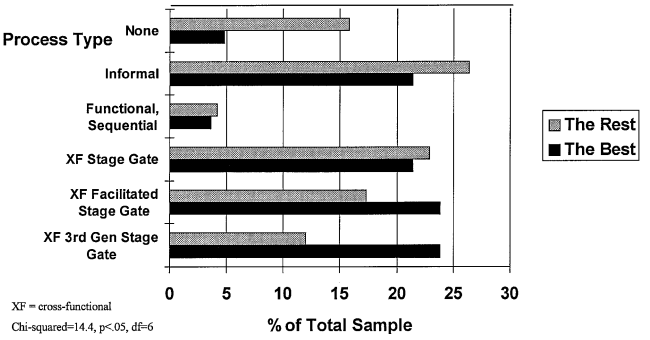

Figure 2. Product Development Processes: The Best versus The Rest

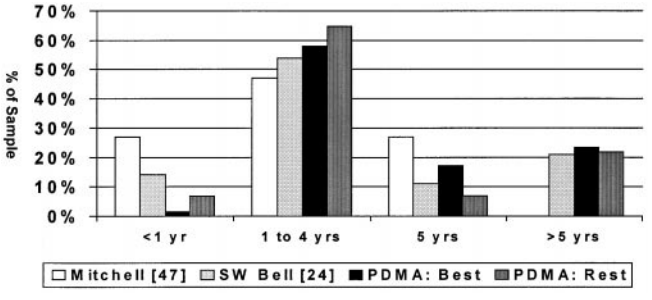

Figure 3. Years Process Has Been in Use

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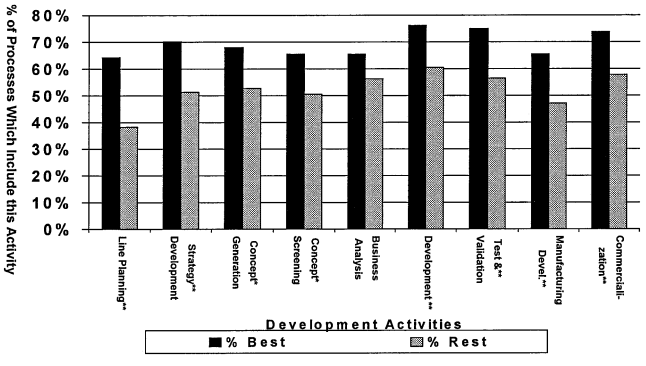
A constant theme which has run throughout NPD best practices reports is the need for a NPD strategy, both at the overall program level and for each project undertaken [1,4,5,33,37,46]. Although Booz, Allen and Hamilton espoused the need for a strategy in 1982, and encouraged firms to set one prior to undertaking NPD, Page reported that only 56.4% of his sample had a specific NPD strategy in 1990 [50]. Strategy use has increased since then. Of the 383 responses in this research, 62.7% (240), "have a specific strategy for their NPD activities which directs and integrates the entire new product program." Mercer [46] found that having a strategy for the NPD program as a whole was an important differentiator between higher and lower performance (68% in higher performers and 43% in lower performers). That finding is replicated here: a statistically higher percentage of the best-performing respondents, 75.9%, have specific strategies, while only 58.8% of the lower performers have one (Anova: $F = 12.1$, $p < .01$, $df = 362$). There are no differences in having an overall NPD strategy between service and manufactured goods producers.

In 1982, Booz, Allen and Hamilton reported that 77% of firms they surveyed started their product development process with a strategy developing step for each project [5]. On average, the NPD processes for 55.6% of the 1995 PDMA sample includes a specific NPD strategy. However, as Figure 4 illustrates, 70% of the higher performing respondents have a process which includes a strategy step, versus only 51% for the lower-performing respondents. These differences in strategy as a step in the NPD process are statistically significant (Anova: $F = 9.6$, $p < .01$, $df = 363$). Figure 4 also illustrates what percentage of the NPD processes include each of the 9 steps described in the Appendix (Question 5). The development and test and validation steps are the most-included NPD process steps. The processes for higher-performing respondents are always more likely to include any particular step than the processes for lower-performing respondents. For each step, with the exception of the Business Analysis step, these differences are statistically significant, as analyzed using Anova.

Overall, the processes for higher performing respondents average 6.2 of the 9 possible steps, while lower-performing respondents only average 4.7, again, a statistically smaller number (Anova: $F = 10.0$, $p < .01$, $df = 363$). Previous research has demonstrated that not skipping steps increases the probability of success for any project [10,15]. The PDMA 1995 research provides additional support that processes which consist of more of the total set of activities required for product development are associated with firms with higher overall performance for their product development programs.

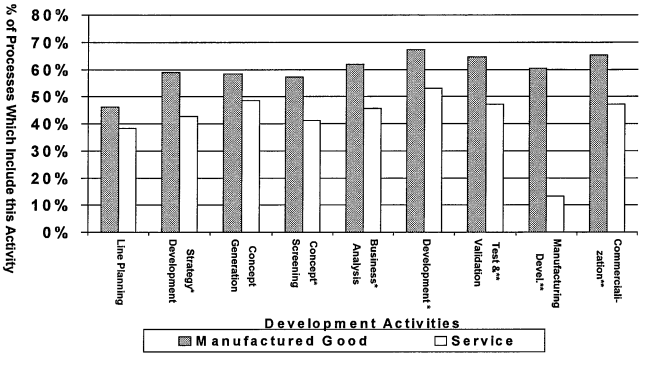
NPD processes for services differ from the processes used for developing manufactured goods, as Figure 5 illustrates. NPD processes for services are always less likely to contain any particular step. As with manufactured goods, "development" is the most-included process step. However, the step next most likely to be included is concept generation, not test and validation. Service processes are as likely as goods-developing processes to include a concept generation phase. Service processes also consist of a statistically significantly fewer number of steps than manufactured goods processes. Service processes, on average, consist of 3.8 steps, versus 5.4 for the average manufac-



** Anova test: p<.01

* Anova test: p<.05

Figure 4. NPD Process Components



** Anova test: p<.01

* Anova test: p<.05

Figure 5. NPD Process Components

tured goods-developing NPD process (Anova: $F = 9.8$, $p < .01$, $df = 360$).

While, on average, service processes are less likely to include any step than are manufactured goods processes, these differences almost completely go away when service and goods differences are analyzed for just "the Best" firms. With one exception, processes for the best service firms are as likely to include a particular step as they are for manufactured goods firms. Service firm processes statistically still are less likely to contain a manufacturing development step. Only 18% of "the Best" service processes include this step versus 73% for manufactured goods developers (Anova: $F = 14.4$, $p < .01$, $df = 83$). The total number of steps, 4.7, in a NPD process for "the Best" service firms, while still less than the 6.5 for "the Best" manufactured goods firms, is not statistically lower due to the smaller sample sizes in the two subgroups. Even if a best practice service NPD process need not include a manufacturing development step because there is no manufacturing development, service processes still are nearly one full step less than manufactured goods processes.

Summary. NPD processes and process use have continued to evolve over the last five years. Change seems to occur more evolutionarily, however, rather than revolutionarily. Furthermore, the ways in which processes are implemented continue to differentiate between best practice and the rest of the firms and between service and manufactured goods producers. In the best firms, processes are more likely to be used, and when used, are likely to be more complex and complete. Additional effort needs to be expended to develop processes which better meet the needs of providers of services.

Organizing for Product Development

How best to organize NPD, where to locate responsibility for NPD in the firm, and who should lead NPD projects have long been questions to which firms would like answers. Both in 1968 and 1982, BAH found that more than half of the firms they surveyed used multiple structures to organize for NPD [4,5], as did Page in 1990 [50]. Souder [54] recommended that the most appropriate structure depended upon the level of innovation desired and the stability of the market and technical environments.

In 1968, BAH identified two basic organizational forms which had evolved specifically to meet the needs of new product development programs. A permanently-staffed new products department is charged with the responsibility of recommending new product objectives, planning the programs, making screening decisions, and directing the progress of projects through all stages of development. The full-time responsibility of people in this department is new product development, and nothing else. Relegating NPD responsibility to a new product committee is a precursor structure to the new product department. This committee is charged with evaluating and coordinating new products at a firm, however, the personnel on this committee fulfill this task only part time. They have other primary tasks and responsibilities.

Souder [54] identified several other organizational structures for NPD. Although he found that a functional structure was superior for handling routine problems, well-known technologies, stable environments, low product evolution rates, and well-defined markets, others have found that projects developed using functional structures were less successful than those developed in matrix structure or by a multi-functional project team [39]. In Souder's research, a divisional or strategic business unit (SBU) structure in which each division is responsible for commercializing new products was able to respond to diverse market needs and evolutionary product improvements. A third structure again organized current products into SBU's, but provided for fostering the development of radical innovations using a new enterprise division, or venture group whose task was to nurture the risky projects into the market place.

A more recently-developed way for the responsibility of NPD to be assigned in the organization is by creating a process-oriented NPD structure, with one or more NPD process owners [27,44]. NPD process owners are responsible for developing a formal process for NPD, documenting and improving the process, and facilitating process deployment and use across the firm. This structure is designed to help ensure that NPD procedures and methods are implemented in standard ways across projects and divisions.

The survey listed these six organizational structures and requested that respondents indicate all of the organizational structures in which responsibility for their firm's more innovative NPD projects are found. Figure 6 displays the overall results, starting from the most frequently-used structure on the left side of the graph, as well as how responsibilities differ depending upon whether the firm produces manufactured goods or services. This graph repeats the long-standing finding that multiple structures are used for organizing the

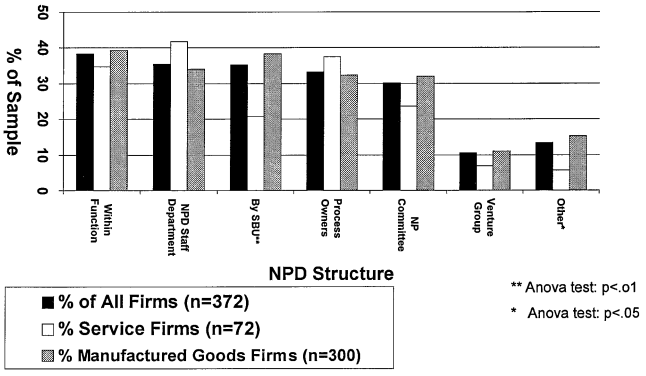


Figure 6. Organizations for NPD

NPD effort within each firm. Page [50] reported that 53% of the firms surveyed in 1990 used more than one structure, and on average, each firm used 1.9 structures for organizing more innovative NPD projects. In 1995, 61.9% of the firms surveyed organize more innovative NPD projects in multiple ways, with an average of 2.0 structures per firm. However, manufactured goods producers use more structures on average, at 2.0 per firm, than service providers, who only use 1.7 (Anova: $F = 6.2$, $p < .05$, $df = 371$). Service firms statistically are less likely to have NPD organized at the SBU level. Permanent NPD staffs and NPD process owners are the most frequent reporting structures for service organizations, although the differences in use are not statistically higher than for manufactured goods-producing firms.

The most-used structure for more innovative product development projects is to have NPD report to a functional area. As Figure 7 illustrates, the functional area in which NPD resides is almost equally likely to be marketing, R&D or engineering. NPD reports into planning only seldomly. Figure 7 also shows how NPD structures differ between services and goods. Service development is most likely to report to the marketing function, and least likely to report to an engineering function, when NPD takes place in a functional structure. It is unclear whether this difference is due to cultural differences between the two types of firms or because service firms do not have engineering functions.

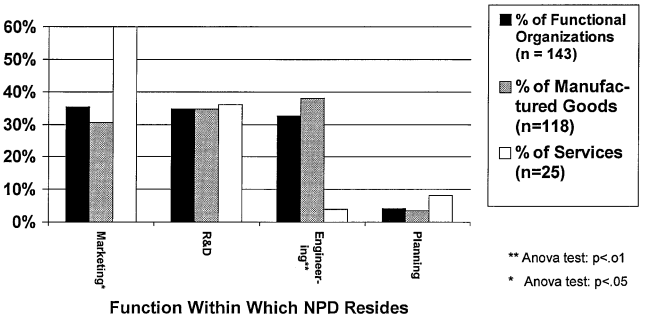


Figure 7. The Function in Which NPD Resides

NPD reporting structures for best practice firms do not differ statistically from reporting structures for the rest of the firms. While the Best are less likely for NPD to report into a function or to use process owners, these differences are not significant (Anova: $p > .1$). Reporting structure does not contribute materially to differentiating the Best from the Rest.

Another important question addressed in this survey was who leads NPD and does who leads NPD differ depending upon whether the firm produces manufactured goods or services, or is a best practice firm or not? Mercer [46] found that nearly 80% of the higher-performing firms in their survey pinpointed specific individuals responsible for NPD and product introduction, while only 55% of lower-performing named those responsible. PDMA's 1995 survey asked respondents to indicate how the more innovative projects are led at their firms. The survey listed five options.

Product development can be led in a number of different ways. Project managers coordinate development activities through liaison representatives from each function, in the case of lightweight project managers, or have full responsibility and "clout" to manage development activities across functional areas, in the case of heavyweight project managers [6,9]. The survey did not differentiate between whether the project manager was a lightweight or heavyweight manager. A second leadership mechanism is the project champion, which Crawford [19] defines as: "A person who takes an inordinate interest in seeing that a particular process or product is fully developed and marketed. The role varies from situations calling for little more than stimulating awareness of the opportunity to extreme cases where the champion tries to force a project past the strongly entrenched internal resistance of company policy or that of objecting parties." The champion's role in new product development has been a topic of discussion for over 30 years, with much anecdotal evidence suggesting they materially contribute to product development success [41]. Another source of NPD leadership may come from the NPD process owners, in a firm that uses a process-oriented reporting structure [43]. Process owners are responsible for implementing and maintaining a successful NPD process in an SBU or company [27].

However, in some firms, these owners may also be responsible for leading NPD projects. According to the practitioners pre-testing the survey, some firms are also experimenting with "leaderless" structures. These structures involve work processes which do not require formal leadership. Finally, respondents were given the option of indicating that no one leads NPD at their firm.

Figure 8 shows that project managers are by far the most widely-used leaders for NPD, followed by project champions. Project managers have become the most-used mechanism for leading NPD projects. Championing projects has been remarkably stable over the last 10 years. BAH reported that nearly half of the firms they surveyed encouraged champions [5]. In Page's respondents, 43.4% of the firms encouraged champions [5]. This is close to the 42.4% leadership by champion number obtained here.

While in over 30% of these firms, product development resides in a process owner group (Figure 6), only slightly more than 10% of the projects are led by NPD process owners. In other words, process owner NPD structures generally operate more like staff groups than line organizations responsible for implementing projects. Leaderless projects still are very experimental, with fewer than 5% of the sample indicating that they use them for their more innovative NPD projects.

There are no statistically significant differences in the proportions of who leads NPD between service or manufactured goods firms, or best practice firms and the rest of the sample. This finding differs from the Mercer study, where champions were associated with 63% of the higher-performing firms, but only 41% of the lower-performing firms [46].

Leadership selection is clearly not an egalitarian process (see Figure 9). Project leaders, whether project managers or champions, are overwhelmingly appointed by management. The second most frequent

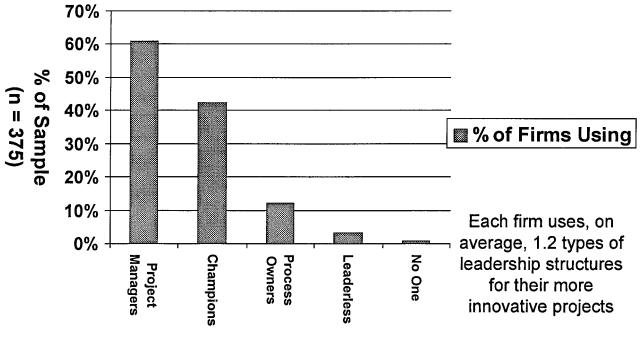


Figure 8. Who Leads NPD Projects

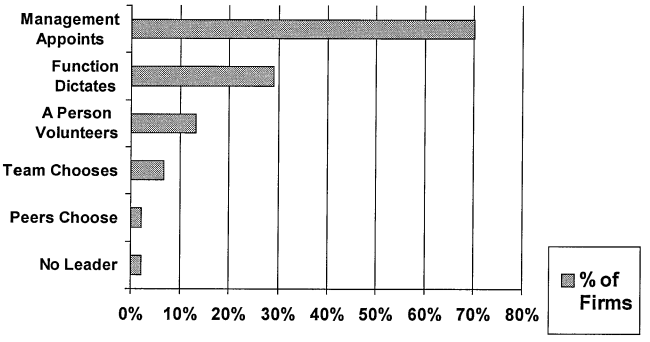


Figure 9. Who Appoints NPD Project Leaders

selection method is that the function in which NPD resides dictates who the team leader shall be. Teams and peers choose their own leaders less than 10% of the time. Leader selection probabilities do not differ between manufactured goods and service sub-groups or best practice and the rest of the firms.

The survey instrument also gathered data on rewarding NPD personnel, another area on which several best practices investigations have focused. In 1982, BAH found that only 5% of the firms in their survey tied compensation directly to new product performance [5]. In 1990, Page [50] found a slight increase in the proportion of firms, to 7.4%, who tied compensation plans (through the bonus system) directly to successful performance of the new product. Another 15.9% tied part of a person's bonus to whether the NPD project was completed. Only 20.6% of the 1990 sample used incentives and awards as NPD personnel motivational tools, with 15.8% providing financial incentives or awards, and 10.0% providing non-financial awards and recognition. In 1993, Kuczmarski [37] found that recognition (pats on the back) was used by nearly 90% of the respondents in their survey, while awards and plaques were used by 43%, bonuses based on new product performance were used by about 15% of the firms, and project-based stock was used by less than 5%. In an extensive survey of the 1994 compensation levels for new product professionals, Feldman found that performance-based financial incentives played a minor role overall [26]. At the lower ranks of the organization, less than 10% of total compensation resulted from NPD performance-based financial incentives. At the vice presidential level, 20% of total compensation could be derived from NPD performance. Feldman found that about 76% of NPD professionals received non-financial incentives. Of these, 38.4% received a plaque or certificate, 36.7% received completion dinners or

award dinners, and 12.3% received some sort of merchandise commemorating project completion.

The results presented in Figure 10 uphold the general trends found by Page [50], Kuczmarski [37], and Feldman [26]. Project-based financial rewards still are seldom used in NPD. Most interesting is that none of the best practice firms use either project-based profits or stock as rewards. The most frequent source of reward for NPD is the completion dinner, where the NPD team goes out for a final meal with the firm picking up the cost. This reward mechanism is the only one which best practice firms use to a statistically significantly higher extent than the rest of the firms. Overall, rewards for NPD are much more likely to be what is referred to as "off W-2 compensation," or compensation which does not increase the employee's reported earnings. Best practice firms do more of all of the forms of off W-2 compensation, but with the exception of completion dinners, the differences are not statistically significant. There is no difference in the reward and recognition patterns between goods producers and service providers.

The final organizational question addressed in this article is the extent to which multi-functional teams are used in NPD. Mercer [46] found that well over two-thirds of their respondents used multi-functional teams for product development, with little difference in use between higher-performing (78%) and lower-performing (66%) firms. On average, the 1995 sample shows slightly lower overall use of multi-functional teams. Only 64.0% of all projects use multi-functional teams. However, best practice firms use multi-functional teams more extensively, at 70.7% of the total projects, than do other firms, which only use them 62.2% of the time (Anova: $F = 5.6$, $p < .05$, $df = 260$). When considered in aggregate, best practice firms do not use multi-functional teams as extensively as previously reported.

Larson and Gobeli [39] found that more complex projects were more successful when project teams were used in development. When multi-functional team use is investigated by project type, the story changes somewhat, as illustrated in Figure 11. Multi-functional team use is much higher for more innovative projects than for less innovative projects. Over 84% of all new-to-the-world, new-to-the-firm and major revisions use multi-functional teams for NPD. For these projects there is no statistical difference in use between best practice firms and the rest of the firms. In Page's 1990 results 76.2% of the companies surveyed used multi-functional teams for their more innovative NPD projects [50]. Thus, multi-functional team use for more innovative projects has increased over the last five years.

Figure 11 also shows that there is less overall multi-functional team use in less innovative projects such as incremental improvement, repositioning, and cost reduction projects. Overall, only about 45% of these projects are completed using multi-functional teams. However, multi-functional team use is statistically higher for best practice firms than for the rest of the firms for each of these project types. Best practice firms use multi-functional teams in the majority of all NPD projects, regardless of level of innovativeness. The rest of the firms are far less likely to use multi-functional teams for less innovative projects.

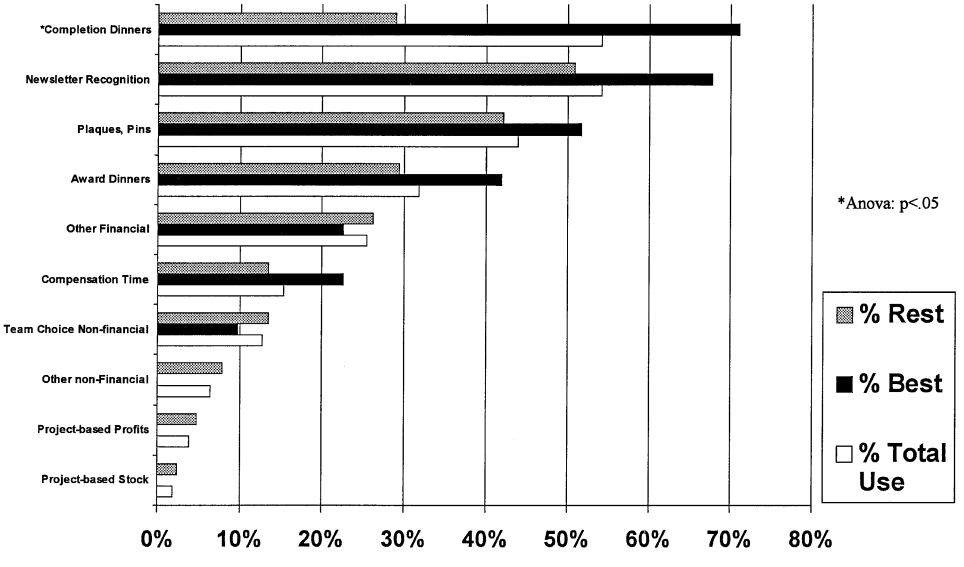


Figure 10. Team Leader and Member Rewards

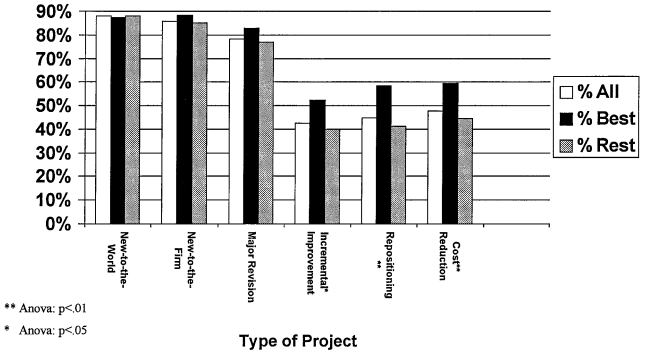


Figure 11. Percentage of Projects Using Multi-Functional Teams

Summary. Organizationally, changes in NPD also are occurring more by evolution than by revolution. However, organizational issues result in far fewer differences in success outcome than do process issues. Best practice firms use multi-functional teams more extensively, especially for less-innovative projects, and provide more completion dinners as rewards for NPD. In addition, there are almost no organizational NPD practice differences between across service and product producing firms. NPD in service firms is less likely to report to SBU leadership or to the engineering function, and is more likely to reside in the marketing function. This research demonstrates that one "best way" to organize NPD has not been found.

Product Development Measurement and Expectations

In some senses, "you are what you measure." Unless a firm measures NPD performance, it cannot determine either how well they are doing, or whether they are improving or declining in NPD performance. One interesting finding from the 1990 PDMA best practices study was that several of the criteria used to measure NPD performance were associated with higher NPD performance [51]. However, not all firms measure NPD performance. BAH claimed that ⅔ of their sample measured product development in 1982 [5]. In 1990, Page found that 76.2% of his respondents developed formal financial objectives against which each NPD project is evaluated. Since then, two other groups have reported slightly lower findings. Southwestern Bell found that only 56% of their respondents measured NPD [24]. Mercer [46] reported that 50% of the higher-performing firms track NPD performance, while only 28% of the lower-performing firms track NPD performance.

In this 1995 sample of firms, 75.6% develop formal financial objectives against which actual performance will be evaluated. While a slightly larger proportion of best practice firms (83.9%) develop formal financial objectives, the difference in proportions across the two groups is not statistically different. However, even though objectives are set, firms do not always go back and evaluate actual performance. Best practice firms only assess performance against objectives in 63.2% of the projects, while the rest of the firms assess performance less than 50% for the time (48.0%), with the difference being statistically significant (Anova: $F = 4.0$, $p < .05$, $df = 149$). On average, when they evaluate projects against objectives, the projects are reviewed about 16 months after initial introduction. There is no difference in this time frame across product type or whether or not the firm is a best practice firm.

Best practice firms are more likely than the rest of the firms to set a target for the portion of revenue growth to come from new product development. Nearly ⅔, 64.7%, of the best practice firms set revenue growth targets, with the average goals of these firms being 45% of sales to come from products commercialized in the last three years. Only 46.5% of the rest of the firms set these targets, with the average goal being to derive 25% of sales from products commercialized in the last four years. Each of these differences is statistically significant ($p < .05$). There are no differences across manufactured goods and services.

Best practice firms also have higher expectations for future NPD performance than the rest of the firms. In the next five years, best practice firms expect 53.5% of their sales and 56% of their profits to come from new products. The rest of the firms only expect 37.6% of their sales and 37.0% of their profits to come from new products over the same time period. These differences are statistically significant ($p < .01$).

The vast majority of firms now measure NPD performance routinely, however, even the best practice firms do not consistently measure it across all projects. Best practices seem to be associated with both higher levels of measurement and higher expectations for NPD performance.

Outcomes from Product Development

As the previous sections have shown, firms have made a number of changes in their product development

programs over the last 15 years. But, have organizations gotten any better at developing new products? This section looks at several aspects of NPD outcomes, compares current results to past results, and compares best performers to the rest of the sample.

The first comparison looks at how NPD success rates have changed. In a summary of research from the 1960s and early 1970s, Crawford found that success rates for consumer goods varied from 58% to 73%, averaging 64% across five studies [17]. Success rates in two studies of industrial goods were slightly higher, ranging from 74% to 80% [17]. Earlier best practices surveys found that around ⅔ of all new goods and services met their original criteria when commercialized. Specifically, in BAH's predominantly industrial product sample, 67% of the projects met them in 1968 [4], and 65% met the original criteria in 1982 [5]. By 1990, the first PDMA study found that only 55% of new products were successful in the US. In a separate study, 54.3% of European products were successful when commercialized, as were 59.8% of Japanese products [23]. Two of the studies published between 1990 and 1995 recorded success rates. In a broad sample of industries, the success rate was found to be 56.5% [37]. However, only 38% of consumer packaged goods were successful [33]. In 1995, the average success rate across the sample is 59%. The average for the Best practice group, however, is 82.7%. Overall, these results suggest that success rates for a broad US industry sample, while they have declined a bit since the early 1980s, have remained in a range between 55% and 60%. Success rates in Europe and Japan are probably comparable, but success rates within the consumer packaged goods industry may be lower. There is no difference in success rate across product type (service or manufactured good).

These success rates have been achieved through commercializing a balance of project types which is only slightly different from the portfolio reported in 1982 [5]. Figure 12 shows that the percentages of both new-to-the-world and new-to-the-firm projects are unchanged over a 13-year period. In recent years, firms undertake fewer repositionings, cost reductions and line extensions, preferring to focus more on improving current product performance. The proportion of projects which are improvements of previously-commercialized goods and services is 35% higher than it was 13 years ago. The cost reduction and repositioning projects are generally considered the least innovative NPD projects. On balance, then, the portfolio of projects seems to be slightly more innovative than the portfolio commercialized 13 years ago, with relatively comparable success rates. There is no difference in the portfolio structure between the Best and the Rest of the firms.

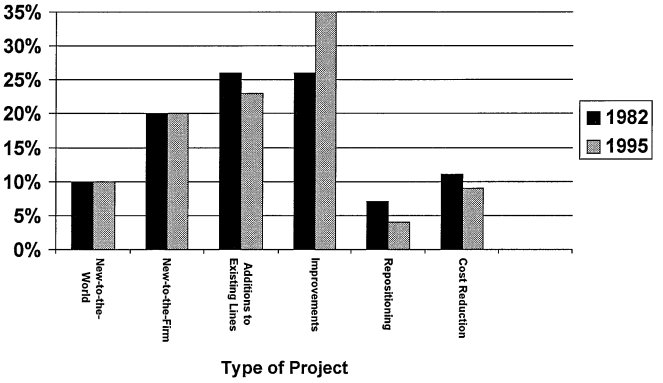


Figure 12. Product Introductions by Project Type

Table 8 presents average values for the four specific items which make up market-financial success for the whole sample and for the Best and the Rest. Also presented are averages by product type, technology base, market served, and annual sales. Average success rates and profit success rates do not vary across any of the partitions (except between the Best and the Rest). Firms experience market success rates ranging from 53% to 61% and profit success rates from 49% to 58%. However, NP sales and profits as a percentage of total do differ by product type, technology base and annual sales. Manufactured goods, high-tech, and smaller firms all have higher NP sales and profits as a percentage of the total. Firms may use these figures to benchmark their own NPD performance on these success measures, given their own competitive situation.

The second NPD outcome comparison presents changes in new product idea mortality curves. The mortality curve represents the progressive rejection of ideas or projects through stages of the new product development process. Figure 13 presents mortality curves by product development project phase for 1968, 1982, 1990, and 1995. BAH started publicizing mortality curves in their 1968 report [4]. At that point in time, 100 ideas lead to only 1.7 commercially successful products. Turned around, it took 58 new product ideas to generate just one successful commercial product. By 1982, it took only seven ideas to generate one successful product, or 100 ideas led to 14.3 commercially successful products [5]. Page [50] found that the mortality curve had eroded a bit in 1990. In his sample, 11 new product ideas were re-

Table 8. Average Success by Demographic Category

	Success Rate[1]	% Profit Success[2]	NP Sales %[3]	NP Profit %[4]
Full Sample	59.0%	54.6%	32.4%	**30.6%**
The Best	**79.8%****	**78.0%****	**49.2%****	**49.2%****
The Rest	**52.5%****	**47.1%****	**25.2%****	**22.0%****
Product Type				
Manufactured Goods	59.6%	55.3%	**34.0%***	**32.4%***
Services	58.2%	52.7%	**24.1%***	**21.7%***
Technology Base				
High-Tech	60.5%	56.5%	**42.3%****	**38.8%****
Mixed	60.0%	55.3%	**28.7%****	**26.9%****
Low-Tech	55.2%	50.3%	**23.7%****	**24.5%****
Market Served				
Consumer Products	58.1%	53.2%	36.2%	32.9%
Mix of Both	60.8%	55.2%	24.9%	23.1%
Business-to-Business	58.6%	54.5%	33.4%	32.0%
Annual Sales				
≤$24 million	62.3%	56.8%	**40.7%****	**37.2%****
$25 to $99 million	60.7%	57.4%	**33.2%****	**35.2%****
$100 to $499 million	60.9%	56.0%	**28.6%****	**27.6%****
≥$500 million	53.0%	48.9%	**23.7%****	**18.8%****

[1] Success Rate: % of products commercialized in the last 5 years categorized as successes.
[2] % Profit Success: % of products commercialized in the last 5 years categorized as financial successes.
[3] NP Sales %: $ sales of products commercialized in the last 5 years as a % of total sales.
[4] NP Profit %: $ profits from products commercialized in the last 5 years as a % of total profits.
** Anova test: $p < .01$.
* Anova test: $p < .05$.

quired to generate one success (100 ideas lead to 9.4 successes). The 1995 sample shows a slight improvement over BAH's 1982 results—100 ideas leads to 15.2 successes (one success for every 6.6 ideas). However, the important difference between 1982 and 1995 is in the shape of the curve. While the 1982 mortality curve declines slowly in the beginning, with the largest number of projects weeded out in the development stage, current practices weed out the largest number of projects in idea screening, with the second largest number eliminated in business analysis. In other words, while the same number of ideas are creating one success, projects are eliminated much earlier in the NPD process, where less time and money has been spent on any particular idea [4,50,54]. Today's portfolios of NPD projects are wasting less money on unsuccessful projects. This is a clear improvement in outcomes over previous reports.

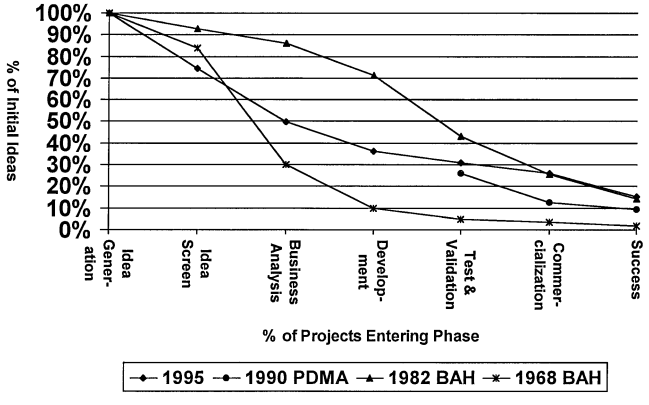


Figure 13. New Product Idea Mortality Curve

Best practice firms are more efficient, according to mortality curve analysis, than the rest of the sample, as Figure 14 illustrates. At each stage of the NPD process, it takes statistically fewer projects to create one commercial success than for the rest of the firms. For best practice firms, the vast majority of projects are eliminated from the process prior to entering the development stage. For every three projects which enter development in best practice firms, two go on to become commercial successes. Development is the stage where large NPD expenses first accrue [54]. While best practice mortality curves differ from the rest of the sample, there are no differences in mortality curves between services and manufactured goods.

Faster product development has become a goal of many firms [1,24], with many firms reporting decreases in the NPD cycle time of specific products or projects. Research in expected development times in

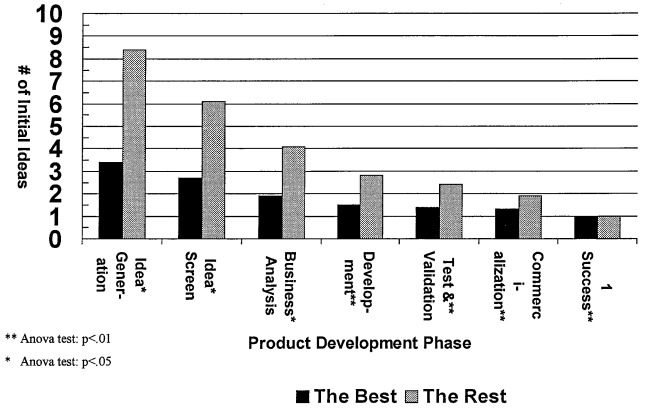


Figure 14. Mortality Curves: The Best versus The Rest

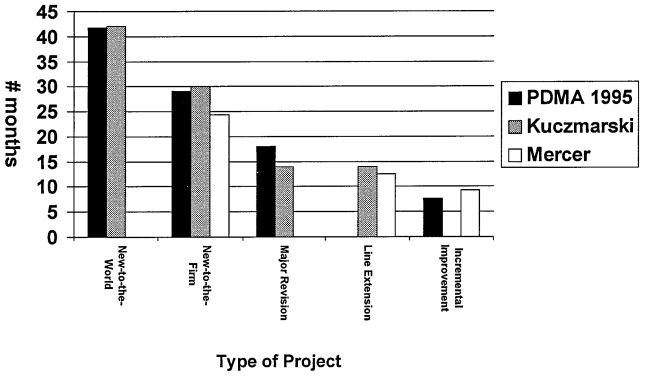


Figure 15. NPD Cycle Time by Project Type

the German mechanical engineering industry has estimated that managers could expect to eliminate somewhere between 30% and 40% of current development times through a concerted reduction effort [48]. In the PRTM survey, firms had actually reduced time to market by 9.5%, on average, between 1992 and 1994 [52]. Across 21 projects reporting specific time reductions in the business press between 1988 and 1992, the average time reduction was 48% [28]. However, this is not a random sample of projects. Because these projects were specifically chosen for reporting due to management's ability to reduce NPD cycle time, one might expect that these projects could have larger reductions than the average project. Page [50] found that firms' "more innovative projects" took 35.5 months to complete in 1990 (3 years). On average, the 1995 sample is developing their "more innovative projects" in 23.8 months (2 years), nearly a one-third decrease in reported development time. This amount of cycle time reduction, while lower than the sample reported in [28], falls in the expected range from [48]. NPD cycle time does seem to be getting shorter for "more innovative projects."

Previous research has not found that NPD cycle time and success are correlated [29]. Interestingly, the Best firms in this sample do not differ from the Rest, in terms of cycle time, supporting the earlier finding. They are neither faster nor slower. Service firms are four months faster than goods-developing firms, on average, but this difference is not statistically significant.

NPD cycle times correlate with the newness of the project [28,29]. Two separate studies, in addition to this research, have investigated recent average reported cycle times by project type [37,46]. Figure 15 suggests that developing new-to-the-world goods and services requires somewhere on the order of 3½ years, new-to-the-firm projects require between 2 and 2½ years, major revisions to existing products take 1 to 1½ years, line extensions require about a year, and incremental improvements are generally completed in ⅔ of a year. It is unclear as to whether the "more innovative projects" are considered new-to-the-firm, new-to-the-world, or somewhere in between, in terms of newness. In terms of the 1995 sample, the reported overall cycle times are most comparable to new-to-the-firm projects which are not new-to-the-world.

Although there are no differences in cycle time in the PDMA sample between the Best and the Rest, as Figure 16 shows, manufactured goods always take longer to develop than services across different types of projects. Service development requires about half the development time of goods, but only for major revisions is this difference statistically significant.

Nearly 41% of 1990 respondents claimed that their firms were developing products more quickly than 5 years ago [50]. A higher percentage of firms indicated that they had taken time out of the NPD development

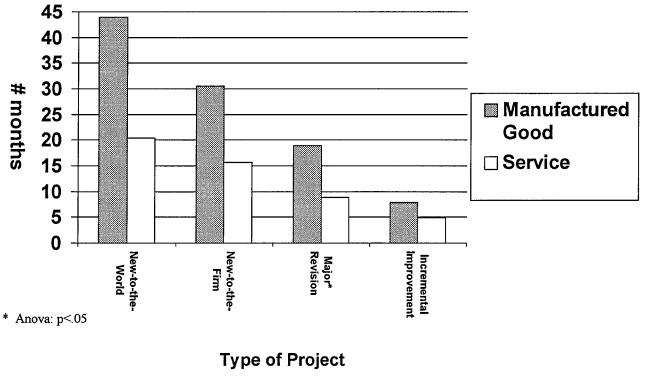


Figure 16. NPD Cycle Time: Manufactured Goods and Services

cycle over the last 5 years than was reported in 1990. Over 60% of all firms report that they have shortened cycle times for incremental improvements, major revisions, and new-to-the-firm projects. Over 50% of the firms reported decreasing cycle time for new-to-the-world projects. While this focus on shortening cycle time is independent of whether the firm produces manufactured goods or services, statistically higher percentages of the Best firms report shortening cycle times for new-to-the-firm and new-to-the-world projects over the last five years. Over ¾ of the Best firms report shortening cycle times for these newer types of projects. The Best also report taking statistically higher amounts of time out of the cycle for new-to-the-world projects. They claim to have shortened this development cycle by nearly 29%, nearly three times the 10% decrease claimed by the Rest of the firms (χ^2: $F = 8.0$, $p < .01$, $df = 125$). On average, development cycles have declined by between 15% and 20% across the population, with the cycles of the Best firms declining around 25%. Even though the Best firms claim to have eliminated more of the development cycle, their development times are no lower than those found in the rest of the population. Either these two sets of findings conflict, or the Best firms started the period with slightly longer development cycles than the rest of the population.

Summary. Although overall NPD success rates have not increased, firms appear to be more efficient in weeding out less probable projects earlier in the process and developing products in less time. The portfolios of projects commercialized consist of a slightly higher proportion of moderately-innovative projects, and fewer less-innovative projects.

Discussion

NPD Trends

Overall, the trends in NPD over the last 15–20 years have been more evolutionary than revolutionary. Perhaps because NPD is so complex, involving so many people across so many functions in the corporation, change comes, but comes slowly. A firm with static NPD processes, policies and methods will find themselves falling behind. However, not even the Best firms have radically changed the face of product development, or its outcomes.

NPD process use has moved from functional and sequential approaches to multi-functional approaches, with formal stages and gates for moving from one stage to the next. Even so, the percentage of firms following no process, or just using an informal process is still astoundingly high, at 38.5% of the total sample. However, this figure is down from Page's findings that only 45.5% of firms had and followed a formal NPD process. Each year, another 3.2% of firms implement a formal NPD process. Using a formal process for controlling NPD is only slowly moving into firms, even though previous research has demonstrated that formal NPD processes improve the probability of product development success [10].

In the early 1980s, BAH recommended that NPD programs be strategy-driven, and that each NPD project start with a strategy-setting step. Although no one since 1982 has found strategy use to be as high as BAH reported in their sample, strategy is becoming a more integral aspect of NPD. More NPD programs are specifically linked to business strategy, and more projects begin with a strategy-setting step. However, because nearly ⅓ of the firms in this sample still develop products unlinked to strategy, this is still an area with further improvement opportunities.

The number of organizations in a firm responsible for NPD are increasing, with a larger number of options available for where NPD reports within the firm. In general, the conclusion is that organizing for product development is becoming more complex. The BAH studies [4,5] have always reported that NPD reported to multiple parts of the organization. Page [50] found that firms organized for NPD using 1.9 structures. On average, this has moved to 2.0 structures in the last five years, although service producers use fewer structures (1.7). No one organizational form for NPD has been the trend toward which the bulk of firms are moving. How "best" to organize NPD is not clear.

Each of five possible organizational structures is used by at least 30% of the sample. Venture groups are the only structure investigated which are seldom used by firms to manage more innovative NPD projects. The most-used reporting structure for more innovative NPD projects is within the functional organization. The extensive use of this structure for these projects is at odds with the capabilities of the structure, which has been suggested as being most appropriate only for projects where little or no innovation is required [54]. This suggests that functional silos are still strong in US

firms. While the largest number of firms use the functional structure, the most frequently-preferred of the structures is to have NPD report into the SBU. This reporting structure is most appropriate for evolutionary product improvement, not for radical innovation. However, perhaps this structure matches organizational needs the majority of the time, since 71.8% of the products commercialized by these firms in the last five years consisted of changes and improvements to current products (48.7% of the total) or additions to existing products lines (23.1%).

Project managers were recommended in the mid-1980s as the most appropriate leadership structure for NPD [9]. The vast majority of firms have taken this advice and implemented their use extensively. New leadership modes are moving only slowly into experimental use. Empowerment may have been espoused by many firms over the last few years, but its application is not particularly evident yet in NPD. Team leaders are not selected by the team or by peers. They come from management, either upper management, or functional management.

Although multi-functional NPD teams are becoming endemic, firms have not grappled adequately with team-based rewards. Multi-functional teams have now been instituted broadly for developing new products. How best to reward joint efforts is a primarily unanswered question. Current practice has trended to "off W-2" rewards. More sophisticated rewards are not used to any material extent. There are no major trends moving toward more sophisticated reward structures.

As a result of these evolutionary process and organizational changes, NPD is slightly more efficient and somewhat faster, even though overall success rates are unchanged, or even slightly lower than 13 years ago. Product portfolios consist of a higher proportion of moderately-innovative projects, and fewer less-innovative projects, but the same proportion of highly-innovative projects. Perhaps increased success will come only by focusing on projects which are newer and more innovative?

In summary, the trends in NPD are evolutionary. Firms cannot allow their NPD practices to stagnate because their competitors do not. If they do not put into place a mentality of and process for continual change, they could, slowly but unceasingly, be left behind competitively. Additional understanding of the impact of organizational structures, project leadership and rewards on NPD might help firms manage these areas better.

Differences Between the Best and the Rest

Many different means could be used to differentiate higher versus lower NPD performance. Some investigations have split their sample at an overall performance mean [37,38,47]. Others have compared the top third to the bottom third, eliminating the middle third completely from the analysis [46]. Still others have used regression to determine performance differentiators [51]. While powerful, regressions only allow the analysis of continuous variables.

The technique used to sort the Best NPD firms from the Rest in this research is rather stringent and allows the analysis of discontinuous variables. It requires that the Best firms be better than other firms along each of three separate dimensions of NPD performance, not just one. This dividing process created groups of unequal sizes. The Best is only 22% of the total population. Many of the firms included in the Rest perform well in one or two of the dividing criteria. A number of them are quite good at NPD. However, each of the Rest falls below the mean on at least one performance criteria, or is not in the top third of their industry for NPD performance.

Many, but not all, of the practices the Best use differ statistically from the practices of the Rest. It seems that the Best do not succeed by using just one NPD practice more extensively, or better, but by using a number of them more effectively simultaneously. This seems key to differentiating between Best practice firms and the Rest. Further research on these data will try to identify the important simultaneous sets of practices which lead to increased success.

A consistent finding in other studies is that process differentiates across NPD success [4,5,46]. The Best are more likely to have NPD processes and strategies, start the NPD process with a strategy, and include any particular step in their NPD process. As previously found [5], they are more likely to have used their process longer than lower performing firms. Their NPD process also has more steps than the process used by the Rest. However, process use can be thought of as a necessary, but not sufficient, condition to produce high NPD performance. A significant number of firms still do not consistently use a formal process, even though they have been demonstrated to lead to higher NPD success [10]. Interestingly, the difference in use extent is higher across manufactured good and service differentiations than across higher versus lower performance differentiations.

Far fewer organizational differences are found be-

tween Best practice firms and the Rest. The way in which NPD reports into the management structure of the firm is independent of whether the firm is a best practice firm or not. While best practice firms are more likely to have NPD report into the SBU and less likely to have them report to a functional group, these differences are not statistically significant. There does not seem to be one best way to organize NPD in the firm. Leadership and leader selection also do not differ between Best practice and the Rest.

Only two organizational differences were found between Best practice firms and the Rest. The Best firms use more rewards which are unrelated to compensation for teams (called "off W-2" rewards in the US), especially providing a much higher incidence of project completion dinners or lunches. Best practice firms also use multi-functional teams more extensively for less-innovative projects.

Best practice firms measure more and expect more out of their NPD programs than their less successful counterparts. This may be one of the reasons they achieve higher performance. Interestingly, the Best do not achieve higher performance in every dimension of NPD outcomes. Best practice firms do not develop new products faster than other firms, supporting earlier evidence that success and NPD speed were uncorrelated [29]. Their focus appears to be on achieving success over achieving speed. You do not necessarily have to be fastest to be highly successful in NPD. As others have suggested, there are hidden costs associated with highly accelerated NPD, which can have serious deleterious effects [20]. On the other hand, because these firms have claimed to eliminate a higher percentage of their NPD cycle over the last five years, Best practice firms feel they cannot be slow and still successful. Apparently, firms walk a knife edge between taking the time to do NPD right and being too slow because they are trying to take the time to do things right [20].

Kuczmarski found that more successful firms at NPD in their survey had product development portfolios which focused more on more innovative projects. This research does not support that finding. Best practice firms are not likely to have any higher proportions of new-to-the-world or new-to-the-firm projects than the Rest of the firms. Best practice firms have a higher proportion of moderately-innovative projects, and fewer less-innovative project, but no difference in the highly-innovative projects.

The Best NPD firms appear to focus on improving performance not in just one aspect of NPD, but on simultaneously improving several managerial aspects of NPD. No one managerial dimension is enough to produce success in NPD.

Differences Between Service and Goods Producers

In some very important ways, NPD is the same independent of whether services or manufactured goods are being developed. Strategies always matter, both overall for the program and for each project as it is initiated. Leaders are still generally project managers appointed by management or the functional area. Multi-functional teams are still used, and important in differentiating between NPD success. Finally, determining appropriate rewards is no less difficult for services than for goods.

However, services differ from manufactured goods in several unique ways [21,55,56]. Services cannot inventory their output. Service is a highly perishable good. If it is not used as available in time, it disappears. In services, manufacturing takes place in real time (as the service is consumed) and, most frequently, the service user is a participant in the manufacturing process. Finally, some aspects of services are intangible, where the benefits to the consumer are not always obvious. These differences affect three aspects of NPD for services as compared to NPD for physical goods. NPD processes, organizational structures, and cycle time differ across developing physical goods and services.

Research on differentiators between success and failures in service NPD has concluded that having a market-driven new product process was the dominant ingredient for achieving new service success [14]. It has also demonstrated that service processes which more completely defined the strategy or charter [18] for projects and which more completely tested services prior to commercialization were correlated with higher success [21]. However, this research also found that few companies used a formal new service development process. This result is replicated here. A statistically lower percentage of service producers use processes for NPD. The majority still either have no process at all, or use an informal process, reproducing earlier results [21].

In general, service processes are simpler than those used to develop manufactured goods, even for the Best service firms. When a process is used in new service development, it consists of fewer steps than those for

manufactured goods. "Manufacturing development" is almost universally not included in the service NPD process, probably due to the inherent nature of service delivery. However, service processes are nearly two steps less than the average goods-developing process. A step in addition to manufacturing development is not used. Which specific step is eliminated depends upon the firm, however, the relative focus in the service process seems to be more on steps in the front end of the process than the later stages. Both service and manufactured goods processes are most likely to include a development step. However, concept generation is the next most frequently included step for service development processes, whereas it is the next to least frequently used step in manufactured goods processes. The relative rank orders of the upfront (pre-development) stages in service processes are lower than the rank orders for the same stages in manufactured goods processes.

Organizationally, NPD in service firms is less likely to reside at the SBU level. Alternatively, they are more likely to report to the marketing function. It is unclear whether these reporting structures result because service firms are less likely to be organized into SBU structures, or whether NPD reporting is different and the overall proportion of firms organized into SBU's is similar to what is found in goods.

The final area of difference is in NPD cycle time. In general, services take about half the time of manufactured goods to develop, for any given level of product innovation. In other aspects of NPD outcomes, there are no differences between service and manufactured good development, but cycle time for services is shorter.

NPD is different in the service world. Unfortunately, most NPD research has been focused more on understanding the needs of and establishing methods for manufactured goods producers [55]. Most of the NPD processes and methods developed have been targeted to goods-producing firms [11,16]. Perhaps because NPD processes have been targeted more at manufactured goods producers than at service firms, fewer service firms use them. Service firms, even highly successful ones at NPD, are able to use less complex processes with fewer steps and develop services faster. More research on the NPD needs of service firms should be done, and practices specific to meeting those needs should be developed, starting with better delineations of best practice processes and organizational structures for service development.

Limitations and Future Research

Several limitations to this research should be kept in mind when applying the results, either to what a firm might want to change to improve NPD performance, or to future research in NPD best practices. First, the response rate was very low, even for survey research. While low response rates were expected with the non-PDMA sample, we hoped that a much higher percentage of PDMA members would respond. Page [50,51] obtained a 27.6% response rate from PDMA member firms in the 1990 survey, which, however, was shorter and traditional in style.

This low rate probably is attributable to several specific actions which were purposefully taken in the research. The survey was long, and parts were complex, requiring more effort and thought than just circling pre-typed numbers or responses. In addition, some types of questions were non-traditional in style. Although the managers in the pre-test did not find the survey difficult to do, it required more effort than the typical survey a manager receives. Respondents did not receive any incentive, other than the opportunity to receive a working paper upon completion, for filling out the survey. Respondent addresses or business cards were received from well over half of the respondents, suggesting that there was a high level of interest in this research by those who responded. Finally, respondents paid the postage to return the surveys.

One lesson from this survey seems to be that long and complex surveys will lower response rates, even if the sample is interested in the results. In the future, then, NPD research may have to be broken into smaller increments. While this survey tried to understand everything about NPD practices in one large instrument, it may be more appropriate to split the research into different parts. Each year a smaller survey, focused on just one or a few aspects of NPD practices, could be mailed out. Across the series, which is sent out over a five-year period, the entirety of NPD aspects could be covered.

In applying these results, then, managers must realize that the respondent firms are most likely different from non-respondent firms, but in an unknown way. Demographic data of the sort gathered and reported on here are not available for any of the three mailing lists used. It is likely, however, that the respondents to this survey are more interested in NPD than the non-respondents. The firms who are least interested in NPD are those who are least likely to have responded. Thus, even the practices of "the Rest" in this sample

may be more sophisticated than the average firm in the overall population.

A second limitation is that the sample is a US sample. PDMA firms are predominantly US-based. Because this research was performed to serve the needs of our members, and due to funding limitations, mailings were made only to US firms. Because management practices, cultures and norms differ around the world, these findings are likely to be less applicable to firms managing NPD outside the US [1]. Differences in NPD Best practices around the world, although expensive to determine, would be a fascinating piece of future research.

This study found fewer differences between NPD practices for manufactured goods and services than it did across the Best and the Rest. One possible reason is that research in improving NPD has predominantly focused on goods-producing firms rather than on the special needs of service firms, which are different from those of goods manufacturers [21]. For example, test markets in service firms are used primarily to ensure the proper functioning of the service rather than to provide a base for a national sales projection [22]. Several factors have been found which statistically significantly impact new service success, in addition to those factors which impact manufactured goods success [13]. Thus, the questions in this survey may not have captured the unique characteristics and aspects of NPD for services which are truly different from those for manufactured goods. A separate study of Best practices for services is another area of future research which could hold great potential.

Additional papers from these data have been published and are in progress. A larger analysis of data from the PDMA sample was published as Chapter 33 of the *PDMA Handbook of New Product Development* [36]. Papers on product development champions [41] and organizing for NPD [42] are underway. Additional papers looking at NPD tools and determinants of NPD success across processes, organizations, and tools are planned. These will be available from the PDMA office as they are produced.

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Appendix
Strategy, Process, and Organization Questions

I. The Process by Which Products Are Developed Internally

Please answer questions as they apply to the more innovative types of new products or services your organization develops. These include such things as new applications, major product changes, new products and product lines, and new-to-the-world products. Please do not include product repositionings, brand or product line extensions and incremental product improvements.

1. Does your organization have a specific strategy for its new product activities which directs and integrates the entire new product program?

   Yes ❑ No ❑

2. a. Does your organization tend to follow a well-defined, structured process for the development of most or all of your more innovative new products?

   Yes ❑ No ❑ (If no, skip to question 4)

   b. Approximately how many years has your organization been following a formal product development process?

   __years

3. Please check the box which most closely describes your firm's product development process:

❑ No standard approach to new product development.

❑ While no formally documented process is followed, we have a clearly understood path of the tasks to be completed in product development.

❑ We have a formally-documented process where one function completes a set of tasks, then passes the results on to the next function which completes another set of tasks.

❑ We have a formally-documented process where a cross-functional team completes a set of tasks, management reviews the result and gives the go-ahead for the team to complete the next set of cross-functional tasks.

❑ We have a formally-documented process where a facilitating "process owner" helps cross-functional teams move through stages and management reviews.

❑ We have a formally-documented process where cross-functional team uses a staged process with overlapping, fluid stages and "fuzzy" or conditional stage decisions.

❑ Other (Please describe):

4. Many new product ideas never reach commercialization. What percentage of your organization's *total* new product ideas/concepts (100%) reach each stage of the development process below, whether you use this process formally or not?

Idea/Concept Generation	Idea Screening	Business Analysis	Development	Test and Validation	Commercialization
100%	__%	__%	__%	__%	__%

5. The development of a new product is often described as a series of interdependent and possibly overlapping stages. Below are descriptions of several development activities.

   a. Please place an "X" in the first column if your organization's formal product development process includes this activity for the more innovative projects.

   b. Please estimate the % of the more innovative projects commercialized by your organization in which each of the listed tasks was completed prior to commercialization.

   c. Please indicate the typical length of time (in weeks) spent on each activity.

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	Process Includes	% of projects Completing	# of Weeks Spent
Product Line Planning: Analyze the firm's current portfolio vis-a-vis the competitive arena.	❑	__%	__ weeks
Project Strategy Development: Delineate the target market, determine market need, attractiveness.	❑	__%	__ weeks
Idea/Concept Generation: Identify opportunities and initial generation of possible solutions.	❑	__%	__ weeks
Idea Screening: Sort and rank solutions, eliminate unsuitable and unattractive options.	❑	__%	__ weeks
Business Analysis: Evaluate the concept financially, write business case, prepare protocol/development contract.	❑	__%	__ weeks
Development: Convert concept into a working product.	❑	__%	__ weeks
Test and Validation: Product use, field, market and regulatory testing with customers.	❑	__%	__ weeks
Manufacturing Development: Developing and piloting the manufacturing processes.	❑	__%	__ weeks
Commercialization: Launching the new product or service into full scale production and sales.	❑	__%	__ weeks
Other: Any other activity included in your firm's formal product development process. (Please specify)	❑	__%	__ weeks

II. Organizing for Product Development

1. Which of the following best describes the way the new product effort is structured in your organization? (Please ✓ all structures used for your firm's more innovative projects.)

❑ New product department with permanent staff members.

❑ Distinct division or venture group.

❑ A new product committee oversees all development efforts.

❑ Each business unit's general manager directs their own NPD efforts.

❑ A single function is responsible for NPD: (Which function?)

❑ R&D
❑ planning
❑ engineering
❑ marketing

❑ A product development process owner helps deploy our process across the firm.

❑ Other (Please specify.)

2. Which of the following best describes how the more innovative projects are led at your firm and how those leaders are obtained? (Please check all that apply.)

Who leads	How the leader is obtained
❑ Project champions	❑ Management appoints the leader
❑ Process owners	❑ A person volunteers
❑ Project managers	❑ Team members choose the leader
❑ No one	❑ Peers choose the leader
❑ Other __	❑ Other

3. What % of each of the following types of projects use multifunctional teams?

__% New-to-the-world products
__% Major revision of current product
__% Product repositioning
__% New-to-your-organization products
__% Incremental improvement
__% Cost Reduction

4. What product development-based incentives and rewards are provided for team leaders and team members? Please check all that are used, and estimate the degree to which each type of reward is used for team leaders and members. (Please check and fill out all that apply.)

	Team Leader					Team Member				
Used	Never	¼ the Time	½ the Time	¾ the Time	Virtually Always	Never	¼ the Time	½ the Time	¾ the Time	Virtually Always
❑ Project-based profit-sharing	1	2	3	4	5	1	2	3	4	5
❑ Project-based stock or stock options	1	2	3	4	5	1	2	3	4	5
❑ Compensation time	1	2	3	4	5	1	2	3	4	5
❑ Recognition in organization newsletters	1	2	3	4	5	1	2	3	4	5
❑ Recognition at award dinners	1	2	3	4	5	1	2	3	4	5
❑ Plaques, pins, project photographs	1	2	3	4	5	1	2	3	4	5
❑ Project completion celebration lunches, dinners	1	2	3	4	5	1	2	3	4	5
❑ Non-financial rewards chosen by the team (eg, trips, family dinners)	1	2	3	4	5	1	2	3	4	5
❑ Other financial rewards (specify) __	1	2	3	4	5	1	2	3	4	5
❑ Other non-financial rewards (specify) __	1	2	3	4	5	1	2	3	4	5