The Effects of Project Novelty on the New Product Development Process

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Abstract

In this paper we review the range of formal tools and techniques available to support the new product development process, and examine the use and usefulness of these by means of a survey of 50 projects in 25 firms. We adopt a four stage model to examine the process of new product development: idea generation; screening and selection; development; commercialisation and review, and identify the effect of project novelty on the frequency of use and perceived usefulness of a range of tools and methods. In terms of usefulness, focus groups, partnering customers and lead users and prototyping are all considered to be more effective for high novelty projects, and segmentation least useful. Cross functional development teams are commonplace for all types of project, but are significantly more effective for the high novelty cases. In addition, many tools rated as useful are not commonly used, and conversely some tools in common use are considered to have low levels of usefulness.

1. Factors affecting the new product development process

Firms that are consistently successful in the development of new products and services are likely to be rewarded by higher margins, increased market share and superior financial performance (Tidd, 2000). However, although central to growth and prosperity, new product programmes are plagued by high failure rates and disappointing results. New product development is perceived as a high-risk activity due to the high cost and inherent
technical and commercial risks. For example, research suggests that the overall success rate of new product introductions is less than 60%, and is declining as the cost and risk of developing new products has increased; some 46% of all resources given to product development and commercialisation is spent on products that are cancelled or fail to yield adequate financial return (Page, 1993).

There have been numerous studies that have investigated the factors affecting the success of new products (Rothwell, 1977; Booz Allen & Hamilton, 1982; Cooper and Kleinschmidt, 1987; Johne and Snelson, 1990). These studies have differed in emphasis and sometimes contradicted each other, but given the differences in timing, samples and methodologies it is possible to identify some consensus (Tidd et al, 2001):

- **Product advantage** - product superiority in the eyes of the customer, real differential advantage, high performance-to-cost ratio, delivering unique benefits to users - appears to be the primary factor separating winners and losers. Customer perception is the key;

- **Market knowledge** - the homework is vital: better predevelopment preparation including initial screening, preliminary market assessment, preliminary technical appraisal, detailed market studies and business/financial analysis. Customer and user needs assessment and understanding is critical. Competitive analysis is also an important part of the market analysis;

- **Clear product definition** - this includes: defining target markets, clear concept definition and benefits to be delivered, clear positioning strategy, a list of product requirements, features and attributes or use of a priority criteria list agreed before development begins;

- **Risk assessment** - market-based, technological, manufacturing and design sources of risk to the development project must be assessed, and plans made to address them. Risk assessments must be built into the business and feasibility studies so they are appropriately addressed with respect to the market and the firms’ capabilities;
• **Project organisation** - the use of cross-functional, multidisciplinary teams carrying responsibility for the project from beginning to end;

• **Project resources** - sufficient financial and material resources and human skills must be available; the firm must possess the management and technological skills to design and develop the new product.

• **Proficiency of execution** - quality of technological and production activities, and all pre-commercialisation business analyses and test marketing; detailed market studies underpin new product success;

• **Top management support** - from concept through to launch. Management must be able to create an atmosphere of trust, coordination and control; key individuals or champions often play a critical role during the innovation process.

These factors have all been found to contribute to new product success, and should therefore form the basis of any formal process for new product development. However, it is less clear which specific tools are most appropriate to support the development process. There are number of reasons for this. Firstly, the gap between managers’ perceptions of, and the reality of, criteria for successful innovation (Cooper and Kleinschmidt, 1993). For example, one study found that only 7% were aware of the main findings of research, and only half of these had attempted to apply the results of the research (Barclay, 1992). Secondly, the widespread lack of formal predevelopment activities based on such criteria (Murphy and Kumar, 1997). Thirdly, that the new product development processes used by firms have changed very little although the business environment has changed significantly (Wind and Mahajan, 1997). In this paper we examine the use and usefulness of various tools and techniques which can be used to support the process of new product development, and identify differences in use and usefulness between routine and non-routine projects.

2. **Models of the new product development process**
The development process is inherently a complex and iterative process, and this makes it difficult to model for practical purposes. There are numerous models in the literature, incorporating various stages ranging from three to thirteen. Page (1993) suggests an intermediate stage model:

1. Concept search - including brainstorming and other creativity-stimulating techniques, preliminary discussions about the product’s design, and identifying new product opportunities;
2. Concept screening - techniques used to eliminate unsuitable concepts;
3. Concept testing - preliminary market research to determine market need, niche and attractiveness;
4. Business analysis - an evaluation of the product concept in financial terms as a business proposition;
5. Product development - technical work to convert a concept into a working product;
6. Product use testing, field testing and market testing - offering the product to a pre-selected group of potential buyers to determine its suitability and marketability;
7. Commercialisation - launching the new product into full-scale production and sales.

The majority of the models do not include what is in fact one of the most crucial stages in the development process, and that is the review of the success of the project and product. After-sales service and support are also part of the product but are not usually addressed as part of the product development process. Moreover, such models are essentially linear and unidirectional, beginning with concept development and ending with commercialisation. The limitations of such linear models are well-documented, principally because they fail to acknowledge the importance of feedback loops and the iterative nature of product development (Tidd et al, 2001). However, for the purpose of simplicity and ease of analysis we adopt a four-stage model that we believe is sufficient to discriminate between the various factors which must be managed at different stages:
1. concept generation;
2. project selection;
3. product development;
4. product commercialisation and review.

2.1 Concept generation

Much of the marketing and product development literatures concentrate on monitoring market trends and customer needs to identify new product concepts. However, there is a well-established debate in the literature about the relative merits of ‘market pull’ versus ‘technology push’ strategies for new product development. A review of the relevant research suggests that the best strategy to adopt is dependent on the relative novelty of the new product. For incremental adaptations or product line extensions, ‘market pull’ is likely to be the preferred route, as customers are familiar with the product type and will be able to express preferences easily. However, there are many ‘needs’ that the customer may be unaware of, or unable to articulate, and in these cases the balance shifts to a ‘technology push’ strategy. Nevertheless, in most cases customers do not buy a technology, they buy products for the benefits that they can receive from them (Wind and Mahajan, 1997); the ‘technology push’ must provide a solution for their needs. Thus some customer or market analysis is also important for more novel technological (Bacon et al, 1994). A number of tools are available to help systematically identify new product concepts, and these are described below.

Most studies have highlighted the importance of understanding users’ needs (Cooper and Kleinschmidt, 1993). Designing a product to satisfy a perceived need has been shown to be an important discriminator of commercial success (Ortt and Schoormans, 1993). Approaches include:

* **Surveys and focus groups** – where a similar product exists surveys of customers’
preferences can be a reliable guide to development. Focus groups allow developers to explore the likely response to more novel products where a clear target segment exists (Mahajan and Wind, 1992).

- **Latent needs analysis** - are designed to uncover the unarticulated requirements of customers by means of their responses to symbols, concepts and forms (Dimancescu and Dwenger, 1995).

- **Lead-users** – are representative of the needs of the market, but some time ahead of the majority, and so represent future needs. Lead users are one of the most important sources of market knowledge for product improvements (von Hippel, 1982).

- **Customer-developers** - in some cases new products are partly or completely developed by customers (Murphy and Kumar, 1997). In such cases the issue is how to identify and acquire such products.

- **Competitive analysis** – of competing products, by reverse engineering or benchmarking features of competing products (Watson, 1993).

- **Industry experts or consultants** - who have a wide range of experience of different users needs. The danger is that they may have become too immersed in the users world to have the breadth of vision required to assess and evaluate the potential of the innovation (Leonard-Barton, 1995). The use of ‘proxy experts’ to help overcome the problem. They suggest selecting a specific group of respondents who have knowledge of the product category or usage context (Ortt and Schoormans, 1993).

- **Extrapolating trends** – in technology, markets and society to guess the short to medium term future needs.

- **Building Scenarios** – alternative visions of the future based on varying assumptions to create robust product strategies. Most relevant to long-term projects and product portfolio development.

- **Market experimentation** – testing market response with real products, but able to adapt or withdraw rapidly. Only practical where development costs are low, lead-times short and customers tolerant of product under performance or failure. Sometimes referred to as ‘expeditionary marketing’ (Hamel and Prahalad, 1994), or
more modestly ‘test marketing’.

2.2 Project selection

This stage includes the screening and selection of product concepts prior to subsequent progress through to the development phase. Two costs of failing to select the ‘best’ project set are: the actual cost of resources spent on poor projects; and the opportunity costs of marginal projects which may have succeeded with additional resources (Martino, 1995).

There are two levels of filtering. The first is the aggregate product plan, in which the new product development portfolio is determined. The aggregate product plan attempts to integrate the various potential projects to ensure the collective set of development projects will meet the goals and objectives of the firm, and help to build the capabilities needed (Clark and Fujimoto, 1991; Clark and Wheelwright, 1992). The first step is to ensure resources are applied to the appropriate types and mix of projects. The second step is to develop a capacity plan to balance resource and demand. The final step is to analyse the effect of the proposed projects on capabilities, to ensure this is built up to meet future demands.

The second lower level filters are concerned with specific product concepts. The two most common processes at this level are the development funnel and the stage-gate system. The development funnel is a means to identify, screen, review and converge development projects as they move from idea to commercialisation. It provides a framework in which to review alternatives based on a series of explicit criteria for decision-making. Similarly, the stage-gate system provides a formal framework for filtering projects based on explicit criteria. The main difference is that where the development funnel assumes resource constraints, the stage-gate system does not.
A range of criteria are used to screen projects prior to development. An early study found financial criteria to be the most common, the most widely used being Net Present Value/Internal Rate of Return having the highest usage (74%), followed by cost-benefit (62%) and payback period (58%) (Liberatore and Titus, 1983). A more recent study confirmed that 76% of companies used financial criteria (Page, 1993). However, most firms use a range of additional criteria:

- **Ranking** - a means of ordering a list of candidate projects in relative value or worthiness of support, broken down into several factors, so both objective and judgmental data can be assessed. These techniques are likely to be of most use in the early stages of the process, since they are fairly ‘rough-cut’ methods.
- **Profiles** - projects are given scores on each of several characteristics, and are rejected if they fail to meet some pre-determined threshold. The projects which dominate on all or most of the factor scores are selected. These methods can be used at all stages of the development process.
- **Simulated outcomes** - alternative outcomes to which probabilities can be attached, or alternate paths depending on chance outcomes and when the projects have different payoffs for different outcomes. The range of possible outcomes and the likelihood of a specific outcome is found. It is used especially in the analysis of sets of projects which are interdependent (the aggregate project plan).
- **Strategic clusters** - projects not selected solely for maximisation of some financial measure, but for the support they give to the strategic position. Groups are clustered according to their support for specific objectives, and then these groups are rated according to strategic importance and funded accordingly (again, this is important at the aggregate project plan level).
- **Interactive** - an iterative process between the R&D Director and project managers, where project proposals are improved at each stage to more closely align with the objectives. The aim of this is to develop projects that more nearly fit the strategic and tactical objectives of the firm. These methods are used mainly at the aggregate project
plan level, or at the early stages of specific projects.

2.3 Product development

This stage includes all the activities necessary to take the chosen concept and deliver a product for commercialisation. It is at the working level, where the product is actually developed and produced, that the individual R&D staff, designers, engineers and marketing staff must work together to solve specific issues and to make decisions on the details. Whenever a problem appears, a gap between the current design and the requirement, the development team must take action to close it. The way in which this is achieved determines the speed and effectiveness of the problem solving process. In many cases this problem solving routine involves iterative design-test-build cycles, which make use of a number of tools.

There are a number of tools, or methodologies, which have been developed to help solve the problems, and most require the integration of different functions and disciplines. The most significant tools and methods used are:

- **Quality Function Deployment (QFD)** – a set of planning and communications routines, which are used to identify critical customer attributes and create a specific link between these and design parameters; it focuses and co-ordinates the skills within the organisation to design, manufacture and then market products that customers (Hauser and Clausing, 1988). The aim is to answer three primary questions: What are the critical attributes for customers? What design parameters drive these attributes? What should the design parameter targets be for the new design? (Cohen, 1995).

- **Design for Manufacture (DFM)** – ‘the full range of policies, techniques, practices and attitudes that cause a product to be designed for the optimum manufacturing cost, the optimum achievement of manufactured quality, and the optimum achievement of life-
cycle support (serviceability, reliability and maintainability)’ (Ettlie, 1990). It includes Design for Assembly (DFA), Design for Producibility (DFP) and other Design Rule approaches. Studies from the car industry indicate that up to 80% of the final production costs are determined at the design stage (Whitney, 1988).

- **Rapid Prototyping** – is the core element of the design-build-test cycle, and can increase the rate and amount of learning that occurs in each cycle. The first design is unlikely to be complete, and so designers go through several iterations learning more about the problem and alternative solutions each time. The number of iterations will depend on the time and cost constraints of the project. One study found that frequent prototyping proved useful for intra-team communication, obtaining customer feedback and manufacturing process development (Bacon et al., 1994). Having an actual prototype as a visual model enables more reliable assessment of preferences and suggestions (Srinivasan et al., 1997).

- **Computer Aided Techniques (CAD/CAM)** – potential benefits include reduction in development lead times, economies in design, ability to design products too complex to do manually and the combination of CAD with production automation Computer-aided Manufacture (CAM) to achieve the benefits of integration (Senker, 1996). However, these benefits are not always realized due to organisational shortcomings (Tidd, 1991; 1994).

In addition to these discrete techniques, the efficiency and effectiveness of new product development will also be influenced by the internal organisation and relationships with other organisations. Both internal and external integrity determine the dynamic capability of the organisation, in exploiting the existing technology and marketing capabilities in response to the changing market and technological environment (Wang, 1997). There is substantial agreement in the literature on the need for effective integration of all the stakeholders in the new product development process, and this is the rationale for multifunctional project teams. In a study of engineering firms the most popular methods of organising new product development were based on the use of teams Barclay and
Benson, 1990), and another study found that more than 76% of firms use multidisciplinary teams (Barclay, 1992).

The other aspect of organisation is concerned with the relationships with suppliers, customers and other external sources of innovation. For example, working closely with key suppliers may reduce the cost, time and effectiveness of product development (Nishiguchi, 1994), and exploiting other external sources of technology and market know-how allow a firm to focus on its own competencies (Tidd and Brocklehurst, 1993; Tidd and Trewhella, 1997).

2.4 Product commercialisation and review

In many cases the process of new product development blurs into the process of commercialisation. For example, customer co-development, test marketing and use of alpha, beta and gamma test sites yield data on customer requirements and any problems is use, but also help to obtain customer buy-in and prime the market. It was not the purpose of this study to examine the relative efficacy of different marketing strategies, but rather to identify those factors that influence directly the process of new product development. We were primarily interested in what criteria firms use to evaluate the success of new products, and how these criteria might differ between low and high novelty projects. In the former case we expected more formal and narrow financial or market measures, but in the latter case we hoped to find a broader range of criteria to reflect the potential for organisational learning and future new product options (Mitchell and Hamilton, 1988; Tidd, 1997).

3. Affect of Project Novelty

Development projects range from simple improvements to existing products, through to radical ‘new to the world’ products. Booz Allen (1982) categorize projects into six types:
• improvements to existing products;
• new-product lines;
• additions to existing product lines;
• new-to-the-world products;
• cost reductions - process development;
• repositioning - product augmentation development.

Clark & Wheelwright adopt a simpler taxonomy: research or advanced development; breakthrough development; platform or generational; and derivative or incremental (Clark and Wheelwright, 1992).

However, such taxonomies can confuse rather than illuminate as they fail to make the critical distinguish between relative and absolute measures of novelty. What matters to practicing managers is how close a project is to their existing skills and past experience, which is a relative, not an absolute matter. Clearly, what is novel for one firm may be routine for another, which is reflected in the common distinction between ‘new to the firm’, ‘new to the market’ and ‘new to the world’. For example, the development of a new electronic control unit might be considered routine by a large electronics firm, but perceived as highly novel by a small manufacturer of machine tools, or large manufacturer of automobiles. This approach is consistent with the test of ‘inventive step’ for a new patent application, which is relative to the industry, being based on what is obvious to a ‘skilled practitioner’ in the same industry. Therefore in absolute terms the test is more severe in electronics than in mechanical engineering. This is largely due to sectorial differences in ‘technological opportunity’ (Geroski, 1994), which is a function of the rate of change of technologies and R&D investments. Therefore we might expect managers to use different tools and approaches depending on the novelty of the products relative to the firm. In this study we simply asked managers to distinguish between routine, low novelty and non-routine, high novelty projects.
4. Sample and Methodology

In this paper we investigate the techniques and methods used in new product development across a cross-section of companies, and whether this differs with the relative novelty of the new product or technology. This is based on a survey of fifty projects in twenty five firms in the UK, covering four sectors. The questionnaire was developed from the relevant literatures on product development, marketing and technology management, and for the sake of clarity organised around the linear model of the product development process, that is the tools and techniques used at different stages of the development process, ranging from concept to commercialisation. Each company was asked to complete the questionnaire for a routine product, and for a more novel product. Respondents were asked to rate the usefulness of the techniques used on a scale of 1 (not useful) - 5 (extremely useful).

The draft questionnaire was tested in a pilot survey, and the subsequent questionnaire sent to 120 UK-based firms from four different industries: chemicals, pharmaceuticals, consumer durables and food. These sectors were chosen to represent a broad spectrum of product type. The questionnaires were addressed to the Technical, R&D or New Product Development Director, chosen to have a broad perspective of the firms overall new product efforts, and the precise respondent was identified in advance by telephone. The number of usable questionnaires returned was 25, covering 50 projects. The response rate of 21% was reasonable given the length of the questionnaire and information requested.

The survey provides two distinct sets of data. First, the relative frequency of use and perceived usefulness of the various tools and techniques available to support new product development. The sample is small and not representative, and therefore no inferences can be made about the population of firms. However, given that the majority of firms which responded are by self-selection relatively innovative, these data provide an upper
boundary for the use of the various tools and techniques. The second set of findings are more robust, and concern the differences in the use and perceived usefulness of these tools and techniques between projects of low and high novelty. These matched pairs of projects represent two dependent samples and therefore allow us to compare the data for low and high novelty projects by the paired difference t test. In the following section we discuss these two sets of findings for each of the four stages of development reviewed earlier. As the sample was small and non-representative, and because no dependent variable or measure of success was used, we do not attempt to infer ‘best practice’ from the study.

5. Analysis and discussion

5.1 Concept development

The use and usefulness of various techniques are shown in Table 1. In terms of frequency of use, the most common methods used for high novelty projects are segmentation, market experimentation and industry experts, whereas for the less complex projects the most common methods are partnering customers, trend extrapolation and segmentation. The use of market experimentation and industry experts might be expected where market requirements or technologies are uncertain, but the use of segmentation for such projects was less expected. Segmentation was also commonly used for the low novelty projects, but in this case technologies and market demand were more well-defined, and therefore extrapolation of trends and customer requirements more reliable. In terms of the usefulness, there were statistically significant differences in the ratings for segmentation, focus groups, customer partnerships and user-developers. Segmentation was considered to be more useful for low novelty projects, essentially product extensions where a reliable basis of segmenting markets was available, but for the novel projects deeper market analysis and closer relationships with lead customers where more important.
### Table 1. Use and usefulness of techniques for concept generation

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<th>High Novelty</th>
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<th>Low Novelty</th>
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<tbody>
<tr>
<td></td>
<td>Usage (%)</td>
<td>Usefulness</td>
<td>Usage (%)</td>
<td>Usefulness</td>
</tr>
<tr>
<td>Segmentation*</td>
<td>89</td>
<td>3.42</td>
<td>42</td>
<td>4.50</td>
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<tr>
<td>Market Experimentation</td>
<td>63</td>
<td>4.00</td>
<td>53</td>
<td>3.70</td>
</tr>
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<td>Industry Experts</td>
<td>63</td>
<td>3.83</td>
<td>37</td>
<td>3.71</td>
</tr>
<tr>
<td>Surveys/Focus groups*</td>
<td>52</td>
<td>4.50</td>
<td>37</td>
<td>4.00</td>
</tr>
<tr>
<td>Trend Extrapolation</td>
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<td>4.00</td>
<td>47</td>
<td>3.44</td>
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<tr>
<td>Latent Needs Analysis</td>
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<td>3.89</td>
<td>32</td>
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</tr>
<tr>
<td>User-practice Observation</td>
<td>47</td>
<td>3.67</td>
<td>42</td>
<td>3.50</td>
</tr>
<tr>
<td>Partnering Customers*</td>
<td>37</td>
<td>4.43</td>
<td>58</td>
<td>3.67</td>
</tr>
<tr>
<td>User-developers*</td>
<td>32</td>
<td>4.33</td>
<td>37</td>
<td>3.57</td>
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<tr>
<td>Scenario Development</td>
<td>21</td>
<td>3.75</td>
<td>26</td>
<td>2.80</td>
</tr>
</tbody>
</table>

* denotes difference in usefulness rating is statistically significant at 5% level

#### 5.2 Project screening and selection

The use and usefulness ratings for different financial criteria for project screening and selection are shown in Table 2. For both high and low novelty projects the most commonly used methods for screening and selection were the estimated cost of the project, net present value and payback. This suggests that financial criteria are determined by company policy, rather than type of project. However, there are significant differences in the usefulness of certain methods. Simple payback criteria appear to be more useful for low novelty projects than for high novelty projects, whereas simulated outcomes are
considered more useful for the high novelty projects. This selection technique can give significant benefits as a project progresses, since many of the possible outcomes of each stage of the development process have already been considered, and contingencies evaluated.

Table 2. Use and Usefulness of financial criteria for project screening & selection

<table>
<thead>
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<th>High Novelty</th>
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<th>Low Novelty</th>
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</thead>
<tbody>
<tr>
<td></td>
<td>Usage (%)</td>
<td>Usefulness</td>
<td>Usage (%)</td>
<td>Usefulness</td>
</tr>
<tr>
<td>Cost</td>
<td>89</td>
<td>3.94</td>
<td>95</td>
<td>4.06</td>
</tr>
<tr>
<td>NPV/IRR</td>
<td>79</td>
<td>3.47</td>
<td>68</td>
<td>3.92</td>
</tr>
<tr>
<td>Payback*</td>
<td>79</td>
<td>3.20</td>
<td>58</td>
<td>4.27</td>
</tr>
<tr>
<td>Ranking</td>
<td>47</td>
<td>3.78</td>
<td>42</td>
<td>3.50</td>
</tr>
<tr>
<td>Simulated Outcomes*</td>
<td>32</td>
<td>3.50</td>
<td>26</td>
<td>2.20</td>
</tr>
<tr>
<td>Profiles/Factors</td>
<td>32</td>
<td>3.33</td>
<td>21</td>
<td>3.25</td>
</tr>
</tbody>
</table>

* denotes difference in usefulness rating is statistically significant at 5% level

In addition to such financial criteria, all firms used a range of non-financial criteria and methods to screen and select development projects (Table 3). The most common criteria for both high and low novelty projects were the probability of technical and commercial success and the predicted market share. Given how subjective estimates of probability can be, the widespread use of such criteria is surprising. The usefulness of market share and fit with competencies was rated as significantly different between low and high novelty projects. The use of market share, which was considered more appropriate for low novelty projects where markets were better defined, although previous studies suggest that market share is not significantly associated with product success (Kleinschmidt and Cooper, 1995). We might expect fit with competencies to be more relevant to high novelty projects, as competencies are a common source of new products (Tidd, 2000; Tidd et al, 2001). There were also significant differences in the usefulness of some methods for assessing the high novelty projects. For the high novelty projects the
use of strategic clusters was believed to be more useful than for low novelty projects, which is consistent with the use of non-financial criteria such as fit with competencies.

Table 3. Use and Usefulness of non-financial criteria & methods for project screening & selection

<table>
<thead>
<tr>
<th></th>
<th>High Novelty</th>
<th></th>
<th>Low Novelty</th>
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<tbody>
<tr>
<td></td>
<td>Usage (%)</td>
<td>Usefulness</td>
<td>Usage (%)</td>
<td>Usefulness</td>
</tr>
<tr>
<td>Probability of technical success</td>
<td>100</td>
<td>4.37</td>
<td>100</td>
<td>4.32</td>
</tr>
<tr>
<td>Probability of commercial success</td>
<td>100</td>
<td>4.68</td>
<td>95</td>
<td>4.50</td>
</tr>
<tr>
<td>Market share*</td>
<td>100</td>
<td>3.63</td>
<td>84</td>
<td>4.00</td>
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<tr>
<td>Core competencies*</td>
<td>95</td>
<td>3.61</td>
<td>79</td>
<td>3.00</td>
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<tr>
<td>Degree of internal commitment</td>
<td>89</td>
<td>3.82</td>
<td>79</td>
<td>3.67</td>
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<tr>
<td>Market size</td>
<td>89</td>
<td>3.76</td>
<td>84</td>
<td>3.94</td>
</tr>
<tr>
<td>Competition</td>
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<td>3.76</td>
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<td>Gap Analysis</td>
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<td>Interactive techniques</td>
<td>68</td>
<td>4.23</td>
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<td>Strategic Clusters*</td>
<td>42</td>
<td>3.63</td>
<td>32</td>
<td>2.67</td>
</tr>
</tbody>
</table>

* denotes difference in usefulness rating is statistically significant at 5% level

5.3 Product development

Having selected projects for development, we asked respondents to rate the use and usefulness of a range of techniques available to support product development (Table 4). Most firms used three or four different techniques to support development, the most common being prototyping, market experimentation, quality standards and design for manufacture (DFM). All of these techniques also received high ratings for usefulness, the only significant difference in perceived usefulness between project types being prototyping. Whilst being rated as very useful for all types of project, it was considered to be more useful for high novelty projects. Similarly, market experimentation was
believed to be useful for all types of projects, but in this case the difference is the rating for high and low novelty projects was not statistically significant.

The high rating for quality standards was unexpected, but perhaps reflects the usefulness of having formal, well-documented processes and deliverables. In contrast, the relatively low use and usefulness of Quality Function Deployment (QFD) was surprising. The low take up may be due the fact that QFD demands close integration between functional groups, in particular design, development and marketing, which is not evident from the survey. The low ratings for usefulness may reflect the difficulty in measuring some of the benefits of QFD, especially in the short term (Griffin, 1992). However, computer-aided methods were rare, and where used rated low in usefulness. This may be due to the small proportion of engineering firms in the survey, or may reflect more fundamental limitations of the technology (Tidd, 1991).

Table 4. Use and Usefulness of techniques to support product development

<table>
<thead>
<tr>
<th></th>
<th>High Novelty</th>
<th>Low Novelty</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Usage (%)</td>
<td>Usefulness</td>
</tr>
<tr>
<td>Prototyping*</td>
<td>79</td>
<td>4.33</td>
</tr>
<tr>
<td>Market Experimentation</td>
<td>68</td>
<td>4.31</td>
</tr>
<tr>
<td>Quality Standards</td>
<td>68</td>
<td>4.08</td>
</tr>
<tr>
<td>DFM</td>
<td>63</td>
<td>4.00</td>
</tr>
<tr>
<td>QFD</td>
<td>47</td>
<td>3.33</td>
</tr>
<tr>
<td>CAD/CAM/CAE</td>
<td>37</td>
<td>3.86</td>
</tr>
</tbody>
</table>

* denotes difference in usefulness rating is statistically significant at 5% level
Clearly, successful product development is more than a set of tools and techniques, and the organisation of the process is critical. Table 5 confirms that firms find cross-functional teams essential to product development. However, there are significant differences in the management and usefulness of such teams. Heavyweight project managers and cross functional teams were thought to be a more effective combination for the high novelty projects, whereas lower weight coordination mechanisms was thought sufficient for many of the low novelty projects. Respondents were also asked to indicate in which stages of the development process - concept, development and commercialisation - different functions were involved. For the high novelty projects R&D and Marketing were both involved in all stages in two thirds of the cases. For low novelty projects both functions were involved in only a third of projects. Production had almost no involvement in the concept generation stage, but were involved in development in a quarter of all cases, and commercialisation in two thirds of all projects. There were no significant differences in the involvement of Production in high or low novelty projects, and this function remains the ‘poor relative’ in most firms. Given the relatively high use and usefulness ratings for DFM, such methodologies may be seen as a substitute for the direct involvement of representatives of Production.

The involvement of external organisations in different stages of the product development process was commonplace. Almost all firms used suppliers to support development, and 70% also used suppliers to support commercialisation. In contrast, customers were twice as likely to be involved in the development and commercialisation of complex projects, compared to low novelty projects: two-thirds versus a third of cases. Contrary to the advice of current marketing texts, customers were rarely involved in concept development. The use of other external partners, other than suppliers and customers, was relatively uncommon, about a quarter of all cases, but twice as likely for the high novelty projects.

Table 5. Integrating mechanisms used for new product development
21

High Novelty | Low Novelty
---|---
Cross-functional Teams* | 4.47 | 3.74
Project Manager (Heavyweight)* | 3.84 | 3.05
Project Coordinator | 3.63 | 3.37

* denotes difference in usefulness rating is statistically significant at 5% level

5.4 Commercialisation & review

Having developed and launched the new product, we asked firms what criteria they used to evaluate the success of the project. As shown in Table 6, financial and market measures dominate. Most firms use at least one simple financial measure, either payback period or return on investment (ROI), combined with a market measure, usually sales growth. A few firms used no financial criteria at all, and instead relied entirely on market-based measures, that is sales growth and market share. The use of discounted cash flow based measures were much less common than the literature and business schools would suggest, even for the high novelty projects. The only significant difference between criteria used to assess high and low novelty projects was ROI, which was more than twice as likely to be used for high novelty projects. This may be because the investments and perceived risk is higher.

Table 6. Success criteria used for new products (% of firms using measure)

<table>
<thead>
<tr>
<th></th>
<th>High Novelty</th>
<th>Low Novelty</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sales Growth</td>
<td>95</td>
<td>95</td>
</tr>
<tr>
<td>Market Share</td>
<td>68</td>
<td>63</td>
</tr>
<tr>
<td>Payback</td>
<td>53</td>
<td>58</td>
</tr>
<tr>
<td>ROI</td>
<td>53</td>
<td>21</td>
</tr>
</tbody>
</table>
6. Conclusions and implications for management and research

In this paper we have reviewed the techniques and methods employed in the new product development process, and how their use and usefulness differs with the novelty of development projects. The size and nature of the sample do not allow us to make robust inferences regarding the practices of all firms, and indeed most of the respondents were atypical in the sense that they were large firms with a strong interest in new product development. Moreover, no dependent variable or object measure of project success was used, so no robust conclusions can be reached regarding ‘best practice’ product development. However, the sample of companies was biased towards those with a great deal of experience with new product development, and therefore the data on the frequency of use is likely to represent an upper boundary, rather than the typical firm. Similarly, in each case managers assessment of usefulness is based on a large number of low and high novelty projects, although they were asked to focus on just two for the purpose of analysis. Therefore the data on the usefulness is more robust, and the analysis of the differences between high and low novelty projects the most reliable because it is based on a matched pairs sample. With these caveats, our study has important implications for technology and innovation management and research.

For managers, the study provides some benchmark for the use and usefulness of a wide range of tools and methods, and indicates how project novelty affects these. In terms of the range and frequency of use, the only major surprises here are the high incidence of quality standards and relatively low level of use of Quality Function Deployment (QFD). This perhaps reflects the path many firms have followed, beginning with quality management, then process improvement. The majority of the methods and techniques reviewed are equally applicable to high and low novelty projects. However, a small number would appear from our analysis to be more effective for specific types of
development project. At the concept generation stage, we found that segmentation is widely used, but significantly more effective for low novelty projects. Focus groups, customer partnerships and user developers are all considered more effective for high novelty projects. At the screening and selection stage, payback period was found to be less effective for high novelty projects than for low novelty, whereas simulated outcome analysis is considered to be more effective for the more complex projects. During the development stage, prototyping is an effective technique for all projects, but significantly more effective for high novelty projects, and may help reduce technological or market uncertainty. Cross functional development teams were commonplace for both types of project, but were significantly more effective for the high novelty cases, as was management by heavyweight project manager, rather than by functional coordinator.

Perhaps not surprisingly, most of the tools in common use are rated as being ‘very effective’ or ‘extremely effective’, as current use no doubt reflects prior positive experiences. There are a few ‘off diagonal’ cases, that is tools which are commonly used but only moderately effective, or conversely techniques rated as being very or extremely effective but not in common use. Gap analysis was commonly used for project selection, but receives a low rating for effectiveness. For concept development, only about a third of firms exploit user developers or customer partnerships, but those that do rated them as being highly effective. This is a warning against adopting tools and methods on the basis of fashion or so-called ‘best practice’ irrespective of the type of development project. More specifically, it suggests that firms would be well-advised to more fully exploit the knowledge of customers and users for the development of more novel products and services.

For researchers of technology and innovation management, the study identifies the potential mediating affect of project novelty on the process of new product development, and some of the dangers of adopting so-called ‘best practice’ methodologies without taking context or contingencies into account. However, as this study did not incorporate
any dependent variable or objective measure of success, the hypothesis that project success is associated with the use of specific tools and methods, mediated by project novelty, remains to be tested. Another future research direction that we are pursuing is to develop a finer taxonomy and better measures of project types. Contingency theory suggests that no single organizational structure or process is effective in all circumstances, and that instead there is an optimal organizational structure that best fits a given contingency, such as size, strategy, task uncertainty or technology (Donaldson, 1996). Moreover, the greater the fit the higher the organizational performance (Drazin & Van de Ven, 1985; Donaldson, 1999). Our initial review of the relevant research suggests two contingent or mediating factors that warrant consideration. First, the affect of technological and market uncertainty on good practice, in particular perceptions of environmental uncertainty which appear to be more relevant that more objective measures of uncertainty (Hauptman and Hirji, 1999; Souder et al., 1998). Second, the affect of technological complexity on good practice, as many of the current management prescriptions are based on the specific experience of new product development in consumer markets which may not be appropriate to other sectors (Dvir, 1998; Hobday et al., 2000). Together, these two dimensions may provide a more comprehensive typology of technology and innovation management, and help to guide management research and practice in the field.
References


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