A managerial cognition perspective on the product innovation performance of Irish industry

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M.A. (N.U.I. at U.C.C.)

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Declaration

I hereby certify that this material, which I now submit for assessment on the programme of study leading to the award of a Ph.D. (Doctor of Philosophy) Degree is entirely my own work and has not been taken from the work of others save and to the extent that such work has been cited and acknowledged within the text of my work.

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*(*The document remains essentially the same as that submitted for examination on 1 October, 1998. The time lapse between said submission date, the Viva Voce examination in mid-March, 1999 and the conferring ceremony in October, 1999 has provided an opportunity for some final editing 'here and there', however.)*

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Abstract

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Ph.D. Abstract

A managerial cognition perspective on the product innovation performance of Irish industry

Little is yet known about the reason(s) for the apparently poor product innovation performance of Irish companies.

The findings of a small preliminary study carried out in the context of the present research (prompted by the discovery and re-interpretation of an under-exploited finding of an isolated and under-publicized study conducted a decade ago by O'Sullivan and Tomlin (1985)), suggested the significance of the manner in which the product innovation process is managed - but, perhaps more importantly, that ineffective management of the product innovation process may stem from 'faulty thinking' about product innovation and an inadequate understanding of the product realization process. A case was thus made for addressing the product innovation performance of indigenous Irish industry primarily in terms of 'product realization performance', for investigating the matter, initially, at least, at an organizational level, for using routine organizational product innovation practice as a focal point for the study and for adopting an overall managerial cognition perspective on the problem, the suggested way forward being the further exploration of the nature and effects of managers' beliefs and understanding of how the process of transforming product innovation ideas into marketable products might best be achieved.

A model of cognition, practice and performance was proposed and tested using Irish-owned electronics firms as test case. The cognitive component of the model was based on a 'top-down, knowledge-how, modified script concept using four core product realization activities and sixty-four principles of effective product innovation practice recommended by the international innovation literature as an *a priori*'ly defined investigative agenda, a Bougon-grid based data elicitation framework and an analytical framework based on the work of Galambos *et al* and Langfield-Smith and Wirth.

The test of the model generated a considerable number of statistically significant and other interesting findings. A number of conclusions were drawn and discussed.

List of Abbreviations Used

Abbreviation	**Represents ...**
a	Cronbach's alpha statistic
B.A.	Bachelor of Arts
BES	business expansion scheme
CAD	computer aided design
CAM	computer aided manufacturing
CEC	European commission
cf.	*Confer*, compare
CIM	computer integrated manufacturing
con	*contra*
DCU or D.C.U.	Dublin City University
e.g.	for example
ENSR	European network of small and medium sized enterprizes
ERAD	The eradication of animal disease board
EUor E.U.	European Union
EUREC	European renewable energy centres
FMS	flexible manufacturing systems
GB or G.B.	Great Britain
Hons.	Honours
IBEC	Irish business and employers confederation
ibid.	*Ibidem*: in the same place
IQA	Irish quality association
ISME	Irish small and medium sized enterprizes association
ISO	(as in ISO9000, et cetera: International standards organization)
JIT	just in time
M.A.	Master of Arts
MNC	multi-national company
MRP	materials requirement planning
n	number or value
NUI or N.U.I.	National University of Ireland
OECD	Organization for European co-operation and development
p. or P.	Page number
PBAs	Printed board assemblies
pp. Pp. or PP.	Page numbers
P or p	page number or probability level, depending on context
PATs	programmes in advanced technologies
PDMA	Product development and management association
PhD or Ph.D.	Doctor of Philosophy
Q-mark	quality mark
rho or Rho	Spearman's rho statistic
r-squared	regression co-efficient
sic.	*Sicut ante*: as before, thus
SME	small and medium sized enterprises
STIAC	Science, technology and innovation advisory council
TQM	total quality management
U	Mann-Whitney U statistic
UCC or U.C.C.	University College, Cork
UK or U.K.	United Kingdom
US, U.S., USA or U.S.A.	United States of America
V	Cramer's V statistic
x	(as in activity x principle) x indicates combination of the two entities specified
Xxxxx	name substitute to preserve the identity of the individual

... also, symbols:

=	equal;
<>	not equal;
>	greater than;
<	less than;
>=	greater than or equal to;
<=	less than or equal to;
&	and;
/	or

Note that, following the DCU convention, appendices are named alphabetically and paginated consecutively but separately from the main text and from each other so that where a page number is prefixed by any of the letters A, B, C or D, the letter merely constitutes a reference to the relevant appendix.

A note on inverted commas: the DCU convention regarding the use of inverted commas in lieu of quotation marks (except in the case of quotations within quotations), necessitates noting the fact that wherever inverted commas are used in the text without citation details, they are to be interpreted in the sense of their normal usage.

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CHAPTER ONE

Innovation, Irish Industry and

the particular case of

the *Product* Innovation Performance of Irish Industry

1.1 INNOVATION AS COMPETITIVE IMPERATIVE

Innovation is now widely acknowledged as ***the*** key to international economic competitiveness worldwide[1] - and as such clearly constitutes an urgent imperative for Irish industry today. Indeed, many studies have shown that innovating firms outperform non-innovating firms in terms of: producing consistently higher profits, demonstrating higher than average growth rates (on turnover), holding substantially larger market shares and demonstrating lesser vulnerability in times of economic recession (see, for example: Geroski and Machin, 1992).

The term *'innovation'* has been variously defined[2] as an ongoing process of learning, searching and exploring which results in the development or adoption of new or modified technologies and/or the generation of new or modified products, process, tools and techniques, new forms of organization and new markets[3] [4].

The international innovation literature identifies three main types of innovation as emerging against the backdrop of global post-mass-production re-orientation toward leaner, more flexible and more adaptable systems of production. Differentiation is on

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[1] See, for example, Udwadia, 1990 and Baldwin (document 16 in the 1994 OECD workshop on innovation patents and technological strategies).

[2] The interdisciplinary field of innovation has no definitional authority. A number of attempts to clarify the conceptual (teminological) framework underpinning activity in the area have been made in recent years - for example: Tudor Rickard's paper on 'potted thinking' and the American Marketing Association's recently issued new set of 'definitions' - but uptake is inconsistent (Crawford, 1994).

[3] (see, for example, Lundvall 1992)

[4] see Appendix D

the basis of degree of change generated by the innovation and the key associated product/process technologies, for example: computer aided design (CAD), computer aided manufacturing (CAM), materials requirement planning (MRP), computer integrated manufacturing (CIM), flexible manufacturing systems (FMS), just in time (JIT), total quality management (TQM) and networking (the adoption of any one of these inevitably generates at least some degree of technological *and* organizational change in the firm). The diffusion of *both* product and process technologies is generally considered essential to the modern economy. Process technologies tend to facilitate productivity gains (though frequently at the cost of jobs), while product technologies facilitate new product development (frequently with job retention/creation). In practice, the diffusion of innovative process technologies tends to predominate over innovative product technologies, however[5].

The three types of innovation identified are (after the annual report of The European Commission (CEC) European Network of Small and Medium Sized Enterprizes (SME) Research (ENSR), 1994 and the Report of the Science, Technology and Innovation Advisory Council (STIAC), 1995): (i) <u>continuous innovation</u> *or* minimally disruptive, minor alterations in existing products/processes; (ii) <u>dynamically continuous innovation</u> *or* moderately disruptive alterations in existing products/processes;

[5] Diffusion may be affected by both potential adopter characteristics and environmental characteristics. For example: it is generally accepted that there is a positive relationship between resistance and degree of discontinuity; or, again, it may be simply the case that firms may be unable to take advantage of technological opportunities because of restricted availability of information or finance or the firm's deficiencies in business skills.

(iii) discontinuous innovation *or* significantly disruptive alterations in existing products/processes.

It has been found that the technological trajectories of many industries tend to fall into a cyclical pattern characterized by long periods of continuous, incremental development punctuated abruptly at intervals, by significant discontinuities of a frame-breaking nature - with associated adjustment sequences (see Dosi, 1982 and Leavy, 1996).

Key sources of development in innovation research (throughout the eighties and nineties, in particular) include, for example, the national interdisciplinary academic research centre at Minnesota in the USA. Much of the more recent research conducted at this (and other) sites has been dominated by the three highly practical research objectives of: (i) evaluating relationships between variables at the individual, group, organizational or national level that are held to be antecedents of innovation with a view to optimizing capacity for innovation and devising methods of minimizing blockages to the successful design, development and implementation of innovation projects; (ii) modelling the innovation process from concept generation through to adoption and diffusion with a view to enhancing the management of innovation activities; (iii) developing metrics with a view to providing formalized tools for the measurement of innovation project outcomes.

Notwithstanding this significant research effort, there is as yet no single unified 'theory of innovation'[6]. A number of authors (Poole and van de Ven, 1989, in van de Ven, Angle and Poole, 1989, for example) have attempted to initiate a move toward its development - or even that of a meta-theory to frame existing work - but efforts to date have been largely unsuccessful. Wolfe (1994) attributes lack of progress to 'a number of significant barriers to knowledge cumulation in innovation research', essentially, the non-generalizability of many potentially significant research results because of their incompatible, limited scopes and underlying theoretical and/or methodological frameworks. Wolfe's observation should not necessarily be read as a slating denunciation of the research effort to date, however - nor, indeed should it be taken as a cause for despair (afterall, as Camus observes 'a despairing literature is a contradiction in terms' (Camus, in Tamplin, 1991, p7)).

The inherently complex, multi-dimensional nature and dynamic process of innovation would most certainly have rendered impracticable if not impossible, any attempt to characterize it as a whole from the outset. Even now, the problems which would attend any serious attempt to develop a 'holistic' model of the innovation process would be many - not least amongst them, the very practical concern of theoretical and methodological manageability.

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[6] (the presumed efficacy of the single, unified theory dates at least from the era of the 'mechanical principles' of Hobbes)

Whilst 'reductionism' (over-simplification) is a frequent critique of the less than holistic approximative models developed to date, it is generally accepted that such models do, at least, help to focus attention on some of the more salient issues. Proposed models vary from simple linear 'technology-push' and 'market-pull' variants to those encompassing the dynamics of psycho-social factors and risk reducing outcome orientation (for a historical review see Rothwell, 1994 and Cooper, 1994). Some of the better known, ranging from the original Schumpeterian and Booz, Allen and Hamilton models are:

- early linear technology-push or market-pull models such as that of Haeffner (1979, in Baker, 1979) and Boucher and Anderson (1977, in Cunningham *et al*, 1977);
- later, more complex *dual-drive* models combining both technology-push and market-pull, for example: Roberts and Frohman (1978);
- the time-based 'dynamic model of process and product innovation' proposed by Utterback and Abernathy (1975);
- 'human factor' models such as the project champion and creative organization model of Twiss (1974) and the decision-cycle model of Blickwede (1969) and Rosegger (1980);
- models incorporating marketplace, organization and project, see, for example: Cooper (1980);

- miscellaneous models such as Hornig's (1978, in Brooks *et al*, 1978) societal model and the public sector model of Robbins, Burke and Milliken (1977, in Cunningham, 1977).

Saren's (1984) five-type taxonomy (departmental-stage, activity-stage, decision-stage, conversion process and response models) would appear to be sufficiently comprehensive to encapsulate most models of innovation proposed to date - if extended to incorporate recently emerging network and/or information-processing and/or organizational learning models - such as those of von Hippel, 1988 and Bienans, 1992 (see Hart and Baker, 1994), also: Hakansson, 1987 and Mc.Kee, 1992.

An excellent example of the value of these less than holistic models and the manner in which they serve to focus our attention on significant issues would be one of the earliest studies of technological innovation conducted by Carter and Williams (1957). Whilst reductionistic, its methodology was certainly that which might be termed 'ecologically valid' - and it was productive in that it generated useful information on innovation practice which could be readily assimilated and acted upon by the innovation practitioner ... The study identified twenty-four characteristics associated with technically progressive firms - but absent in unprogressive firms - and these factors appear repeatedly in subsequent literature as factors which have been shown to contribute to the successful outcome of innovation activities generally - the key factors identified are listed in section 1.5.5 of the present text.

There is no doubt that these models are valuable, yet, thematically at least, research still appears largely *ad hoc* with minimal overall organization in terms of any particular theoretical, methodological or other framework. Whilst there is some evidence of the emergence and evolution of that which appears to be at least 'not so loose approximations' to Lakatosian 'research programmes' or Kuhnian 'paradigms'[7] (reflected in, for example, the progression from independent and rival technology-push and market-pull to combinatorial dual-drive theories of innovation) to frame its progression as a discipline (that is: a legitimate area of inquiry and endeavour), there is, even still, much evidence of that which constitutes the rigidity and circularity of work that characterises the (Lakatosian) early programmatic or (Kuhnian) pre-paradigmatic stage of an emergent discipline.

A number of years ago this would have represented an enormous stumbling block to the perceived status of innovation theory as a legitimate area of inquiry and endeavour. In today's postmodern era of chaos and contingency, this is less of an issue. The present status of the discipline is, however, mildly reminiscent of Baddeley and Wilkins' (1984, in Harris and Morris, 1984) comment in the early

[7] a Lakatosian research programme or Kuhnian paradigm are roughly equivalent terms which may be described as a generally accepted, conceptual, methodological and problem-solving framework for the observation, description and attempted explanation and/or prediction of a particular aspect of reality (within that frame.) - see Chalmers, 1994.

eighties, on the status of an emergent cognitive psychology ... that it was in danger of becoming gradually engulfed in a mass of unrelated empirical observation.

Throughout the eighties there was much concern expressed amongst the broader psychology fraternity regarding the paradigmatic status of the overall discipline. Was it pre-, poly- or a- paradigmatic? Gradually the debate dissolved under the dual weights of, firstly, the realization that the concept of paradigm may be applied at many different levels of abstraction with correspondingly different assessments of status and secondly, the return to the notion of coming to grips with everyday phenomena in a practical and problem-solving way as key concern for the discipline with the stepwise application of whatever approximative or actual paradigms are available until one is effective' as overriding meta-paradigm for the science.

Perhaps, eventually, this will also be found to have been the case with innovation. Concern that innovation as a discipline may (have) become and, moreover, be allowed to remain as Luigi Pirandello's 'six characters in search of an author' (Pirandello, 1954 translation by May), may ultimately have to be abandoned in favour of getting on with the job of innovating.[8]

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[8] (perhaps not inappropriately either ... "I talked about wings - you just flew" (The Waterboys))

1.2 THE PARTICULAR CASE OF PRODUCT INNOVATION

The term **'*product* innovation'** is defined as the conceptualization, development, operationalization, manufacture, launch and ongoing management of a product (see Dougherty (1996 in Clegg *et al*, 1996). This definition is deceptively simple. It is, in fact, considerably more nebulous - and potentially more confusing - than it first appears. The term 'products' may be used to refer to tangible products, less tangible services or a combination of the two - while the term 'innovation' is used to refer to varying degrees of development that range from the clearly pioneering (that is: truly inventive) to the less obvious incremental modifications (degree of development being held to be largely 'in the eye of the beholder' and, hence, variable across innovator, consumer and marketplace perspectives - see, for example, Rothberg, 1981, Baker, 1975 and Hisrich and Peters, 1984, respectively, for innovator-, consumer- and marketplace- based definitions).

Product innovation is, in fact, held to be an *inherently* ambiguous - amorphous even (see, for example, Daft and Weick, 1984, in Dougherty, *ibid.*). This perception is, no doubt, fuelled by the fact that its generation is normally an intensive interfunctional affair. According to Crawford (1983, in Dougherty, *ibid.*) product development is, in fact, second only to corporate strategy in the manner in which it involves all aspects of all functions of management and all aspects of the organization.

Booz, Allen and Hamilton (1982) identified six categories of product innovations:

1. new to the world products: these are essentially the first of their kind and create an entirely new market;
2. new product lines: new products that enable a company to enter an established market for the first time;
3. additions to existing product lines: new products that enhance a company's established product lines;
4. improvements and revisions to existing products: new products that provide improved performance or greater perceived value and replace existing products in a firm's product line;
5. repositionings: essentially new applications for existing products which are targeted towards new markets or market segments;
6. cost reductions: new products that provide similar performance and benefits at a lower cost.

The Booz, Allen and Hamilton taxonomy is widely accepted (cited and used) by the innovation community as a useful breakdown for several reasons. One of its advantages, for example, is that it distinguishes between new products and line extensions. This is particularly important from an applied perspective. As Davidson (1987) observes, companies which fail to distinguish between the two tend to overrate their overall level of innovation and so tend toward underperformance.

Essentially a company has two options in regard to product innovation, that is: old product development: improvements/extensions of existing lines and new product development based on existing or new technologies (Johne and Snelson, 1988a-c). In practice, most companies will engage in both - though old product development is prevalent - probably because it is perceived as being less risky.

In the same way that the broader innovation literature once distinguished between innovations generated as a result of 'technology-push' and those generated as a result of 'market-pull' but now refers to a *'dual drive'* (see Wrixon, Rooney and Palz, 1993), the notion of *'market-technology linking'* in relation to product innovation emerged in the late seventies - see, for example: Allen Burgelman (1977, in Dougherty, *ibid.*) and Burgelman (1983, in Dougherty, *ibid.*).

The principal motivations for engaging in *product* innovation are, after Thomas (1993)[9]: establishing competitive advantage, changing strategic direction, enhancing corporate image, improving financial return, increasing R&D effectiveness, improving utilization of production/operations, leveraging marketing effectiveness, effectively utilizing human resources.

The perception of a link between product development and the achievement of corporate objectives, industrial success and general economic growth originated in the fifties. This perception persisted throughout the sixties, steadily gaining

[9] Thomas' list appears to be a most comprehensive summary of the relevant literature

strength such that, by the seventies, the case for product innovation 'seemed largely proven' - to paraphrase Kraushar (1977). By the mid- to late- eighties, new product investment was considered *'essential for all companies ... to secure their existing position and to achieve new competitive advantage as a basis for further growth'* (Davidson, 1987, p.345).

In the early nineties, many authors were advocating new and old product innovation as *'the'* strategy for corporate development - presenting the particular case of *product* innovation in the context of a growing acknowledgement of the significance of innovation in all its myriad forms as key to competitiveness in the nineties and beyond (see, for example, Barclay, Benson and Lunt, 1990).

This 'contextualization' of product innovation as a 'particular case' of innovation warrants consideration. It is important to realize that whilst product innovation may be examined as a 'particular case' of innovation, it would be inappropriate to consider it to be an activity that is isolated from the other innovative activities of the firm (process innovation, technology acquisition, total quality management, industrial design and design communications, for example). Indeed, Chris Voss (1994), in considering the linkages and inter-dependence between product innovation management and these other innovative activities as a significant issue for the future of product innovation, goes so far as to urge a conceptual movement from 'product innovation management' to 'total innovation management'.

(Voss' undoubted familiarity with the theoretical status of the discipline (as member of the editorial board of the Journal of Product Innovation Management) coupled with his own personal background (considerable academically/industrially based knowledge of and experience in the area of quality management) would seem to indicate that he is perhaps (unwittingly?) advocating a grounded theory[10] approach to the development of a metatheory of innovation?!?)

1.3 ASSESSING INNOVATION PERFORMANCE

The concept of 'innovation performance' is, hardly surprisingly, at least as controversial, complex, multi-dimensional as the concept of 'innovation' itself. There is, consequently, as yet, at least, no *one* generally accepted metric with which the product innovation performance of the firm may be evaluated.

A substantial body of literature exists on the overall effectiveness/performance of the firm - and the various ways in which this might be evaluated (see, for example: Hooley, Lynch and Jobber, 1990 and Saunders, Brown and Laverick, 1991). Until the late eighties, this work remained fragmented, problematic and controversial. Indeed, in the early eighties, a number of authors called for its suspension, see, for example: Bluedorn, 1980 and Boodman, *et al*, 1982 - both cited by Bedeian, in

[10] (actual phenomenon/data- as opposed to perspective/theory-driven research - see Glaser and Strauss, 1967)

Cooper and Robertson, 1994a. Ironically, this was about the time when the work of integration was about to begin (see Quinn and Rohrbaugh, 1981 also cited by Bedeian, *ibid.*).

Progression toward a metatheory and 'metameasure' of organizational effectiveness/performance continues but is hampered by the multi-level 'nature of the beast'. Effectiveness can be conceptualized at the level of the individual, group and supra-group, construed in terms of an enormous range of criteria and measured either within or across companies and/or time-periods using an equally enormous variety of evaluative metrics. These are classified deceptively simply by Hart and Craig (in Baker, 1993) as financial (profit-, asset-, sales-, capital- or equity- based), non-financial (design, activity, market, technological or commercial) or a combination of the two.

Innovation, research and development (R&D) and product development are each acknowledged as distinct and significant aspects of a company's overall performance (see Hart and Craig, *ibid.*). It is perhaps surprising, therefore, that whilst the effectiveness literature generally treats each separately, the performance measurement literature generally fails to make a distinction between these terms. An excellent example is: Mc.Grath and Romeri's 'R&D effectiveness index: a metric for product development performance' (Mc.Grath and Romeri, 1994).

Where specific product development performance literature exists, Hart and Craig (*ibid.)* categorize the evaluation metrics *it* offers according to the classification system they propose for those of the general competitive performance literature, referred to earlier. This is, again: financial (profit-, asset-, sales-, capital- or equity-based), non-financial (design, activity, market, technological or commercial) or a combination of the two (Hart and Craig, *ibid.*). They further suggest that the four key issues in product development performance evaluation are: level of analysis (firm, program or project), source of data (objective, expert, peer or self assessment), data collection technique (questionnaires, desk research or interviews) and type of measurement (financial, non-financial, combined financial and non-financial).

The suggestions of Hart and Craig (*ibid.)* concur well with the findings of the 1993 Product Development and Management Association (PDMA) task force on product development (see Griffin and Page, 1993)[11]. The 1993 PDMA task force review constitutes one of the most comprehensive reviews of innovation outcome success/failure assessment to be carried out in recent times. Its investigation sought to identify all measures currently used by academics (publication-based listing) and industry (survey-based listing) in the evaluation of product

[11] The reader's attention is drawn to the fact that the public-domain documentation of the research efforts of Hart and Craig and the PDMA task force for the period available to the present researcher at the time of writing, did not render it entirely clear whether the two research efforts were entirely separate and independent:- there may (or may not) have been some degree of mutual awareness, at least, at the time (named researchers/authors, PDMA membership lists, *et cetera*, refer).

development performance and then categorize these measures by function and academic/industry preference.

Hart and Craig *(ibid.)* and the 1993 PDMA task force concur well in that following a comprehensive review of currently and internationally used product development performance indices, the PDMA task force identified **five independent dimensions of product development success/failure: firm, program and product success, financial success and customer acceptance.** A number of indices were identified as 'core measures' of success/failure in that they were identified in the survey responses of *both* academics and practitioners.

The core firm-based measure identified was: percentage of sales provided by products less than five years old.

The core product-level measures identified were: cost of developing the product, launched on time, technical performance of product, performs to spec, met quality guidelines, speed to market.

The core measures of financial performance identified were: break-even time (from start of project), attains margin goals, attains profitability goals, internal rate of return or return on investment.

The core customer acceptance measures identified were: customer acceptance, customer satisfaction level, met revenue goals, revenue growth.

No 'core' program measures were identified per se, though the following measures featured: program hit our five-year new product objectives, program exceeds our objectives, impact of the new product program on corporate performance, return on investment for the new product development process, overall success of the product development program, new product program profitability, new product program sales, subjective importance of our new product program.

For other measures see Griffin and Page (*ibid.*).

It is interesting to note that practitioners were found to use about four measures from a total of two different dimensions, most frequently customer acceptance and financial performance, whilst researchers were found to use slightly fewer measures (average: three) from one to two dimensions. The particular dimensions used varied across three different clusters of research focus: not surprisingly, product-focused research was associated with product measures, balanced end results with customer and financial measures and strategic outcomes with program and firm measures.

Perhaps more interestingly, however, the concentration of interest was found to differ significantly between academics and practitioners: researchers were found to investigate product development predominantly at the firm level, focusing more on overall firm-level impacts of success/failure - whereas practitioners focus on, measure and indicate that they want to understand more completely: individual project success/failure.

Whilst other research attempts to explore the concept and its measurement in more particular and/or applied ways, the Hart and Craig (*ibid.*) and PDMA papers are, clearly, particularly valuable in that they offer a more capacious insight into product development performance as a multi-dimensional concept which may be **measured** in a variety of ways.

This provides a more complete (yet, extremely accessible and adoptable) starting point / reference point / framework than any other currently available from / within which researchers and practitioners alike may work in a more thoroughly 'aware' way (whether in a theoretical or applied setting - or in a complete or selective way).

The value of more specific and/or applied research, in offering useful insight into the overall product innovation performance debate should not be underestimated, however ... as the work of Loch, Stein and Terwiesch (1996) on product innovation performance in the worldwide electronics industry, for example, demonstrates ... Loch *et al*'s discussion of product innovation indices in terms of process and output measures highlights the significance of the manner in which the notion of product innovation performance is **conceptualized** as well as the manner in which it is **measured**. This underlines the necessity of working in a way that is not only 'aware' but also 'discerning'.

It should be noted that whilst Loch, Stein and Terwiesch's 1996 differentiation of *process* and *output* performance offers a not insignificant contribution to clarification of the performance evaluation debate, the inclusion of some reference to the probability/frequency of engagement in product innovation activities as another significant dimension of product innovation performance, would have provided more complete coverage of the product realization process - the stated object of the measure. There are also a number of problems with specific indices considered.

Loch *et al*'s indices are based on the analysis of data generated by an international project on 'Excellence in Electronics' which was jointly undertaken by Mc.Kinsey & Co., Stanford University and the University of Augsburg recently (see Mc.Kinsey *et al*, 1994), to investigate significant aspects of product strategy, development, manufacturing and marketing. Ninety-eight electronics firms across America, Europe and Japan participated in the study.

From nine performance variables, the five key indices of **output performance** identified by Loch *et al* were: (i) market leadership (ability to tackle new needs not yet satisfied in the market with products which cannot be copied - and to successfully launch these before competitors), (ii) design quality, (iii) innovation rate (the number of major new products introduced compared to the industry average and the overall number of product introductions normalized by the product life cycle in the industry), (iv) product line freshness (particularly relevant to the personal computer and consumer electronics industries) and (v) design to cost (measuring the development capability of designing manufacturable and cost-efficient products). Together, these accounted for almost eighty per cent of the dataset's explained variance (rounded individual values were: twenty-four, nineteen, fifteen, ten and ten per cent, respectively). Loch *et al* (*ibid.*) also suggest an index of development productivity based on personnel and expense intensity and new product productivity expressed in terms of number of new products / development employees ratio.

Some of the indices identified may be considered 'problematic' from a theoretical and/or pragmatic perspective. The general applicability of the first index identified is very much open to challenge from a marketing theory perspective, for example. The second would seem to be more appropriately linked to product performance than output performance. The third incorporates no measure of incremental product change - thus the value of the index as a measure of overall product innovation output is questionable.

In exploring **process performance** indices, Loch *et al* examined four areas of development process quality: (i) focus and structure of R&D, (ii) project management, (iii) cross-functional integration and (iv) people management and learning - BUT instead of generating a set of *measures of* the effectiveness of management of these areas of *process* performance - as might have been expected, they simply identified a set of measur*able* process characteristics having demonstrable links to development *output* performance, offering no suggestions as to how this reduced set of process characteristics might be measured. From a total of twenty-eight individual variables a number of so-called key 'process performance' indices were identified. These are: use of external sources of ideas, early use of prototypes, design complexity, value engineering, team rewards with negative loadings for early purchaser and marketing involvement, job rotation and team structure.

Clearly, the *specific indices* of product innovation performance considered by Loch *et al* are significantly less useful to the present study and, indeed, generally less useful than they may have at first appeared.

The value of Loch *et al*'s contribution to clarifying the ongoing performance measurement debate ***at a philosophical level*** does, however, stand.

1.4 THE INNOVATION PERFORMANCE OF IRISH INDUSTRY

It is interesting to find that *every major report on industrial policy in Ireland, published since the* <u>*sixties,*</u> *has expressed concern for innovation.*

Some of the more recent reports include the 1992 Culliton Review, the Henley Centre Ireland / Synectics Ireland 'Innovation in Ireland Report', the 'Innovation in SMEs' report of the Irish small and medium sized enterprizes association (ISME) and the 1995 report of the Science, Technology and Innovation Advisory Council (STIAC). The Culliton Review identified technological innovation as a non-optional pre-requisite for growth in output, employment and competitiveness in Irish industry (Culliton, 1992).

Indeed, there is substantial evidence to suggest that there is still ***considerable*** scope for increasing innovation activity, in all its forms, at all levels throughout Irish industry:- the findings of recent research indicate that, overall, its innovation levels appear to be quite low.

For example:

- The 1994 Forfas Irish Innovation Survey[12] (Fitzgerald and Breathnach, 1994) constitutes the most recent and most comprehensive[13] overview of innovation practice and performance in Ireland today[14]. The findings of this survey indicate that just 33% of the 3,074 Irish firms surveyed could be classified as innovation-performing (products/processes) during the period 1990-1992.

- Findings of the 1994 Irish Innovation Survey, relating to ***product*** innovation, indicate that just 18% of Irish industry turnover may be accounted for by products that are either completely new or changed to some degree[15].

- Cogan (1993, in Kleinknecht and Bain, 1993) indicates a product innovation ratio of just 0.32 innovations per 1000 employees for Irish indigenous manufacturing firms[16].

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[12] conducted as part of a European Union, europe-wide (EC:OECD/EUROSTAT) innovation survey
[13] it should be noted that whilst this study does not constitute an *in-depth* analysis, it does provide an excellent *overview* of the innovation practices and performance of Irish industry today
[14] in which 3,074 manufacturing firms with 10 or more employees were surveyed
[15] this is deemed relatively poor when compared with both european and world statistics
[16] It would seem appropriate to add an cautionary note with regard to the value of *'shock statistics'* such as this purported indicator of Irish industry's comparatively poor innovation performance, that is: the reader's attention is called to the basis of assessment and comparison provided by such statistics.

- The second (1994) annual report of the European Observatory for Small and Medium Sized Enterprises (SMEs)[17] places Irish innovation performance in a european context. It shows that whilst innovation levels in Ireland compare[18] well with countries like Greece and Portugal, they compare poorly with countries like Britain, France and Germany.

The foregoing are the *only* currently available overall performance indicators for Irish industry - and growing concern over the less than ideal performance profiles depicted by them, means not only that 'innovation as competitive imperative' has taken on a new significance for Irish industry today ... but also that the particular case of *product* innovation (for which available profiles are cause for particular concern) would, certainly, seem to warrant special attention.

> The Chief Executive of the Irish Exporters Association commented in an article in the Irish Times (October, 1993) that '...we have a major product problem in this country. There is a major need for investment in product design, in packaging, in the application of technology. In order to go to market, you have to have marketable products'. (Fitzgerald and Breathnach, 1994, p. 1).

This observation still holds true today.

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[17] most Irish manufacturing firms employ less than 500 people and as such would be deemed SMEs according to EU classification; indeed, 60% of firms employ less than 20 people
[18] comparison based on 1990/1 OECD figures for gross expenditure on R&D as a percentage of gross domestic product

1.5 FACTORS UNDERLYING THE INNOVATION PERFORMANCE OF IRISH INDUSTRY

1.5.1 The determinants of action: trait, state and interactionist theories.....

A formal definition of action is not easily made. The concept extends beyond the observable to underlying potentials, propensities and processes. Psychologists have traditionally modelled action in terms of purposive behaviour - whether rational or irrational, adaptive or mal-adaptive. If the notions of innate and acquired potentials and propensities and socio-economic context are added, Warr's (1980, in Chapman and Jones, 1980) classification of purpose is extensive enough to encompass the majority of explanations proposed to date:

- *innate and acquired potential and propensities;*
- enduring motive structures;
- the intrinsic desirability of an immediate outcome;
- the intrinsic desirability of consequential outcomes;
- beliefs about outcomes;
- trends in aspiration level;
- social comparisons;
- social pressures;
- role context;

- spatio-temporal context;
- motivational context
- *socio-economic context*.

Without the addition of potentials and propensities, Warr's taxonomy constitutes a predominantly situational perspective on action and whilst the nature/nurture debate remains unresolved, it would seem unreasonable to overly de-emphasise the other generally accepted non-situational determinant of action.

The nature/nurture distinction between innate determinants and situational determinants has long been considered by psychological theorists to be of substantial importance in explaining and predicting behaviour.

The term 'trait' has been used to refer to those innate characteristics or basic 'drives' which demonstrate relative stability over time while the term 'state' has been used to refer to those more modifiable characteristics that are acquired through 'living and learning' and which therefore being situationally linked, show considerable fluctuation over time. Both have been considered important - though distinct and separate - combinatorial determinants of behaviour (see, for example, Kline, 1983).

The notion of traits or trait clusters (the sum total of the characteristics (traits) of an individual which contribute to his/her behaviour, to his/her being him/herself, different from others - see Kline, 1983) has been implicit to most psychometric models proposed/adopted to date and it has been the aim of personality research to elucidate and measure these traits/trait-clusters while, until recently, 'state' theorizing has, on the other hand, been largely left to the behaviourists.

Formal re-evaluation of the relative value of traits and states as explanda and predictors of behaviour was initiated by Mischel (1968) who found very little evidence for the temporal stability and cross-situational consistency in behaviour that would be expected if traits were the more valid and reliable. Block (1977, in Magnussen and Endler, 1977) suggested that the poor empirical support found was not so much due to inadequacies inherent in the trait model, as to a number of methodological inadequacies in much of the personality research conducted.

An interactive 'trait x situation' model was later proposed by Mischel (1977, in Magnussen and Endler, 1977). With the introduction of this latter model, personality research entered a new era, however, with a move toward person-centredness and more contextually oriented approaches to personality. Dominating current thinking seems to be the dictum: 'continuity amidst change and change amidst continuity' . Thus, today, it is studied at many different levels ranging from the concrete (for example: behavioural responses) to the abstract (for example: central orientations or behavioural styles that typify individuals across a variety of situations).

This fits well with cultural psychology's consideration of individual psychological (personality) traits as being activated (or not) and shaped by exposure to particular cultural influences through participation in normative social institutions and practices (for example: national or organizational). Indeed, learning processes can no longer be deemed incompatible with the existence of an inherited system of complex forms:- it is a core assumption of cultural psychology that what is innate may, indeed, be refashioned through 'cultural learning'.

Notwithstanding the fact that the interactive 'trait x situation' model has more intuitive appeal than either of the more reductionistic trait or situation models alone, the interactive model is not without its problems, however, if one needs to know how the array of characteristics of each individual interacts with the array of characteristics of each situation, in order to explain and predict behaviour. The interactionist model may, however, be imminently useful in cases where one can specify in advance the more generalized interactions which facilitate the prediction of behaviour in a broader range of situations or for a broader group of individuals.

1.5.2 Current speculations on the determinants of the innovation performance of Irish industry

We are just now, in fact, beginning to systematically examine the general overall innovative performance of Irish industry. Thus little is yet actually *known* about the reason(s) for its relatively poor innovation performance. There is, however, much *speculation* on the subject.

> "Speculations", he says, "are useless until you have all the facts. But I've noticed often enough that it isn't like that with him, really. He begins speculating right away, if you ask me, and his speculations suggest which factors to hunt for next....I really believe he is guessing all the time, and this is what makes him so good a Detective Inspector" (Innes, 1946, in Sims et al, 1986, p. 248).

A review of existing literature and popularly held belief indicates that speculations on the reason(s) underlying the relatively poor innovation performance of Irish industry, run the full gamut from non-innovativeness and risk averse psycho-cultural trait theories (see, for example: Healy, 1982, the 1995 STIAC report which discuss negative attitudes to risk taking in the context of the overall lack of an enterprise culture in Irish society and, to a lesser extent, the Irish innovation survey's reference to 'excessive perceived risk') to practicabilities such as significant financial constraints (Fitzgerald and Breathnach, 1994).

Notwithstanding this, existing proposed explanations appear inadequate and incomplete. Firstly, while interesting and potentially useful, they tend to constitute global claims which are presented in such general terms as to prevent their subjection to empirical testing for validation or refutation - as Lee (1995) observes, there may well be some anecdotal evidence to suggest that there is at least some truth in each of these perspectives BUT there is, at present, at least, little or no solid empirical evidence to support any one of them. Secondly, when existing proposed explanations are examined in relation to each other, it is found that they would appear to contradict each other. They offer alternative perspectives but no attempt to reconcile or account for significant inconsistencies. According to one proposed explanation, the relatively poor innovation performance of Irish industry is taken to be due simply to lack of innovative ideas (non-innovativeness). According to another, poor performance is taken to be due to a reluctance to take a chance on investing in innovative activities (risk aversion) - which would seem to indicate that ideas exist but the problem lies in getting started on doing something about them. The third seems to indicate that ideas do indeed exist and that there is indeed a will to do something about them - but that the real constraint on the innovation performance of Irish industry is that of funding the process of 'realizing' ideas for innovation.

Clearly, we are faced with the prospect of examining that which Whitelaw would term 'alternative anomalies' (Whitelaw, 1981, in Rees, 1982, p 128).

Given that 'the jury is still out' on underlying causes, it is interesting to note that some researchers are already proposing possible solutions to the problem of Irish industry's relatively poor innovation performance. For example: in the Irish context, the 1995 Report of the Science, Technology and Innovation Advisory Council (STIAC) provides a number of very specific recommendations on enhancing the innovative capacity of Irish industry, *vis-à-vis*: (i) the development of technology- and innovation- based strategies for growth and development and increased focus on technological innovation transfer, diffusion and application; (ii) increased spending on R&D; (iii) more extensive inter-firm collaboration. The recommendations made are hardly unreasonable. Commitment (focus and spend), information and external linkages are, afterall, the three most consistently recommended means of enhancing innovative capacity in evidence throughout the innovation literature today.

The problem is that, notwithstanding the excellent primary and secondary research which forms the basis of STIAC's recommendations, *the problem space* for which solutions are proposed, *remains incompletely defined*. We simply do not (as yet, at least) know enough about at least the weightings of the various proposed underlying causes to either (a) propose anything but very approximative 'best guess' solution paths or (b) assess with any degree of confidence, the real value of any (albeit well intentioned, well-founded and quite possibly entirely appropriate) 'best guess' solution paths proffered.

It is, of course, possible to counter argue that no problem space is ever completely defined and that approximative 'best guesses' are the only guesses ever possible. Given that the present problem space is currently defined in terms of a set of 'alternative anomalies', however, it would hardly seem unreasonable to aspire to better problem space definition in the future with attendant implications for the proposal and assessment of related 'best guess' solution paths.

1.5.3 'National, psycho-cultural traits' and the notion of the (non-)innovativeness of a people

Both historical, national psycho-cultural traits and current national cultural milieu are widely held to exert a strong influence on a country's 'innovative potential' (see, for example, Nakata and Sivakumar, 1996). Certainly, it is *claimed* that historical cultural traits have been shown to contribute to as much as thirty to fifty per cent of a society's capacity to innovate - though current national cultural milieu (other country-specific factors such as the acceptability and/or encouragement of entrepreneurship, size of the national economy and bureaucratic flexibility, not to mention national systems of innovation) would also appear to mediate the observed effect (see, for example, Dunphy and Herbig, 1994).

Anthropological conceptualizations of culture are held to be amongst the most significant and influential of the twentieth-century (Keesing[19], 1981). The following definitions capture the essence of anthropological perspective.

1. 'Culture ... is that complex whole which includes knowledge, belief, art, morals, law, custom, and any other capabilities and habits acquired by man as a member of society' (Tylor, p.1874, in Wallace, 1970, p.6);
2. '[Culture consists of all the] historically created designs for living, explicit and implicit, rational, irrational, and nonrational, which exist at any given time as potential guides for the behaviour of man' (Kluckhohn and Kelly, 1945, in Keesing, 1981, p.67-8).

O'Sullivan *et al* (1994) describe the notion of 'culture' or the 'psycho-cultural' as a multi-discursive determin*ing* sphere of shared meaning which unifies the spheres of production or economics and social relations or politics (see also Hofstede, 1984 and Roth, 1995) but warn that: 'If you are planning to use the term culture as an analytical concept ... it is unlikely that you will ever be able to fix on just one definition that will do for all ... occasions' (O'Sullivan *et al*, 1994, p.68).

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[19] (notwithstanding the fact that the point is valid - it seems appropriate to draw the reader's attention to the fact that Keesing is, in fact, an anthropologist by profession)

That said, Schein's (1990) definition of culture highlights a number of key dimensions of the concept which should probably be reflected in *any* given definition of the concept 'fixed upon' for *any* given occasion. Schein's definition may thus be used as a general guide in either formulating or evaluating any particular definition of the concept for use / as used on any particular occasion - as indicated by the annotated text of Schein's definition which follows (the set of recommended considerations proffered by the present author is presented in emboldened text, enclosed in emboldened parentheses at various points throughout the text).

> (a) a pattern of basic assumptions **[what assumptions , what pattern(s)]**, (b) invented, discovered, or developed by a given group **[what group, how]**, (c) as it learns to cope with its problems of external adaptation and internal integration **[what problems, how good was the coping]**, (d) that has worked well enough to be considered valid **[by whom, as evidenced by ...]** and, therefore (e) is to be taught to new members **[as decided by ..., how]** as the (f) correct way to perceive **[check]**, think **[check]**, and feel **[check]** in relation to those problems ...the strength and degree of ... consistency of a culture **[is it consistent]** [being] ... a function of the stability of the group **[is there evidence of stability]**, the length of time the group has existed **[check]**, the

> intensity of the group's experiences of learning **[what are they, how might their intensity be measured]**, the mechanisms by which the learning has taken place **[that is...]**... and the strength and clarity of the assumptions held by the founders and leaders of the group **[which assumptions: some or all, how clear, how strongly held]** (Schein, 1990, p.111).

As Schein (*ibid.*) observes: '...any definable group with a shared history can have a culture' (again, Schein, 1990, p.111).

Thus the idea of '***national*** psycho-cultural traits and (non) innovativeness of a people' would appear to be an essentially valid one.

The notion of 'nation' or 'the national' is a discursive concept; a relational term; a **symbolic referent** used to differentiate one human group or 'imagined community' from others (see O'Sullivan *et al*, 1994). In 1970, Wallace wrote: 'What distinguishes national character ... is, first, its usual restriction to the citizens of modern, political[ly] organized states; and, second and more important[ly], its emphasis upon the articulation of a large number of components into a structure or pattern' (Wallace, 1970, p. 149).

Today, the heterogeneity of pluralistic multi-racial, multi-cultural and multi-lingual territories engendered by ever increasing human migration and mobility, begs the question ... 'Are national identities as unyielding as the land in which they exist or do they cross boundaries of social and cultural integration creating new meanings? Is there such a thing as authentic 'Irishness'?' (O'Toole, in O'Kelly, 1995, p.15). ...or, indeed, one might add, authentic 'Irish (non) innovativeness'...?

(Lee (1994), for example, refers to 'a contemporary Irish psyche' as an elusive matter, the assumption of the existence of which requires a 'soaring leap of faith' (Lee, 1994, p.245).)

Certainly, it would seem that issues of territories, ethnicities and ethnic transcendancies would have to be addressed before an assessment of a national psycho-cultural trait model of the innovation performance of Irish industry could be attempted. The investigation of current national cultural milieu is, however, another matter entirely...

1.5.4 National systems of innovation

Generally speaking, the term 'national systems of innovation' refers to the institutional and infrastructural, innovative capacities and capabilities of national economies.

Nelson (1993) suggests that the term may, in fact, be interpreted in a variety of ways depending on how each of its component terms 'national', 'system' and 'innovation' are defined. In searching for a 'common denominator definition' to facilitate comparative analysis, Nelson and Rosenberg (in Nelson, 1993) suggest that in essence the term may be defined as follows:

1. They suggest that, in essence, the term 'innovation' may be defined as: 'the processes by which firms master and get into practice product designs and manufacturing processes that are new to them' (Nelson and Rosenberg (in Nelson, 1993, p. 4)).
2. They suggest that the term 'system' may be defined in terms of a (not necessarily consciously designed and built) 'set of institutions whose interactions determine the innovative performance ... of national firms' (again, Nelson and Rosenberg (in Nelson, 1993, p. 4)) ... though, their usage of the term 'interactions' would be better replaced by the term 'cumulative actions' to encompass the independent as well as interactive actions of these institutions.
3. Finally, they suggest that the term 'national' may be 'too broad' (Nelson and Rosenberg (in Nelson, 1993, p. 5)) or at least problematic. They, too, question the extent to which 'national' communities exist, asking 'To what degree, and through what mechanisms, do the individuals and institutions that advance technology divide up into 'national systems'?' (Nelson and Rosenberg (in Nelson, 1993, p. 15)).

The focus upon the national reflects the view that:

> national economies differ regarding the structure of the production system and regarding the general institutional set-up. Specifically, [it is assumed] that basic differences in historical experience, language, and culture will be reflected in national idiosyncrasies in:
>
> -Internal organisation of firms
> -Interfirm relationships
> -Role of the public sector
> -Institutional set-up of the financial sector
> -R&D intensity and R&D organisation.
>
> (Lundvall, 1992, p.13).

Tangible evidence of the growing popularity of alternative views - with an emergent shift of focus from 'national' to that which is viewed as more theoretically valid and more practically useful 'sectoral' and other (local, regional and global, for example) delineations, has, however, begun to appear in the literature of late (see, for example, the proceedings of the second conference on management research in Ireland, 1997).

In 1993, Nelson and Rosenberg observed that regardless of whether the concept of a national system of innovation makes any sense at all in theory or practice, most national governments certainly seemed to act as if it did. They still do.

As Lawton (1996) observes, some form of industrial policy is generated and implemented by all industrialized and industrializing states. Certainly, throughout the nineties, most, if not all, policies have become increasingly characterized by at least some (direct or indirect) reference to the importance of innovation and the state's national system of innovation - and Ireland is no exception as indicated in section 1.4 of the present text.

'over the last 10 years ... Improved company capability, particularly in technology marketing and management, has become the priority' (O'Doherty and Mc.Devitt, in O'Doherty, 1995, p.318).

In this context, it is interesting to note that the 1995 Report of the Science, Technology and Innovation Advisory Council (STIAC) advocates the Irish State's adoption of a more coherent approach to innovation, science and technology across the whole spectrum of government policy and spending and the continued development of the following innovation support structures in particular:

- services and grants administered by Forbairt, FAS and ABT;
- Business expansion scheme (BES) tax reliefs;

- Programmes in Advanced Technologies (PATs),

  equity funds / loan guarantees, et cetera.

Indeed, it recommended that the government should immediately allocate an additional IR£25million in developing Ireland's National System of Innovation.

It should be noted that at the time, the major part (89%) of government support for Irish manufacturing is directed towards improving productivity and reducing manufacturing costs:- only 11% of government support is directed towards investment in R&D and other intangible assets - the areas of greatest need as highlighted by the Organization for European co-operation and development (OECD)[20] (see Cogan and Moran, 1995, in O'Doherty, 1995).

1.5.5 Other cultural perspectives: organizational or corporate culture, for example

Organizational or corporate culture may be defined in terms of an organization's values and ideologies[21], both of which are, obviously, prone to change over time. Traditionally these elements have been framed in

[20] The comparative figures for Denmark are practically the inverse: 21% and 79% respectively
[21] (and, of course, the observable artifacts of these)

terms of concrete behavioural and normative processes. Today they are being re-framed in abstract form: 'ideational, descriptive phenomena ... webs of significant meanings, open to negotiation, interpretation and misinterpretation' (Leavy and Walsh, 1995 , pp.193 and 209).

Over the years, researchers have identified a number of factors which seem to differentiate between technologically progressive firms and technologically non-progressive firms; innovative and non-innovative firms; firms with high innovation success rates and firms with low innovation success rates.

In one of the earliest studies of technological innovation (referred to earlier in section 1.1 of the present text) Carter and Williams (1957) identified twenty-four characteristics associated with technically progressive firms - but absent in unprogressive firms.

The key factors identified by Carter and Williams (*ibid.*) may be summarized, after Barclay (1992), in terms of: an open-minded, committed, supportive and professional management; a customer- and market- based business strategy including a willingness to take on new knowledge and utilize external sources of innovation; a unique and superior product that meets customer wants and needs; good internal and external communication and co-ordination; adequate resource provision for technological activities. These factors appear repeatedly in subsequent literature as factors which have been shown to contribute to higher rates of innovation and the successful outcome of innovation activities generally.

The Carter and Williams study was significant in two ways. Firstly, it emphasised not so much what a company did, as how it did it. Secondly, it highlighted not just concrete behavioural processes but also a number of ideational and symbolic phenomena.

Today, the effective crafting[22] of corporate capacities, capabilities, competencies and processes is identified as a key 'core competence' competitive strategy for the nineties by, for example, Prahalad and Hamel (1990) and Wheelright and Clark (1992). This does not mean a return to the rational planning and control era. It refers, rather, to the sculpting of process - the preparation and preparedness of the elements of process, the planning, sensitivity and complementarity (appropriateness) of process element activation and, of course, the ultimate performance and effectiveness of the activated process. In effect, this means a slight shift of focus: (a) from the simple 'how' of Carter and Williams to questions of 'how readily' and 'how well'; (b) from the predominantly concreteness

[22] (with apologies to Mintzberg ... see Mintzberg, 1987 on crafting *strategy*)

of Carter and Williams characterizations to a more symbolic representation; (c) from the goals of fine-tuning, fit and excellence to the pursuit of symbolic shaping (see, for example, Pennings *et al*, 1985, Prahalad and Hamel, 1990, Boam and Sparrow, 1992, Leavy and Walsh, 1995, Handy, 1995 and Stalk 1992 and Hammer and Champy, 1993 - both in Leavy, 1996).

Yet whilst the importance of developing a well crafted process cannot be overemphasised, evidence suggests that, above all, those organizations that succeed at innovation are those that make an unwavering commitment to it (Storage, 1989, in Mc.Kee, 1992).

Finance is, of course, a very tangible manifestation of corporate commitment. It is hardly surprising that the findings of the Irish innovation survey indicate a positive association between innovative expenditure and innovation activity levels. Both were found to be greatest in the electrical/electronic equipment and machinery categories. The same pattern of association was found in the areas of: chemicals and pharmaceuticals; non-metallic minerals; instruments; transport; textiles, though absolute values for expenditure and activity in these latter areas were lower.[23] As regards those absolute values, it is interesting to note that STIAC

[23] It is interesting to note that current innovation expenditure within firms was found to be greatest in the area of research and development (36% of budget on aggregate across all firms) and product design (28%) with trial production at 22% on aggregate, market analysis at 10% and patents and licenses at 4%.

recommends that indigenous Irish firms, across the board, work to substantially increase spending on research and development.

1.5.6 'Situational factors' as determinants of the innovation performance of Irish industry

The many situational factors which impact upon a firm's propensity to innovate may be subsummed under two main headings:

1. the more transient aspects of internal and external, human or organizational, technological and financial resources;
2. environment factors such as customers, suppliers, competitors, technical, legal, financial and state conditions.

Innovative capacity may be significantly enhanced through becoming more attuned to each of these factors. In this regard, an adaptation of West's (1992) innovation matrix which incorporates both resource and environmental considerations, may be used by the firm as a general guideline in assessing its likely ability to carry out particular types of innovation as shown in Figure 1.1 ...

Figure 1.1: The Innovation Matrix - adapted from West (1992)

	RESOURCE POSITION		
ENVIRONMENTAL FAVOURABILITY[24]	**high**	**medium**	**low**
high	sector creating	performance extension	reformulation
medium	process	technological re-organization	design
low	branding	service	packaging

Whichever type of innovative undertaking is contemplated, it should be noted that, in general, studies show that innovative undertakings must be appropriate to the strategy, size and capabilities of the enterprise and that the innovator must plan and cost the project as precisely as possible.

[24] West uses the term 'market attractiveness' here.

In a preliminary analysis of data derived from the Irish innovation survey, Fitzgerald and Breathnach (*ibid.*) identified three significant clusters of situational factors hampering innovation in Irish companies. These were:

(a) financial factors,

predominantly: excessive perceived risk in relation to anticipated scale and speed of return on investment, lack of finance;

(b) company-specific factors,

predominantly: the firm's knowledge, information and skill base;

(c) miscellaneous other factors,

predominantly the current framework of legislation, norms and taxation, perceived lack of technological opportunities, lack of external technical support services and anticipation of poor customer responsiveness.

It is interesting to find that the three clusters identified incorporate not just some but *all* of the situational factors identified by the literature - albeit to varying extents across the individual companies surveyed (detailed cluster analyses are, unfortunately, as yet unavailable).

1.5.7 The notion of risk: objective/subjective, perception, taking, resistance and aversion

Risk is an interesting factor to consider in the present context. Risk and innovation are inevitably, inextricably linked. Inherent in product innovation is something of a 'risk dilemma':- companies which do not engage in product innovation activities risk reduced competitiveness and eventual decline while those which do risk failure and its attendant costs.

Though the notion of risk in the context of the innovation performance of Irish industry is usually ‘couched’ in terms of a psycho-cultural trait, it is, perhaps, more correctly viewed as a multidimensional concept best described within the interactionist framework.

The concept of 'risk' has been variously defined in terms of uncertainty, probabilities, objective versus subjective perceptions - generally, the weighting of possible undesired consequences of action (losses) relative to comparable possible desired consequences (gains):- see, for example, the 1992 report of the Royal Society Study Group on Risk.

Unpredictability, risk, uncertainty are widely regarded as an integral - almost definitive aspect of innovation and decision-making for innovation (Gold, 1971).

Freeman (1974) identifies three broad categories of unpredictability as general business, market and technical and further classifies innovations by degree of associated uncertainty, as shown in Figure 1.2 ...

Figure 1.2 Classification of innovations by degree of associated uncertainty (after Freeman, 1974, in Kay 1979)

1.	true uncertainty	fundamental
2.	very high degree of uncertainty	radical product/process outside the firm
3.	high degree of uncertainty	major product innovations radical process innovations in own establishment or system
4.	moderate uncertainty	new generations ofestablished products
5.	little uncertainty	licensed innovation, limitation product innovations, modification products/processes, early adoption of established process
6.	very little uncertainty	new model, product agency for established product innovation, late adoption of established process innovation in own establishment, minor technical improvements.

A number of formal risk assessment techniques have been developed to help clarify these uncertainties (see, for example, Souder and Bethay, 1993).

Knight (1921) was amongst the first to distinguish between measurable and quantifiable uncertainty or risk and unmeasurable or true risk. Conceptually, risk and uncertainty are quite distinct, the former depending on the existence of replicability and homogeneity of events and the consequent calculation of probabilities of, for example: occurrence and cost using statistical techniques, the latter on the other hand, defying reduction to objective probabilities and necessitating more intuitively based decision-making (Kay, 1979).

Final risk perception, resistance and aversion are each complex, multi-dimensional concepts which refer to the judgement of the characteristics and consequences of an activity. It would be naive to suppose that such a judgement might be reduced to a single subjective correlate of, say, the product of probabilities and consequences. This would impose unduly restrictive assumptions about what is 'an essentially human and social phenomenon' (Pidgeon *et al*, 1992, in the report of The Royal Society Study Group on Risk, 1992). For example: *attitude toward risk* is an important consideration as it has been shown to constitute a major factor in formulating objectives and establishing priorities for the firm (Ansoff, 1987).

Within the interactionist paradigm, resistance to engage in innovative activities may be viewed as an innate propensity that is subsequently shaped by primary or secondary experience, made manifest as a final behavioural response, more specifically, a form of behavioural resistance. The literature suggests that behavioural resistance is a function of two factors: (i) perceived risk and risk resistance; (ii) habit and change resistance (see, for example, Sheth, 1981, in Ram, 1989).

'Perceived risk' may be broken down into the following categories, after Sheth, *ibid.*: (a) functional risk: the fear of performance uncertainty; (b) economic risk: the fear of economic loss; (c) social risk: the fear of social ostracism or ridicule; (d) psychological risk: the fear of psychological discomfort.

Degree of perceived risk and degree of risk resistance are held to be positively related $(0 < r < 1)$:- the higher the perceived risk, the higher the 'risk resistance' to innovation.

'Habit' refers to reluctance to change from current practice or routines to which the resistor has become accustomed. Degree of habit formed and degree of change resistance are held to be positively related $(0 < r < 1)$:- the greater the change from current habit 'threatened' by a potential innovation, the greater the 'change resistance' is likely to be to it.

It follows that overall 'behavioural resistance' to innovation is highest (thus disfavouring the adoption of innovative behaviour) where both risk resistance and change resistance are present - and lowest (thus favouring the adoption of innovative behaviour) where neither perceived risk nor habit is present.

Actually, the general organizational change literature boasts a vast array of explanda and suggested interventions for the inertia, risk avoidance and resistance to change which characterize many individuals and organizations, many of which may be readily adopted by those wishing to address resistance to habit change in the context of innovation.

The behavioural/interactionist framework presents the simplest potential solution path, however. Within this framework, the problem of risk resistance in the context of innovation may be addressed as follows:- firms, though perhaps innately predisposed to excessive risk resistance, can reduce perceived risk by implementing a positive behaviour modification / organizational learning (see, for example, March and Olsen, 1975 and Fiol and Lyles, 1985) cycle of firstly, actively seeking and gaining a better understanding of the innovation process (in particular, those known determinants of outcome success/failure) - and then using this knowledge to build innovative capacity, adopt a more effective, perhaps more structured approach to managing innovation projects ... reducing risk through building known success factors into each stage of each project (in particular, those early stages of concept, market and technical screening).

1.5.8 On the diversity and (relative) significance of factors underlying the innovation performance of Irish industry

> ...the search for the source of ... performance has much in common with hunting the Heffalump. The Heffalump is a rather large and very important animal. He has been hunted by many individuals using various ingenious trapping devices, but no one so far has succeeded in capturing him. All who claim to have caught sight of him report that he is enormous, but they disagree on his particularities (Kilby, 1971, p.1).

Much work must be done before full and accurate explication (nomination and assessment of the relative significance) of those factors underlying the overall innovation performance of Irish industry is achieved (particularly in the absence of a meta-theory of innovation which might serve to illuminate the contingency in that which at present appears chaos)[25].

Yet, at least some practicable progress is possible in the shorter term ... particularly in relation to the *product* innovation performance of Irish industry ...

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[25] In the *pre-'postmodern'* (!) era of chaos and contingency, attempts would have been made to choose between factors - which would have been construed as competing theories.

1.6 FACTORS UNDERLYING THE PRODUCT INNOVATION PERFORMANCE OF IRISH INDUSTRY

> If the scientist had at his disposal infinite time...it would only be necessary to say to him, "Look and notice well"; but as there isn't time to see everything, and as it's better not to see than to see wrongly, it's necessary for him to make a choice...There is a hierarchy of facts...Choose those that *seem* simple (Pirsig, 1974, p.267-8).[26]

One possible route to gaining a clearer understanding and progressing the issue of the factors underlying the *product* innovation performance of Irish industry (the key concern of the present study) may lie in the 'Pirsigianly' simple facts to be found in the underexploited finding of an isolated and underpublicized study conducted a decade ago[27] by O'Sullivan and Tomlin (1985)[28].

In the course of their study, O'Sullivan and Tomlin observed that, over the five year period 1980 - 1985, established Irish companies had initiated a large number of product development undertakings (that is: had *begun* to develop a considerable

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[26] The Neisserian principle of studying variables that seem simple in an *elemental* and *ecologically important* sense moreso than an *easily manageable* sense (Neisser, 1976) constitutes a useful explication of the term 'simple' as intended in the Pirsigian sense.
[27] Several researchers (including, for example: Spindler and Spindler (1982, in Spindler, 1982)) have demonstrated how new application or new interpretation of even decades old data can generate significant insight into old or new problems.
[28] ...but what of other facts ... indicative of other factors? Well, as Kaplan and Manners observe, in the end, all theorizing is, afterall, 'in practice...' and, certainly, for most, if not all practical purposes '...a matter of emphasis' Kaplan and Manners (1986, p 90, in Flinders and Mills, 1993, p 110)...

number of innovated and innovative products) *but* had successfully completed *just some* of these (that is: had brought just some of these product development initiatives through to final successful launch onto the marketplace). Now it must be said that failure to realize the *total* complement of innovative ideas is not unusual.

There are, in fact, *many* possible reasons why even in the context of a flawlessly executed robust product realization process, the most brilliant, innovative ideas may never actually be realized. In reviewing the international innovation literature we find that - as Knobil and O'Dwyer observe:

> There is a multiplicity of reasons why some brilliant ideas never [even] get past concept stage: the work was presented in a ...pitch that wasn't won; the ...budget was cut;...too controversial; the...handler failed to present it well; ...didn't research well; the chairman felt uncomfortable about it; etc. (Knobil and O'Dwyer, 1993, p.8).

There is, also, of course, to paraphrase Larson (1990), the occasional idea that just plain and simple doesn't work (and, presumably, by extension, the occasional idea which is not inappropriately deemed *in advance,* unlikely to work and, therefore, arguably appropriately screened early on in the process).

It is interesting to note that, again, as Knobil and O'Dwyer (1993) observe, the 'never seen' ideas are frequently far more creative than those which eventually are ('...good things lost amidst a wilderness of weeds, to be sure', Bronte, in Cookson, 1983, p. 181).

Thus it must *not* be considered *unusual* to find that a substantial proportion of a company's product innovation effort is ultimately unproductive of a realized new or improved product ... HOWEVER .... The possibility that *almost half* of Irish industry's overall product innovation effort may be found to be ultimately unproductive of a marketable realized new or improved product as indicated by the O'Sullivan and Tomlin study, must surely constitute a cause for concern (forty-two per cent of products could not be shown to have been successful)

The fact that the greater proportion of unsuccessful product innovation initiatives were found to have failed in commercialization could, of course, be interpreted as being an artefact of poor marketing skills. A more interesting alternative interpretation of this statistic might be the possibility of its being ***an artefact of an under-estimation of failure-in-development figures***.

O'Sullivan and Tomlin entertained only the former interpretation - and, not unreasonably: Irish figures appeared to compare reasonably well with US figures published around the same time. On the latter, O'Sullivan and Tomlin cited a report on the findings of a Booz-Allen survey which indicated that: '...only one product in five put into development succeeds commercially: about 67% fail in development or testing (usually because of negative commercial feedback), while about 33% of the survivors fail after being commercialized' (Booz-Allen, in O'Sullivan and Tomlin, *ibid.* p. 68). Taken at face value, an overall success rate of fifty-eight per cent for established Irish industry certainly appeared to compare more than well with twenty-two per cent for US firms. Nevertheless, it is clear that O'Sullivan and Tomlin noticed that the Irish figures were 'phenomenally high', (O'Sullivan and Tomlin, *sic.*). They attributed this to **<u>an apparent</u>** tendency of Irish firms to 'follow a more conservative policy than larger U.S. corporations, introducing fewer and 'safer' products.' (O'Sullivan and Tomlin, *sic.*). In going on to state that: 'Such failures as there are take place at the commercialization phase rather than in development...' (O'Sullivan and Tomlin, *ibid.*, p. 68[29]), O'Sullivan and Tomlin seemed to suggest that any observed failure in Irish product development undertakings should be interpreted as having nothing to do with the firms themselves or how they went about the process of innovating - that they were doing *their* job (development) just fine and failure, when it occurred, was due to factors that were essentially 'beyond their control' (market acceptance) - that it is 'not their fault' and therefore somehow acceptable. Thus a generally positive impression of the product innovation effort of Irish industry was generated.

[29] this statement seems inconsistent with the earlier cited forty per cent failure rate in the course of development - unless the other was considered to be entirely an artefact of effective screening?!

... BUT what if ...

the fact that the greater proportion of unsuccessful product innovation initiatives were found to have failed in commercialization WAS, IN FACT, entirely, largely or even partially an artefact of an under-estimation of failure-in-development figures AND NOT just an artefact of poor marketing skills?!?

O'Sullivan and Tomlin seem to have entirely overlooked possibility that where rates of failure-in-development are relatively lower than rates of failure-in-commercialization, this could, possibly, be indicative of a development process that is failing to generate an appropriate level of screened-and-abandoned and/or properly realized (that is: commercially readied) product innovation ideas.

Presumably, at least some early commercial screening, generally better 'market ready-ing' and later market readiness testing can be built into the development process in advance of the process of commercialization *per se* (the findings of an American based investigation by Cooper and Kleinschmidt (1986) into the impact of the manner in which new product development is conducted on final project outcome, are suggestive of the validity of this supposition).

The ultimate failure of a completed development effort must surely represent a more substantive waste of valuable resources than the failure of a partially completed undertaking and should therefore arouse greater concern. It follows, therefore, that failure in the course of development is arguably preferable to failure in the course of commercialization.

In the absence of data we can merely speculate that it may well have been the case at the time, that at least some new or improved product ideas should never have been progressed to commercialization stage[30] and that at least some of those which were, were quite possibly ill-*pre*-pared for commercialization. We can certainly argue from a theoretical perspective, that optimization of the development process (in terms of both design and execution) could conceivably lead to reduced failure rates at commercialization (if only by virtue of the fact that fewer ill-fated projects make it through to commercialization.) and whilst this might not necessarily lead to reduced failure rates overall (failure rates at the development stage may be increased), it would probably mean that valuable resources would be used to best advantage (if only freed up from unsound projects and re-directed to alternative and potentially, ultimately, more successful innovative undertakings) thus rendering the overall product innovation effort ultimately more effective, more productive and potentially more successful in the final analysis (though this may not perhaps be reflected in all quantitative measures.).

[30] (at least, at that particular point in time)

The foregoing exposition of O'Sullivan and Tomlin's oversight should not be viewed as a slating criticism of the research as presented. Afterall, the researchers' interpretation of the data was entirely supportable - as shown. The alternative interpretation presented may, indeed, have occurred to and, upon deliberation, been dismissed by the researchers.

It is, however, sometimes interesting to (re-visit and) explore the less obvious - less likely interpretation - for the effects found in data ... in the present case, based on 'within process' rather than 'cross-cultural' comparisons (indeed, the latter basis of comparison may not have been as useful as might have been ***assumed*** - as indicated by, for example the possibility that overall *US* failure rates may well have been, in an objective sense, inordinately high and, consequently, perhaps not a great basis for comparison, for example (a possibility which O'Sullivan and Tomlin may have but did not present as having considered)).

Both interpretations have potentially important implications for both the immediate and the more general issues at hand, that is, in regard to factors underlying the product- and, more generally, the overall- innovation performance of Irish industry. Summarily, they suggest that, with regard to *product* innovation, at least[31], ideas for innovation do exist and that there is a will to do something about them BUT that it is possible that the issue of what is done and, more specifically,

[31] (though there may be attendant implications for innovation generally)

how it is (or, indeed, may best be) done, *may* constitute a far more *immediate* if not significant determinant of the final innovation performance of Irish industry than any of the various other factors that have been suggested to underlie Irish industry's relatively low *overall* innovation performance levels and therefore a reasonable starting point from which to explore these various factors.

The alternative interpretations proferred suggest two possible bottlenecks in the process of transforming innovative ideas into performance statistics. The O'Sullivan and Tomlin interpretation would seem to indicate a post-development marketing bottleneck; the interpretation presented in the context of the present research would seem to indicate an earlier, in-development bottleneck. Further exploration of both seems warranted, the long-term research path usually found to be productive in such cases, being: in-depth, individual and/or sequential (for expediency) progressing, if deemed appropriate, to comparative.

To begin, the present research would explore the earlier bottleneck suggested.

'I have never doubted the truth of signs ... they are the only things man has with which to orient himself in the world', (Eco, 1980, translated by Weaver, 1984, p.492).

It certainly seemed that investigation of the manner in which Irish companies 'manage'[32] the process through which innovative ideas are transformed into marketable products could well prove useful route to gaining a clearer understanding of the final product innovation performance of Irish industry and identification of any possible deficiencies in the practices of Irish companies in this regard - and, indeed, the manner in which these deficiencies might be addressed, could well prove an important key to more successful product (and, perhaps by extension - certainly, by virtue of contribution: overall) innovation performance in the future[33]. Certainly, the broader innovation literature seemed to suggest that successful product innovation might be validly viewed in terms of a skill which might be learned, performed at varying levels of competence and gradually mastered (see Mc. Kee, 1992, for example). Evidence for this exists in the form of the observable ability of some firms to develop and launch new an improved products with more consistent success than their competitors - but also in the observable differences across firms and over time, which would seem to indicate

[32] that is: design, mobilize and execute - see section 1.5.5 on the 'crafting of process' (versus rational planning and control)

[33] The notion of 'the crafting of process' should not necessarily be viewed as a panacea for the difficulties that face Irish industry today, however.

the practice effects of exposure to and action on the basis of exposure to the learning experiences of previous innovation undertakings.

A number of important questions arose ...

Firstly, there was the question of the degree to which the findings of the O'Sullivan/Tomlin study related to *current* product innovation practices and performance of Irish companies - afterall, the study had been carried out a decade earlier. Then, there was the question of whether the phenomenon of an under-optimized development process' was contributing to the poor final product innovation performance levels in Irish industry so frequently decried today. If it were found to be so doing, then the question of the extent and nature of the problem and the extent of the contribution would follow ... and, of course, the question of how the problem might be addressed ... for example ... Does an 'idealized formula'[34] or, alternatively[35], some form of 'useful framework' or a 'baseline set of craftable strategic building blocks' for the product realization process exist? If so, to what extent is this formula/framework/baseline set in evidence in Irish firms - what are the (in-)consistencies? Does the extent of its implementation impact on ultimate project outcome (that is: successful and appropriate realization of new or improved product or not)? How is this impact effected? Is it through the

[34] (whether 'politically correct' or not *a propos* recent paradigm shifts in management thinking away from formulaic panaceae)
[35] (and, at present, immensely more politically correctly)

effectiveness or ineffectiveness of full or partial implementation:- are projects which should be halted being halted and is it only projects which should be halted that are being halted? Is there any particular 'weak point' where a breakdown in the realization process or inappropriate continuance in the realization effort is more likely to occur? If no 'idealized formula', 'preferred framework' or 'baseline set of craftable strategic building blocks' exists, how is the product realization process characterized or crafted in Irish firms - what are the (in)consistencies across firms? Again, what are the impacts of each of the various characteristics and craftings identified, on final project outcome? Again, is there any particular characteristic or crafting more strongly associated with either failure to realize or success in inappropriate realization, than the rest?

A small preliminary study was conducted in the context of the present research in order to further explore both the general issues raised and more specific questions listed ... with a number of rather interesting results. Details of the design and findings of this study - which will be referred to henceforth as 'Study One' - are presented in Chapter Two.

CHAPTER TWO

Study One:

a preliminary, exploratory investigation into

the product development practices

of Irish industry

2.1 INTRODUCTION AND OVERALL AIM OF THE STUDY

Study One constituted a preliminary investigation into the possibility that the relatively poor product innovation performance levels which have been found to characterize Irish industry today, might be linked to deficiencies in the manner in which the process of transforming innovative ideas into marketable products (the product realization process) is managed by Irish firms. This exploratory study was prompted by the issues outlined in section 1.6 of the present text. In the course of discussing these issues informally with a number of individuals familiar with innovation in Irish industry (representatives of government and semi-state bodies and business consultancies), it became increasingly apparent that as an *initial* exploration of the problem space, the study should take as its primary focus the *realization* power rather than the screening power or both the realization and screening powers of the product development process - such that the focus of the study would be that of the rate of transformation of innovative ideas into *market-ready* products rather than the rate of transformation of *commercially promising* product innovation ideas and its overall aim would be to explore the notion that an under-optimized product realization process (that is: a product realization process that is deficient in respect of either design or execution) has the capacity to negatively impact on the rate of transformation of innovative ideas into market-ready products and thence, ultimately, to negatively impact on final product innovation performance levels.

2.2 DESIGN: METHODOLOGICAL FRAMEWORK AND STUDY OBJECTIVES

The key objectives of Study One were:

(1) to obtain a general level characterization of the product realization process as (routinely) managed by Irish companies;

(2) to assess its adequacy;

(3) to identify possible deficiencies in its characterization;

(4) to explore the possibility of differential association of process adequacies and deficiencies with successful realization of product innovation ideas (that is: with completeness and incompleteness of transformation of innovative ideas into market-ready products);

(5) to assess the potential validity of the suggestion that the currently, relatively poor final product innovation performance of Irish industry may be attributable *a priori*, at least in part, to a deficient product realization process.

The principal (and, inevitably, closely linked) issues to be addressed in designing the study were (i) level of characterization; (ii) basis of evaluation and comparison (whilst the study was intended to be generally exploratory in nature, its objectives were very specific, requiring comparison based analyses and comparative assessments). Hence, the investigation would have to be formally structured from the outset in order to ensure that it would generate a data set of a sufficiently useful and consistent level of detail so as to facilitate meaningful characterization, evaluation and comparison.

The possibility that the Cooper and Kleinschmidt (1986) study referred to in chapter one, might provide some indication of an appropriate structure for Study One, was suggested by the similar objectives and productive nature of the earlier study. A generic template of the product innovation process formed the basis of Cooper and Kleinschmidt's investigative framework. The template consisted of thirteen key product development activities[1]. These were: initial screening, preliminary market assessment, preliminary technical assessment, detailed market study or market research, business or financial analysis, product development, in-house product testing, customer tests of product, test market or trial sell, trial production, pre-commercialization business analysis, production start-up and market launch. The aim of the

[1] The template was both theory- and practice- based, in that it was based on case studies as well as on the more theoretically based prescriptions of the international innovation literature.

study was to assess the extent to which and proficiency with which this template was implementation in target firms (based on the questionnaire and interview prompted assessments of managers most responsible for new product development) with a view to answering the following questions ...

- What happens as a new product project moves from idea to launch? What occurs within each stage of the process - what do people do?
- How well are the tasks or activities undertaken? And what improvements are needed?
- What is the impact of each of these activities on project outcomes: commercial success or failure. Does excellence in each of these tasks really matter?

(Cooper and Kleinschmidt, 1986, p.73).

This brief description of the Cooper and Kleinschmidt study is sufficient indication of reasons why it might have been considered an appropriate guide to framing Study One ... to the extent that Study One should, indeed, mirror the Cooper and Kleinschmidt study.

Regarding the template used in the Cooper and Kleinschmidt study, an overview of the literature indicates that the product development process is traditionally divided into a number of tasks or activities - the precise number being determined by *level of discourse* rather than type of innovation (old or new product development) undertaken (a review of the literature would seem to indicate that all activities are considered to be applicable to all product development initiatives, though any particular one may be carried out in a more or less extensive way, depending on the type of undertaking).

The manner in which Cooper and Kleinschmidt used the notions of product development *activities* and *stages* in the innovation process interchangeably was significant in that it reflected a particular stage in the evolution of the innovation literature's definition of the product development process.

In the past, process tasks or activities were considered to be the sequential stages of a stage-gate type process (see, for example, Booz, Allen and Hamilton, 1982, cited by Hart and Craig, 1993, in Baker, 1993). More recently, however, in accordance with the background developments in the more general management literature, 'The traditional, sequential, product development process ... has been strongly criticized for being too time-consuming, for not bringing out [the best in the process, people or product involved]' (Trygg, 1993, p. 404).

Significant early indications of that which would later become a general - though not complete - move away from the traditional sequential model included, for example, Winner *et al*'s (1988) reference, in a US Institute for Defence Analysis report, to the concept of 'concurrent engineering' as a means to improved quality and reduced cost and cycle time.

Whilst it is true that, throughout the 1986 paper, Cooper and Kleinschmidt appeared to de-emphasize the notion of *sequence* of activities in favour of the notion of *set* of activities - *they never did so explicitly*. The manner in which they employed the terms 'stage' and 'activity' as interchangeable equivalents could thus be taken to be indicative of an implicit sequential perspective.

Before jumping to the conclusion that the Cooper and Kleinschmidt model of the product development process constituted a 'dated', and as such, an inappropriate or invalid guide to framing Study One, however, it was noted that *whilst the notion of product development as 'sequence of activities' had been largely abandoned,* ***the activities themselves endured***. This meant that, *in essence*, Cooper and Kleinschmidt's investigative framework could be viewed as being still substantively valid **today**.

Accordingly, it was decided that Cooper and Kleinschmidt's generic template of the product realization process could be validly adopted to form the basis of Study One's investigative framework - but that it should first be updated to more accurately reflect the latter-day international innovation literature.

A fifteen activity modified template was subsequently developed. The fifteen activities making up the modified template were as follows (italics indicate where the template has been updated): *formalized idea generation* (formalization of the generation process can, in some firms, constitute something of a pre-screening process for informally generated and thus perhaps incompletely articulated innovative ideas), initial *concept* screening (which enables clearer differentiation between concept, market and technical screenings), preliminary market assessment and preliminary technical assessment, detailed market research, business/financial analysis, *prototype/sample* development (Cooper and Kleinschmidt make potentially confusingly reference to 'product' development as an activity nested within the product development process?!?), in-house product testing, customer *field* testing, trial sell, trial production / *test of facilities*, pre-commercialization business analysis, production start-up, *formal launch planning* and formal launch.

With regard to the rest of the investigative framework, it was decided that the key objectives of Study One could be met by conducting a structured-interview-based study[2] (target interviewee: person with greatest authority/responsibility for product development) to examine the extent to which this product innovation process management template which was based on the recommendations of the international innovation literature, was (a) formally/routinely implemented in firms participating in the study (Cooper and Kleinschmidt did not attempt to estimate this) and (b) proficiently executed (as rated by the interviewee) by these companies:- firstly, in the case of the most recent successful product innovation initiative undertaken by these companies and secondly, in the case of the most recent unsuccessful product innovation initiative undertaken by these companies - thus providing a basis for establishing the extent to which degree and proficiency of implementation was linked with final innovation project outcome. For the purposes of Study One, project outcome was defined in terms of whether an idea for a new or improved product had been completely transformed into a realized, market-ready, marketable, launchable product - and so 'completed transformation of idea to launchable[3] product' constituted a successful outcome ... and 'partial or incomplete transformation' (or project abandonment) constituted an unsuccessful outcome (Cooper and

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[2] Cooper and Kleinschmidt used a questionnaire also - but this was deemed unnecessary in the case of study one which was just a preliminary study.

[3] most reliably assessed by checking whether a product has been / is actually being launched

Kleinschmidt defined outcome in terms of 'commercial success and failure' (Cooper and Kleinschmidt, *sic.*). In order to ensure a compatible basis of comparison, it would also be necessary that the unsuccessful project would have 'made it past' initial concept screening. Thus, where a company's most recent unsuccessful project did not make it past initial concept screening, the second/third/... most recent unsuccessful project would have to be used as a basis for comparison *providing* it had been initiated within a reasonable time of the successful project ... that is to say: where successful and unsuccessful projects were undertaken more than five years apart, an alternative company would have to be examined as company practice would probably not be constant over a greater-than-five-year-time-period.

Finally, it was decided to conduct a supplementary investigation of the product development practices of participating companies from the perspective of at least one employee who had been directly involved in the successful product development undertaking targeted in the main part of the study and (at least one employee who had been directly involved in) the unsuccessful product development undertaking targeted in the main part of the study. It was decided that structured interviews should form the basis of this supplementary study and that interviews should be structured in an informal manner in terms of: (i) generally ensuring coverage of the areas of: *(a) clarity of requirements (objectives, tasks (in the sense of 'jobs'),* *responsibilities), (b) the availability/scarcity of time and resources (budget), (c) quality of communication and information flows, (d) general approach to innovation: planning/trial-and-error and (e) quality of in-process assessment* and (ii) clarification, as appropriate, of points raised in the course of the earlier meeting with relevant management personnel.

2.3 SAMPLE SET

Study One was based on a sample of ten Irish indigenous small and medium sized enterprises. Firms were selected on an *ad hoc* basis with a view to maximizing potential variability of response across firms *vis-à-vis* industry, firm, management and product portfolio characteristics for two reasons. Firstly, it was deemed inappropriate to attempt to control *a priori* for the possible contingency effects of these variables in the context of an early, small scale, preliminary, exploratory investigation. Secondly, it was realized that any noticeable patterns which might be found in a data set generated by this type of sampling strategy would hardly be a product of chance. The final sample set consisted of: (i) a computer hardware manufacturer, (ii) a telecommunications components manufacturer, (iii) a tour operator, (iv) a food company, (v) a security firm (systems development and installation), (vi) a secretarial, business and computer training centre, (vii) a pottery and general craft works, (viii) a leisure magazine, (ix) a design and print studio and (x) a baker/confectioner.

Target subjects were: (i) the individual having the greatest authority/responsibility for product development in the company AND familiarity with both the company's routine product development practice and the manner in which its most recent successful and unsuccessful product innovation initiatives were managed (interestingly, in each case, this was found to be the owner-manager / managing director); (ii) one or more employees having had direct involvement in the company's most recent successful and unsuccessful product innovation initiatives were managed.

2.4 PROCEDURE

The study proceeded on a company-by-company basis. Appropriate target subjects were identified and arrangements were made to meet them, in advance of arriving 'on-site'. Within each company, the investigation proceeded in three stages:

1. initial owner-manager / managing-director interview;
2. employee interview(s);
3. concluding owner-manager / managing-director interview.

Stage One: initial owner-manager / managing-director interview

1. The owner-manager / managing-director of each of the ten companies participating in the study, was given a brief introduction to the study.
2. (S)he was then asked to bring to mind: (i) her/his company's most recent, successfully concluded product innovation project, that is: the company's most recently initiated product innovation undertaking to result in the generation and launch of a realized, marketable, innovative/innovated product ... and (ii) her/his company's most recent, **un**successfully concluded product innovation project, that is: the company's most recently initiated product innovation undertaking which did not result in the generation and launch of a realized, marketable, innovative/innovated product. Again, in order to ensure a compatible basis of comparison, it would be necessary that the unsuccessful project would have 'made it past' initial concept screening and so, where a company's most recent unsuccessful project did not make it past initial concept screening, the second/third/... most recent unsuccessful project would have to be used as a basis for comparison *providing* it had been initiated within a reasonable time of the successful project ... that is to say: where successful and unsuccessful projects were undertaken more than five years apart, an alternative company would have to be examined as company practice would probably not be constant over a greater-

than-five-year-time-period. As it happened, termination of the interview at this point[4] was found to be unnecessary in all cases.

3. Next, the subject was shown a fifteen-activity template of the product innovation process and asked to indicate those template activities which were, 'normally' / 'routinely' completed by her/his company in the course of its various product development undertakings. Responses were recorded on a pre-pared data sheet (data sheet one) - a copy of which is presented in Appendix A.
4. Attention was then re-focused on the successful project identified earlier. Having been asked for an identifier for the project which would be easily recognized by employees in stage two of the study, the company's owner-manager / managing-director was then asked to complete two exercises in regard to that project. Firstly, (s)he was asked to identify those template activities which had been formally completed by her/his company in the course of the project. Then, for each activity identified, (s)he was asked to rate the proficiency with which each had been completed on a scale from zero to ten where zero indicated non-proficiency, five: moderate proficiency and ten: great proficiency. Again, responses were recorded on a pre-pared data sheet (data sheet one) - a copy of which is presented in Appendix A.
5. Attention was then drawn to the unsuccessful project. Having been asked for an identifier for this second project which would be easily

[4] with appropriate de-briefing

recognized by employees in stage two of the study, the company's owner-manager / managing-director was asked to complete two exercises in regard to that project. Firstly, (s)he was asked to identify those template activities which had been formally completed by her/his company in the course of the project. Then, for each activity identified, (s)he was asked to rate the proficiency with which each had been completed on a scale from zero to ten where zero indicated non-proficiency, five: moderate proficiency and ten: great proficiency. Again, responses were recorded on a pre-pared data sheet (data sheet one) - a copy of which is presented in Appendix A.

Stage two: employee interview(s)

1. One, two or more employees were met on an informal, individual or group basis as convenient and given a brief introduction to the study, the text of which was the same as that used for stage one.
2. Following the introduction, employees were first asked to bring to mind the most recent, successfully concluded product innovation project undertaken by their company **in which they had been directly involved**, that is: the company's most recently initiated product innovation undertaking which resulted in the generation and launch of a realized, marketable, innovative/innovated product. In order to ensure

that the same projects were being targeted in stages one and two, employees were asked for an identifier for the project. This was then checked against that which had been given by managers in stage one. If the two were found to be inconsistent, then the identifier supplied by managers was given to employees and clarification sought, and action taken as appropriate.

3. When congruence of focal projects was established, employees were asked to comment on a number of issues in regard to that project, namely their experience of / opinion on: clarity of requirements (objectives, tasks, responsibilities), the availability/scarcity of time and resources (budget et cetera), quality of communication and information flows, general approach to innovation: planning/trial-and-error and quality of in-process assessment. Throughout, key points were recorded on the pre-pared data sheet (data sheet two) - a copy of which is presented in Appendix A.

4. Employees were next asked to bring to mind the most recent, **un**successfully concluded product innovation project undertaken by their company **in which they had been directly involved**, that is: the company's most recently initiated product innovation undertaking which did not result in the generation and launch of a realized, marketable, innovative/innovated product. Again, in order to ensure that the same projects were being targeted in stages one and two, employees were

asked for an identifier for the project. This was then checked against that which had been given by managers in stage one. If the two were found to be inconsistent, then the identifier supplied by managers was given to employees and clarification sought, and action taken as appropriate.

5. When congruence of focal projects was established, employees were asked to comment on their experience of / opinion on: clarity of requirements (objectives, tasks, responsibilities), the availability/scarcity of time and resources (budget et cetera), quality of communication and information flows, general approach to innovation: planning/trial-and-error and quality of in-process assessment in regard to this latter project. Throughout, key points were recorded on the pre-pared data sheet (data sheet two) - a copy of which is presented in Appendix A.
6. Finally, as appropriate, employees were asked to clarify points raised in the course of the earlier meeting with relevant management personnel. Once more, key points were recorded on the pre-pared data sheets.

Stage three: concluding owner-manager / managing-director interview

Data from both exercises were discussed informally with owner-managers / managing-directors. Any noteworthy observations were recorded as 'additional notes' on data sheet one. The interview was then concluded with a general de-briefing.

2.5 FINDINGS AND CONCLUSION OF STUDY ONE

2.5.1 Introductory note

It was decided that the data set generated by Study One should be subjected to elementary exploratory data analysis *only*. The application of inferential statistics to the data seemed inappropriate given: (i) the fact that the study was designed simply to be a preliminary, exploratory investigation; (ii) the indeterminability of statistical error due to the study's sampling strategy (*ad hoc*) and open design (minimally controlled, for example, for nature, size and scope of projects reviewed). The Statistical Package for the Social Sciences (SPSS) for Windows: release 6.1 (24 June, 1994) was used as appropriate, to expedite the analysis.

2.5.2 Descriptive statistics

Table 2.1 summarizes Study One's characterization of the 'normal' or 'routine' product development process of firms participating in the study based on 'self-report' data.

Table 2.1: Summarial characterization of the 'normal' or 'routine' product development process of firms participating in Study One (percentage 'self-reported' incidence of product development activities across firms participating in the study)

Product development activities	Reported routine incidence of each
formalized idea generation	40%
initial concept screening	80%
preliminary market assessment	70%
preliminary technical assessment	40%
detailed market research	20%
business/financial analysis	30%
prototype/sample development	70%
in-house product testing	60%
customer field testing	50%
trial sell	10%
trial production / test of facilities	20%
pre-commercialization business analysis	10%
formally planned production start-up	40%
formal launch planning	10%
formal launch	40%

Whilst there was considerable variability across companies studied, there was clear indication that the Irish *'product realization process'* (that process through which product innovation ideas are transformed into marketable product) is generally considerably less complete (for example: specific steps (undervalued and consequently) omitted) and less proficiently completed (specific steps under-formalized, under-resourced or inadequately performed) than the international innovation literature would seem to prescribe - whether ***or not*** the process is characterized by development conditions that are in some way constrained in terms of time or budget.[5]

Further, a more complete / more proficiently completed product innovation process was found to be associated with successful projects, whilst a less complete / less proficiently completed process was found to be associated with unsuccessful projects.

Table 2.2 summarizes the incidence of formal implementation of each of the prescribed activities in the product realization process, across the ten companies surveyed.

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[5] Cooper and Kleinschmidt's study generated a similar finding for American firms. At the time, they suggested that "there may be good reasons why certain commonly recommended [activities] .should be omitted" (Cooper and Kleinschmidt, *ibid.*, p. 74). Today, the greater body of innovation literature suggests that all activities should be included in all undertakings - though perhaps to a greater or lesser extent, depending on the size and scope of the innovation.

It is interesting to note that of the ten companies studied, only two had formally completed all fifteen activities in at least one of the projects and that almost half (four of the ten companies) completed less than half of the prescribed activities routinely.

Commonly prescribed product realization activities such as a *detailed* market research study, a trial sell and a pre-commercialization business analysis were undertaken in less than half the companies studied - and were, in fact found to be the *least* prevalent activities.

Notwithstanding the fact that seventy per cent of the companies studied did engage in *preliminary* market assessment activities, two key marketing activities were omitted in nearly eighty percent of the innovation projects.

Low incidence was also indicated for trial production / facilities test and formal planning of product launch (both featuring in less than half of the companies studied).

Table 2.2: Incidence of formal completion of each of the prescribed activities in the product realization process, across the ten companies studied.

Prescribed activity	**Number of companies completing this activity in either a successful project, an unsuccessful project or both**									
	1	2	3	4	5	6	7	8	9	10
formalized idea generation	*	*	*	*	*	*	*	*	*	
initial concept screening	*	*	*	*	*	*	*	*		
preliminary market assessment	*	*	*	*	*	*	*			
preliminary technical assessment	*	*	*	*	*	*	*	*		
detailed market research	*	*	-	-						
business/financial analysis	*	*	*	*	*	*				
prototype/sample development	*	*	*	*	*	*	*	*		
in-house product testing	*	*	*	*	*	*	*	*		
customer field testing	*	*	*	*	*	*				
trial sell	*	*	-							
trial production / test of facilities	*	*	*	*						
pre-commercialization business analysis	*	*	*							
formally planned production start-up	*	*	*	*	*	-				
formal launch planning	*	*	*	*						
formal launch	*	*	*	*	*	*				

Note 1:Two additional companies were omitted from the total *detailed market research* count because they were found to have formally implemented *detailed market research* only in terms of a *minor update* of *preliminary market assessment.*

Note 2:One additional company was omitted from the total *trial sell* count because it was found to have formally implemented this activity only in terms of incorporating a small element of *trial sell* into *customer field testing.*

Note 3:One additional company which claimed to conduct *formally planned production start-up* on a *routine* basis was omitted from the total count for this activity here as it featured with such a minimal implementation rating in one of the two *specific* product innovation projects investigated and not at all in the other.

Table 2.3 summarizes the findings of the pilot study in regard to the differences found in both the incidence and proficiency of completion of prescribed activities across projects with successful and unsuccessful outcomes. The code 'S' is used in Table 2.3, to indicate instances where an activity was formally completed in the case of a successful project but omitted altogether in the case of an unsuccessful one. A single digit code (value: $0 < \text{code} < 10$) is used in instances where an activity was completed in both the case of projects with successful outcomes and the case of projects with unsuccessful outcomes - but where that stage was thought to have been completed more proficiently in regard to a successful project than an unsuccessful one (no instance of greater proficiency was found in relation to unsuccessful projects). The digit code is used to indicate the *extent to which* the activity was completed more proficiently in the case of projects with successful outcomes. Thus a zero ('0') is used in instances where proficiency ratings for successful and unsuccessful projects are the same. A null set (a blank) indicates the complete omission of an activity from either formal practice or the analysis (see notes accompanying Table 2.2). Where absolute performance values are rated subjectively, as in the case of the present pilot study, a measure of the degree of difference across ratings is thought to be more reliable than comparison of absolute values.

Table 2.3: A breakdown of the differences in the incidence of prescribed activities and the proficiency of completion of each of these where used, across projects with successful versus unsuccessful outcomes.

Prescribed Activity

Incidence across successful and unsuccessful innovation projects

'S' indicates successful projects only

A digit ($0 < n < 10$) indicates degree of increased proficiency in the case of successful projects

'0' indicates zero difference in proficiency across successful and unsuccessful projects

Company

	A	B	C	D	E	F	G	H	I	J
formalized idea generation	3	S	S	S	S	S	S	S	S	
initial concept screening	2	2	3	1	1	1	1	1		
preliminary market assessment	3	3	2		3	3	2	2		
preliminary technical assessment	2	2	2	S	1	3	3	1		
detailed market research	0	0							S	S
business/financial analysis	3	2		S	S	S		S		
prototype/sample development	2	3	2	2	3	3	3	S		
in-house product testing	2	1	2	3		2	S	S	S	
customer field testing	2	1	S	S	S		S			
trial sell	S	0			1					
trial production / test of facilities	S	S			S		S			
pre-commercialization business analysis	2	S					S			
formally planned production start-up	S		S	S		S	S			
formal launch planning	S	2	S	S						
formal launch	3	1	3	S		1		S		

<u>**note:**</u> all cases of zero difference correspond to Table 2.2 omissions for partial/dubious implementation

An inspection of the data presented in Table 2.3, indicates that the inclusion / proficient completion of prescribed activities is generally associated with successful project outcome (that is: a lot (over 50%) of data points are filled). That said, there is also evidence of considerable variability across companies with regard to the number and nature of additional activities implemented and the number of activities completed more proficiently in the case of projects with successful outcomes - as indicated by the letter/digit/blank configurations for each company.

Differences in the various within-company stage incidence configurations are striking (as indicated by differences in specific stage data-points filled and not filled for columns A-J) and are most marked in comparing companies A and B with companies H, I and J (it is important, however, when doing so to note that company I appears to be incorporating at least some elements of initial concept screening, preliminary market assessment and preliminary technical assessment activities into formalized idea generation as they execute it).

Across-company differences in incidence figures indicate two clusters of activities the inclusion of which a lone seemed t o make a difference in terms of more successful outcome. These are: (i) formalized idea generation and formally planned production start-up activities and (ii) business/financial analysis, customer field testing, trial production / test of facilities (as indicated by the prevalence of 'S' markers).

Differences in proficiency ratings across successful and unsuccessful projects were neither very large nor very variable across companies:- ratings of differences of between one and three out of a possible ten are cited, though this was less important than the fact that *differences were found*. These differences were most marked in the cases of: preliminary market assessment and prototype/sample development.

Table 2.4 provides some indication of the (not inconsiderable) scope for improvement in proficiency of execution of product development activities observed overall.

Figures shown constitute conservative estimates, based on the residuals of averaged (mean) highest proficiency ratings supplied by firms claiming to have implemented each activity in at least one of the two specific projects reviewed.

Table 2.4: Estimated scope for improvement in the proficiency of execution of product development activities currently implemented

	Estimated scope for improvement in proficiency of execution of each product development activity
formalized idea generation	20%: * *
initial concept screening	30%: * * *
preliminary market assessment	40%: * * * *
preliminary technical assessment	40%: * * * *
detailed market research	60%: * * * * * *
business/financial analysis	50%: * * * * *
prototype/sample development	30%: * * *
in-house product testing	40%: * * * *
customer field testing	30%: * * *
trial sell	50%: * * * * *
trial production / test of facilities	60%: * * * * * *
pre-commercialization business analysis	40%: * * * *
formally planned production startup	70%: * * * * * * *
formal launch planning	60%: * * * * * *
formal launch	30%: * * *

In this context, it is interesting to consider the findings of the supplementary employee interviews. These structured interviews revealed that:

1. Employees perceived successful innovation efforts to be characterized by clear objectives, good planning, good communication and a well-planned approach to the development effort.

2. Failure in innovative undertakings was attributed most strongly to the adoption of an open trial-and-error approach to the project.

3. Regular progress evaluation was not perceived as having any significant differential effect. Nor, interestingly, was budget size.

4. Clear responsibilities were more frequently associated with failed projects than successful projects. (This finding was unexpected - perhaps, even, counter-intuitive to some extent ... though it may be attributable to, for example: a stifling of the innovation effort through excessive 'turf-guarding' on the part of the participants.)

It is also useful to consider additional data obtained in the course of initial and concluding interviews with the owner-manager / managing director of firms participating in the study. Discussions with managers regarding the incidence of each of the template steps and proficiencies and deficiencies in their execution were not recorded in detail. Some notes were made and a number of strong overall impressions were, however, formed by the researcher as follows:

(i) Formalized idea generation

Formalized idea generation featured in nine out of ten successful innovation projects. It was interesting to find that - with two exceptions - most companies seemed to have a limited overall view of the range and usefulness of potential sources of ideas. An overall 'occasional' and 'market-pull' perspective on ideas for product innovations predominated. 'Technology-push' did not seem to feature very strongly at all. Neither did internal sources such as general 'think-tanks'. Formalized idea generation was thus generally operationalized in terms of formal meetings with key customers to discuss their particular requirements.

(ii) Initial concept screening

This activity was observed in eight out of the ten firms studied and in all cases was shown to have been carried out with greater proficiency in the case of successful project outcomes. Formalization was generally operationalized in terms of set agenda and minuted meetings only - with the exception of companies A and C which had devised a series of formal 'checklists' to support the activity and which reported two of the three largest differentials in proficiency of execution of this activity across unsuccessful and successful projects, thus, perhaps, suggesting the value of the checklist approach.

(iii) Preliminary market assessment

Two of the three companies out of ten which did not include this activity in their innovation management process did actually carry out detailed market research at a later stage (though in both cases, this was in the case of a successful project only). The manager of the one which included neither, reported 'sufficient familiarity with its customers and markets to justify this'. The companies which did include this activity generally concentrated on projected overall customer demand taking surprisingly little account of competitors' products.

(iv) Preliminary technical assessment

Most managers felt that improved proficiency in this activity was attributable to moving from just a general engineering assessment to a more detailed and a better documented product design specification which was then *formally* reviewed by engineering and management together.

(v) Detailed market research

This constituted one of the least prevalent activities investigated. The two companies who reported engaging in this activity on a routine basis seemed to view it as a valuable activity and both seemed fairly satisfied with the proficiency of their execution of it. Self report data indicated that these companies normally adopted a very focused approach to this task with good definition of markets and segments ... and the activity seemed to be a productive one in that it apparently helped to better define the more subtle aspects of their product innovations. Yet, in the course of analysing two specific recently completed product development projects, one of these companies was found to have implemented detailed market research in terms of just a minor update of preliminary market assessment conducted earlier in the course of the project - in both projects?!?

(vi) Business/financial analysis

This activity was generally perceived as being costly and not normally required (its reported routine incidence was just thirty per cent). Those reporting improvements in the proficiency with which they executed this activity across projects, attributed the improvement to allowing more time for this activity and to using a more detailed formal approach to the analysis.

(vii) Development of prototype/sample

Improved proficiency in the execution of this activity (the routine incidence of which was seventy percent) was attributed mainly to better budgets and better co-ordination of the development effort.

(viii) In-house product testing

The principal improvements reported here were in terms of using more ecologically valid testing conditions.

(ix) Customer field testing

Interestingly, notwithstanding the fact that a number of companies reported not having implemented this activity in relation to unsuccessful projects but having implemented it in relation to successful projects, most of these companies considered it an unnecessary extra step in addition to in-house testing and market assessment and suggested that it was unlikely that they would implement customer field testing in future projects.

(x) Trial sell

Again, with the exception of one of the ten companies studied, trial sell was considered an unnecessary step in the process and most companies indicated that it was unlikely that they would include it in future projects. Improvements in the proficiency of execution of this activity reported by the one company engaging in it, were attributed to a switch from limited-geographic area selling to selling to particular groups of customers.

(Xi) Trial production / test of facilities

Trial production or facilities testing was carried out routinely in just two of the ten companies studied. It was perceived as being necessary only in cases where indicated by preliminary technical assessment and where carried out, companies were generally satisfied with proficiency of implementation, though they did seem to concentrate on production system testing only, omitting tests of the integrity of the end-product as yielded by the system.

(xii) Pre-commercialization business analysis

Two of the three companies which implemented this activity, did so in addition to engaging in an earlier business/financial analysis. One did so for the first time in relation to what turned out to be successful project but perceived it as being an unnecessary additional exercise which would not be included in future projects. The other perceived the activity as being valuable and suggested that it was likely that it would be included in future projects. Both suggested that the principal proficiency considerations for this activity should be in relation to updating *all* information to be used in the analysis. The third company which had not engaged in an earlier business/financial analysis found the step to be useful and suggested that it too was likely to include the activity in future projects.

(xiii) Formally planned production start-up

Notwithstanding the fact that this activity was associated with successful project outcome in several cases, opinion was generally divided as to whether this apparently, relatively straightforward act warranted formalization. Generally it was considered important where significant changes in plant and machinery were introduced but not otherwise. Proficiency with regard to formal production start-up was attributed to good procedural awareness and good overall co-ordination.

(xiv) Formal launch planning

It seemed a little strange that whilst six of the ten companies held a formal launch of their products, just four engaged in formal planning for this launch. The remaining companies engaged in that which might be better described as 'informal launch preparation'. In all cases, the introduction of or the improved proficiency of the execution of formal launch planning was associated with improvements in the proficiency of the actual launch / successful overall project outcome. The key to acquired or anticipated improvements in the proficiency of formal launch planning was perceived to centre on clarity of definition of marketing objectives.

(xv) Formal launch

It was interesting to find that the most commonly mentioned key to improving the proficiency of formal product launch was neither budgets (referred to by just one company) nor co-ordination (though this was mentioned by three companies) as would perhaps have been expected. It was, rather, better preparation of marketing/sales staff (as indicated by four companies).

(xvi) Overall process management

Overall managers expressed general/reasonable satisfaction with the manner in which their companies managed the innovation process and implemented lessons learned from previous experiences in this regard.

Perhaps not surprisingly, though, companies I and J, the innovation management process of each of which was very much under-formalized, expressed and interest in improving formalization of / generally developing the process when briefed on the recommendations of international innovation management theory and various known demonstrations of the value of its application in ensuring innovation project outcome success (the Cooper and Kleinschmidt study was cited as an example). That said, it should again be noted that company I seemed to be already incorporating at least some elements of the activities: initial concept screening, preliminary market assessment and detailed market research, into their own, particular approach to the formalization of idea generation.

At the opposite end of the continuum from companies I and J, the two companies with reasonably 'complete' formalized innovation management processes (companies A and B) had been audited by the Irish Quality Association and were thus very much orientated toward formalization and documentation of procedures.

(It is interesting to note that there was one particular activity that both of these companies had little interest in as regards incorporating it as a routine aspect of their product development process. This was: trial sell.)

Company H believed in bringing product to market as expediently as possible. This company perceived much duplication in the generic template of the product development process (for example: preliminary market assessment, detailed market research and trial sell) and felt that adding to their existing complement of activities (routinely just initial concept screening and preliminary market assessment - with, of course, some *in*formal form of production start-up and some *in*formal form of launch of the initial idea being tested where that idea is not rejected in the course of early screening activities) would be redundant. This company's business was perceived to be characterized by short product lifecycles tight delivery deadlines and thus its management policy on process configuration would be dictated by a number of time/activity trade-off considerations.

(xvii) The screening versus realization power of the product realization process

When asked to comment on the general screening power of their routine product innovation processes, managers **estimated** 'appropriate non-realization due to effective screening' rates of <u>at least sixty per cent</u> of ideas. Regarding the realization power of their routine product innovation processes, managers **estimated** that <u>up to forty per cent</u> (minimum: thirty per cent) of the remaining forty per cent of ideas were *as yet* unproductive of a marketable product *(a number of these ideas had been partially developed (perhaps up to prototype stage) but then abandoned (invariably: 'temporarily' even if this meant 'for several - even many - months or years') for a range of reasons)*.

(xviii) The commercial success of successfully transformed innovation ideas

When asked to comment on the commercial success of successfully transformed innovation ideas, managers reported at least moderate commercial success for each. A minimum commercial success rate (informally defined in terms of meeting whatever success rate expectations individual firms had had for their new/improved products) of seventy per cent of projects, a maximum commercial success rate of ninety per cent and an average (mean) commercial success rate of eighty per cent were reported.)

2.5.3 Conclusions

The key initial conclusions which may be drawn from the findings of Study One are...

Firstly, regarding overall product innovation performance indicators for Irish industry in the late nineteen nineties, a comparison of the rates of success/failure in development and commercialization estimated in Study One with the figures presented in the 1985 O'Sullivan and Tomlin paper, in the context of the overall findings of Study One, would seem to suggest not just a reversal over time, in the previously observed 'failure-rates-in-commercialization-being-greater-than-failure-rates-in-development' effect (minimum: 16, 21 (+5?) then; minimum 30, 10 now (for established companies) but also a marked increase in rates of failure-in-development and a marked decrease in rates of failure-in-commercialization.

Lower rates of failure-in-commercialization and higher rates of failure-in-development may be interpreted as supporting the researcher's earlier suggestion that some proportion of the failure-in-commercialization rates presented by

O'Sullivan and Tomlin may have been attributable to failure of the development process to generate an appropriate level of screened-and-abandoned and/or properly realized (that is: commercially readied) product innovation ideas.

Nevertheless, estimates of circa sixty per cent for the concept/technical/market screening power of the routine product innovation process would seem to suggest that estimates of up to forty percent non-realization for surviving ideas which somehow become 'lost in development', do warrant some consideration (thus supporting the suggestions of experts that, at present, it is the realization rather than the screening power of the routine product innovation processes of Irish companies which warrants the greater attention).

In general, the notion that the routine product innovation practices of Irish industry may well 'provide a useful window on' its final product innovation performance would seem to be supported by the findings of Study One.

The key findings of the study regarding routine practice were as follows ...

Firstly, the presence and proficiency of completion of prescribed activities is associated with successful product innovation effort (as defined in section 2.2) - the converse also being true. Notwithstanding Cooper and Kleinschmidt's (*ibid.*) observation that neither the presence of prescribed activities nor their effective completion can guarantee the successful outcome (developmental or commercial) of product innovation projects, the association observed in both the American and Irish studies, would seem to suggest that the manner in which the product innovation process is managed must be significant to at least some extent.

Secondly, Irish industry operates a considerably reduced product development process *vis-à-vis* the recommendations of the international innovation literature (on average, a forty percent routine implementation was reported across companies surveyed).

Thirdly, this considerably reduced product development process is not necessarily a very proficiently executed one (on average, a forty-percent 'below par' proficiency was observed).

These findings are of themselves not insignificant - however, it was in the course of discussing them with managers that ***the most*** significant finding of the study emerged, namely, that much of the ineffective management of the product innovation process would appear to stem from what might be termed: 'faulty' thinking about product innovation and an inadequate understanding of the product innovation process.

Many managers were making erroneous assumptions regarding the equivalence and consequent substitutability of various activities in the product realization process.

This was particularly true with regard to concept screening where there was evidence of perceived equivalence/substitutability of early in-house concept screening and early marketing activities, trial sells, et cetera. The potential impact in terms of the construction of a more than likely significantly reduced product realization process is clear.

The decision to include/omit particular activities in the realization process was frequently made on the basis of potentially erroneous anticipation of the content and value of the output of these activities. For example: in a number of firms, preliminary market assessment activities were omitted because 'sufficient familiarity with customers and markets' was *simply assumed* (indeed, where they were included, they appeared to be inadequately completed:- research into competitors' products appeared to be surprisingly scant, for instance).

Astonishingly[6], the managers of two of the companies surveyed were apparently previously entirely unaware of the existence of formal product innovation management theory - expressing great interest in learning more about it.

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[6] (given the amount of research going on everywhere, on everything at the moment, not to mention the upsurge in interest in and research on innovation in general and product innovation in particular and the fact that almost all managers of almost all firms are regularly approached on the subject of this massive and ubiquitous research effort)

Thus, whilst the earlier findings of the study identified the issue of the effectiveness of management of the product innovation process as a potentially significant determinant of the final product innovation performance of Irish industry, this latter finding provides an indication of the level at which this issue might usefully be addressed.

A further investigation into *the nature and effects of managers' beliefs and understanding regarding the manner in which the process of transforming product innovation ideas into marketable product is best managed* is strongly suggested as a potentially fruitful next step in addressing the issue of the relatively poor product innovation performance record of Irish industry. **Thus the case for** pursuing **a managerial cognition perspective on the product innovation performance of Irish industry is made.**

The fact that this case is made on the basis of the findings of a small, informal study does not in any way detract from its weight. Indeed, the case for a managerial cognition perspective on the product innovation performance of Irish industry is arguably *strengthened* by the fact that it is indicated by a data set that is so clearly marked despite having been generated under circumstances which would normally be expected to generate a more variable data set and hence less definitive results.

The reader's attention is drawn to the fact that pursuing this line of inquiry effectively re-casts the present work from its initial form: 'an Irish study' as such ... to that of more general research undertaken in an Irish context.

CHAPTER THREE

Cognition

3.1 THE COGNITIVE APPROACH TO ORGANIZATIONS

Argyris and Schon (1978) suggest that an organization is, at its root, a cognitive enterprise which acquires, organizes, develops and utilizes information or knowledge. The exploration of cognition in organizations dates from the fifties (see, for example: Simon, 1955 and Cyert and March, 1963) but has gained increasing prominence in organizational studies in recent years (see Thomas, Clark and Gioia, 1993).

The term *'cognition'* refers to the content, structures and underlying processes of thought (both conscious and unconscious) as it influences and is influenced by its perceived historical, current and anticipated individual, organizational and environmental context (see Sims *et al*, 1992). The cognitive approach to organizational research is based on the view of organizations as 'interpretative systems' and 'enacting bodies' (see Pfeffer, 1981).

Thus the basic unit of currency of the cognitive approach is, of course, 'knowledge'. Knowledge may be defined essentially, as consisting of: (a) information or facts ('knowledge what') and (b) the manner in which this information or these facts may be applied ('knowledge how'). There is also, of course, knowledge about knowledge, or, at least, about extent of knowledge (as epitomised by Socrates' claiming to be wise on the basis that he knew he didn't know anything.). This latter type of knowledge is referred to as *meta*-knowledge.

Cognitive psychology is the key primary research area which serves to inform cognitive research in organizations. As the cognitive paradigm becomes increasingly popular, terminology, models and methods are enthusiastically adopted from cognitive psychology to frame exploration activities. Indeed, cognitive psychology would seem to provide something of a 'ready-made' framework within which research on cognition in organizations might usefully proceed.

3.2 'WHAT' COGNITION

In western tradition, cognition is generally held to be a bridge between perception and action[1] (eastern tradition tends to reflect a model of cognition that is less 'relational' in character). The nature of the bridge has, however, been much debated over the years. Some (Husserl, for example) held that the relation of thinking to its object was immediate (see Husserl, 1929, in Johnson-Laird, 1993) whilst others (Craik, 1943, for example) held that this relationship was mediated by the mental process of generating, organizing and manipulating symbolic representations. It was Piaget who, in the nineteen thirties, originally proposed the notion of cognitive 'frames of reference' as mental representations which act as the

[1] The western model is the one clearly indicated in the present context.

organizing frameworks of knowledge/information representation within the individual to guide the behaviour of the individual (see Piaget, 1954 and Mussen, Conger and Kagan, 1984). Today, the 'representationalist' perspective predominates. It is, however, a 'new representationalism', for, today, knowledge and information are held to be organized at a number of different levels both within the individual and across groups of individuals[2].

The terms *symbols, propositions, beliefs, concepts, categories, schemata, scripts, mental models, frames of reference, cognitive frames* and *mindsets* are used to refer to these various levels of organization and cognitive psychology offers many well-developed models and methodologies which have been shown to be useful, valid and reliable in investigating and analysing cognitive structures, content, processes and styles and, of course, their development and deployment.

Knowledge structures are held to be initially generated and subsequently developed[3] through a process of knowledge *assimilation and accommodation* - and *used* (manipulated and deployed) in either: (a) a *'top-down'*, theory-driven manner - where previously encoded past experiences in similar circumstances are used as primary guide to current information processing *or* (b) a *'bottom up'* (data-driven) manner - in which previously encoded structures are secondary, and current

[2] It should be noted that some theorists reject the notion of 'cognition as (manipulation of) internal representations' ... however, as Johnson-Laird observes, 'arguments are never decisive' (Johnson-Laird, 1993, p. xiii).
[3] Barr, Stimpert and Huff, 1992, for example, have demonstrated that knowledge content/structure changes over time.

information acts as the primary guide - see Walsh, 1995a, for details[4] (Louis and Sutton (1991) argue that 'top down' processing is likely to be the dominant response in all but the most novel situations). Furthermore, they have been shown to vary along the two dimensions of *structure* and *content* (see Walsh, *ibid.* for a review of the relevant literature).

It is important to note that whilst the business literature has adopted the terms, models and methodologies of cognitive psychology as a convenient and accredited research framework, it has done so in an alarmingly haphazard fashion - with little regard to the origins or intended usage of these terms, models and methodologies adopted. There is, consequently, to say the least, considerable variability and inconsistency of usage of terms, models and methods - not only across the two literatures but also within the business literature itself which has come to be characterized as being 'littered with borrowed and often ill-defined concepts' Sparrow (in Cooper and Robertson, 1994b, p.160)[5].

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[4] ... and so the notions of cognitive processes and cognitive style are introduced in addition to cognitive structure ... in addition to assimilation / accomodation, knowledge processes also include: biases, retrospective rationalization and attribution, whilst cognitive styles include serialist/wholist processing, tolerance of ambiguity, visual/verbal/enactive imaging, *et cetera* (see Schneider and Anglemar, 1993, for example)

[5] There is also evidence of some potentially harmful and misleading re-labeling of psychological concepts, for example: with regard to the manner in which knowledge structures may sometimes be used, the business literature uses the rather inappropriately 'loaded' term 'mindlessness' in lieu of 'automatic, schema-driven processing' or 'automaticity' (see, for example: Polyani, 1962, in Nissani, 1996 and Ashforth and Fried, 1988)

Yet, there are, nonetheless, a number of key, fundamental concepts that are used not only with surprising consistency *within* the business literature, in describing the ways in which knowledge and information may be represented at the individual, group, organizational and industry level but also in a manner that is reasonably reflective of their original definition and usage within the psychology literature...

Firstly, there is the notion of *categories*. People are held to tend to group objects, individuals, social roles and common events into equivalent clusters in their thought processes and this action is referred to as *categorization* and its resultant groupings are referred to as *categories*. Closely related to categories is the notion of a *schema* which refers to the organization of information or knowledge about a particular concept or category. The schema contains the features or attributes that are associated with category membership. A particularly vivid representation of a category and its associated schema is referred to as a *prototype*. A *'script'* refers to a behaviourally oriented (algorithmic) schema, incorporating (causally connected) action sequences, props and participants which specify behaviour or event sequences (appropriate for specific situations) and which is used to guide the planning and execution of activities. This latter knowledge/information structure may develop over the course of successive experiences of the sequence of events or through observation of exemplars.

'The script construct is particularly useful in studying organizational phenomena because it bridges the gap between cognition and behaviour' (Gioia and Manz, 1985, in Gioia, Donnellon and Sims, 1989, p.507).

Knowledge structures vary in types of information stored, level of detail and the degree of interconnectedness of this detail, that is, in terms of their *'cognitive complexity'* (see Eden, Ackermann and Cropper, 1992).

The positive artefacts of organizing knowledge are, after Gioia (in Sims, 1986):

1. facilitation of cognitive economy
2. structuring of experience
3. facilitation of the interpretation of ambiguous situations
4. speeding of information processing and problem solving
5. provision of 'default options' for missing information
6. provision of a basis for evaluation of people/events
7. facilitation of prediction of future events and outcomes
8. provision of a basis for action

whilst the more negative artefacts of organizing knowledge are, again, after Gioia (in Sims, *ibid.*):

1. encouragement of stereotypic thinking
2. subversion of controlled information processing
3. filling of data gaps with typical rather than veridical information
4. ignoring of discrepant though possibly important information
5. biasing of information processing toward existing schemata
6. resisting revision of current cognitive structures
7. inhibition of creative problem solving.

It is important to note that knowledge may be organized in a similar manner across a number of individuals - in which case the relevant knowledge/information structure/content package is referred to as being '*consensual*'[6] or '*shared*'[7] - but that *both* individual *and* shared knowledge structures may be used *independently* at individual, group, organizational or industry level.

3.3 'WHOSE' COGNITION

The question of the relative importance of composition versus *ownership* of cognition (the relative importance of, for example: cognitive complexity on the part

[6] Smircich (1983, in Sims *et al*, 1986) defines organizational culture in terms of networks of related and integrated consensual cognitive schemata and scripts.
[7] Of course, as Wallace (1970) observes: '... human [groupings] may characteristically require the nonsharing of cognitive maps ... (1) it permits a more complex system to arise than most, or any, of its participants can comprehend; (2) it liberates the participants in a system from the heavy burden of learning and knowing each other's motivations and cognitions' (Wallace, 1970, p.35).

of organizational managers and leaders versus cognitive commonality within the organization would seem to constitute a significant emerging issue for cognition in the organizational context.

With regard to 'individual cognition', research to date has focused almost exclusively on organizational managers and leaders. Researchers have long argued the practical importance of understanding how managers understand and act on the events, data, interactions, meetings, reports, hearsay and other stimuli they encounter in their work (see Isenberg, in Sims and Gioia, 1986). Organizations have, afterall, been defined in terms of groups of people, the actions of whom are determined by that which, in particular, its leadership (Lyles and Schwenk, 1992) perceives, believes to be true and thinks will bring about desired outcomes (see Huff, 1990). (Wang and Chan (1995), for example, describe top managers perception of strategic information processing and its link to organization development.) Organizational research on the role of leaders in organizations suggests that whilst they are by no means omnipotent, they do exert at least some modest influence over their organizations - especially in the case of smaller and younger firms - (un-)consciously shaping thoughts and actions through strategy formulation and decision making (see, for example, Bass, 1990 cited by Tenbrunsel *et al,* 1996, in Clegg *et al,* 1996).

It is interesting to find that the theoretical and empirical investigation of cognitive representation, development and use in the individual predates the same for the group, organization and industry by at least a decade (see, for example, Simon, 1955 and Axelrod, 1976). Cognition should not, of course, be construed as occurring solely at the level of the individual. In section 3.2 of the present text, reference was made to the fact that knowledge/information may be organized in a similar manner across a number of individuals, in which case the relevant knowledge/information structure is referred to as being common, consensual or shared.

Certainly, organizational researchers have amply demonstrated that organizations develop shared frames of reference, memories, myths, and learning (Lyles and Schwenck, 1992). For example: Prahalad and Bettis (1986) suggest that companies' strategic decision making is guided by a *'dominant management logic'* which exists in the form of a schema that is shared amongst the dominant coalition (or top management team) of the firm[8] and that the extensiveness and content of the dominant logic determines the diversity of technologies or markets in which a firm ultimately participates[9]. Lyles and Schwenk (1992) suggest that shared knowledge structures evolve in response to environmental influences:- when environmental change invalidates existing assumptions, organizational members articulate and advocate contents of the new knowledge structure which are then

[8] They do not, however, specify the mechanisms by which such schemata are generated or 'become shared'.
[9] (though, again, they do not specify the mechanism of determination)

combined through the activities of the organization's dominant coalition into a new knowledge structure which is then communicated to other members of the organization.

Apparent in both Lyles and Schwenk and Prahalad and Bettis models is the implicit assumption that the generation and development - and hence the final content and structure - of important if not all organizational schemata are the reserve of a few organizational elites and that schema sharing beyond this small circle merely means direct adoption and application. The present researcher's early experiences in industrial settings suggest that this can be a grossly inaccurate representation of the situation in at least some cases:- an excellent example of which was the regular (and remarkably germane to the present research) 'refrain' of one of those 'elites' who was, it seemed, much of the time 'without as much as two concepts to rub together': 'any thoughts on this' (Xxxxx, 1989 - 1991, *regular* personal communication).

Alternative, broader based approaches include those of:

1. Smircich (1983, in Sims *et al*, 1986) who refers to **networks** of related and integrated consensual[10] cognitive schemata and scripts;
2. Douglas (1986) who describes organizations in terms of their subgroups - referred to as 'thought **worlds**' (quantum leaps of consensuality implied);

[10] or, presumably, in practice at least 'common'

3. Weick and Roberts (1993) and Russ (1993), for example, who explore the concept of 'the **collective** mind' of the organization.

It is commonly thought (!) that the key challenge in considering any of these proposed supra-individual level knowledge structures is that of accounting for the role of social processes in their generation, retention and usage (Walsh, 1995a). It is, however, far more likely to be the somewhat more fundamental issue of procuring a proper characterization of the nature of the structure. (It is presently unclear whether supra-individual knowledge structures are most appropriately construed in terms of: (a) simply an aggregation of a set of individual knowledge structure elements, (b) the cumulative set of overlaps in relevant individual knowledge structures or (c) something that exists independently of individual knowledge structures such that any correspondence between this knowledge structure and individually held knowledge structures is in fact largely co-incidental.) Any speculation on the role of social processes in the generation, retention and usage of collective knowledge structures where the nature of these knowledge structures has not been properly defined, would appear to be somewhat premature - though the two issues could conceivably be addressed in tandem.

It should, of course, be borne in mind that several authors (Wallace, 1970, Langfield-Smith, 1992 and Marcokzy, 1994, for example) have presented both theoretically and empirically based arguments *against* the *necessity* of (substantive) cognitive commonality in organizations - though it is generally accepted that cognition is, almost always, at some level, at least collaborative in its generation and/or representation and/or usage (Resnick, 1987, cited by Levine, Resnick and Higgins, 1993, in Porter and Rosenzweig, 1993). Nevertheless, the question of the desirability of (too much) 'like-mindedness' remains (see Schneider and Anglemar, 1993). For example: 'like-mindedness' may be desirable for facilitating quick mobilization for action, perhaps, undesirable where alternative views could contribute to the resolution of an action *impasse*.

In theory, however, the bottom line is that individual, group, organizational and industrial knowledge structures may each be generated, retained, developed and deployed at individual, group, organizational and industrial level.

The primary challenges in adopting a cognitive perspective on any particular aspect of organizational life are, therefore, those of: (i) correctly identifying key individual/supra-individual cognizer(s), (ii) ensuring that where cognitive commonality is apparent that it is not merely co-incidental, (iii) remembering that whilst it may be true that 'If we can't think together we can do nothing together' (Bohm, cited by Bielecki in Wijers, 1996, p.120) thinking together does not necessarily mean - or need to mean - thinking alike.

3.4 COGNITION AND ACTION

'Mind is the creator of everything...thought...finally assumes a tangible outward form' (Yogananda, in Dayton, 1995, p.83[11]).

It is generally held that cognition and action are reciprocally and therefore inextricably linked[12]. Indeed, some would say that in distinguishing between a thinking world and a separate physical world of action, we have created something of a 'two world myth' (Ryle, 1970, for example). Others' observation of the human condition would, however, seem to indicate that this so-called 'two-world-ness' is, in fact, no myth. Indeed, many would agree that the Goethian sentiment that thinking may be easy, acting may be difficult - but that transforming thought into action may be the most difficult thing in the world, captures the very essence of the human experience.[13]

Fiske and Taylor once referred to action as 'the silent and elusive partner' of cognitive research (Fiske and Taylor, 1984, p.369). Moreover, whilst a substantial amount of organizational research has been dedicated, over the years, to examining the manner in which organizations might be influenced by various individuals and groups of individuals, that research has, in the main, taken as its primary focus, the *personality*, psycho-social and socio-economic *attributes* (for example: educational

[11] ... no doubt, with implicit apologies to The Creator of mind!
[12] take, for example, the case of the 'self-fulfilling prophecy' (see Aronson, 1992)
[13] *cf.* Goethe's Faust's: *'Im Anfang war die Tat'* (In the beginning was the deed) and, indeed, more significantly, John's Gospel's: 'In the beginning was the Word'

background), *attitudes* and *behaviour(s)* of the influencing individual or group - though not necessarily its *cognition(s)*.

Gradually, this rather glaring oversight in the literature has been redressed, however - and general indications are that knowledge structures generated at individual and/or group and/or organizational and/or industry level and represented at individual and/or group and/or organizational and/or industry level could, indeed, be used to influence organizational behaviour at individual and/or group and/or organizational and/or industry level. For example:

- Schein (1990) presented evidence to show how the beliefs, values and assumptions of a company's founder can determine organizational behaviour
- Zajac and Bazerman (1991) presented evidence to suggest that individual cognitive shortcomings can contribute to new business failures
- Weick and Roberts (1993) argued that the enormously high reliability requirement attending work on aircraft carrier decks could only be met by a 'heedful collective mind'.

The link between cognition (action oriented cognition, in particular) and action can be recognised, represented and understood only through the elucidation of 'the content of cognitive systems ... their underlying structure and

... how [each is used] to produce behaviour' (Lord and Kernan, 1987, p266). Eckblad's scheme enactment theory (see Eckblad, 1981) suggests that cognitive structures affect behaviour by guiding movement towards goals and objectives based on their transformational means-end, sometimes multi-path, algorithmic chain, for instance. Others, for example: Locke (in Dunnette, 1976), suggest that transformation from intention to goal state is mediated by task, social and other behavioural feedback loops which serve to constantly re-focus attention, alter affect and temper motivation. Both Eckblad's algorithmic chains and Locke's feedback loops are accommodated by Norman (in Norman and Draper, 1986) in his proposed 'approximative' theory of cognitively driven, automated tool assisted action for cognitive engineering, which describes the 'gulfs of execution and evaluation' which exist between cognitive goal and system state, in computer-assisted task execution and which are gradually bridged through an iterative process of goal establishment, intention formation, action sequence specification, action execution, perceiving the system state, interpreting the system state and evaluating the system state with respect to specified goals and intentions ...

In perusing the ever expanding literature, it becomes apparent that three significant inter-related issues which arise repeatedly throughout the research on personality, attributes, attitudes and behaviour, are significant in research on cognition and behaviour, also. These are:

1. the question of **appropriate levels of analysis** (for example: the desirability of compatibility in operationalization of cognitive and behavioural variables);
2. the issue of **correspondence versus causality** (realization that the former does not necessarily imply the latter but also that the latter is not easily established);
3. the questions of **mechanisms of determination** in causality **and contingent/mediating/moderating variables** in general (for example: is the development of socially shared cognition mandatory, in order that the cognition of the individual may influence the behaviour of the organization?);

(Echoes of all three issues can be detected in the five key issues for cognition within and between organizations, identified by Meindl, Stubbart and Porac (1994), namely: an appropriate construct system, an appropriate way to treat level-of-analysis issues, the relationship between cognitive structure and process, the relationship between individual cognition and organizational outcomes and the role of cognitive aids in shaping cognition.)

3.5 COGNITION AND INNOVATION

At the heart of the concept of innovation lies the notion of the generation (or acquisition) and realization (transformation into product or practice) of **ideas** (see, for example, Van de Ven, 1986). **Innovation *is*, thus, arguably, fundamentally**[14] **cognitive in nature**. Yet (as Swan (1995), for example, observes) both knowledge and cognition have been greatly de-emphasized in the innovation literature. Some notable exceptions are:

1. Berg (1993) who asserts that organizations should constantly expand their mental frameworks as: 'business advances will be made by those organizations that out-think the others' (Berg, 1993, p. 9), citing Le Boeuf's 'Ignorance is not bliss. It's bankruptcy' (Le Boeuf, in Berg, *sic.*).
2. Clark and Staunton (1989), Howells (1995) and a small number of others who characterize innovation in terms of something that is primarily psycho-socially constructed, to be later made manifest in accordance with particular organizational contexts, Dougherty (1992) and Fiol (1995) who make reference to the notion of thought worlds in innovation processes and Weick (in Goodman and Sproull, 1990) who suggested that the effective management of new technologies requires ongoing 'sensemaking'.
3. Kuczmarski, who, in 1992, wrote of the urgent necessity of realizing the importance of 'inspiring and implementing' that which he termed the 'innovation mind-set' in organizations (Kuczmarski, 1992, p1.).
4. Swan and Newell (Swan and Newell, 1994 and Swan, 1995) who described the nature and importance of knowledge bases and cognitions for decisions about technological innovation and suggested some ways in which these might

[14] that is necessarily - though, granted, not necessarily sufficiently

be explored - and Mc.Donough and Barczak (1992) who investigated the effects of cognitive problem-solving orientation and technological familiarity on speed of product development.

5. The small group which debates the nature of knowledge required for innovation - organizational, procedural, technical, tacit (see, for example, the proceedings of the 11th. Annual Colloquium of the European Group on Organization Studies, 1993).
6. Calantone *et al* (1995)'s very loosely but arguably interpretable as at least partially, approximatively cognitive research on practitioners' levels of agreement with product innovation research findings (it included an examination of the extent to which the findings product innovation research is known to practitioners).

The fourth exception noted is of particular significance to the present study. In his 1994 paper, Kucmarski remarks that...

> In order to regenerate themselves through the introduction of successful new products, companies must first instil an innovation mind-set in their management ... in the late 1990s and the early 2000s, the focus is going to be on 'people' ... Success in the future lies in leaders and team members learning how to cultivate and harvest innovation. (Kuczmarski, 1992, p.37).

Firstly, it attests to the potential validity of the supposition that managerial cognition may play a significant role in determining the final product innovation performance of Irish industry. Secondly, it supports the notion that if it is found that managerial cognition does indeed play a significant role in determining the final product innovation performance of Irish industry, the implication is that the problem of sub-optimal product innovation performance of Irish industry may, be addressed in the first instance and/or to some extent, at least, very simply and very effectively by means of the accretion, tuning and/or restructuring of managerial thinking on the nature of the product realization process and the manner in which it may best be managed.

3.6 ELICITING AND REPRESENTING COGNITION - COGNITIVE MAPPING

The process of eliciting and representing cognitive structures and their contents is referred to as *'cognitive mapping'*. The term 'cognitive mapping' dates from the work of Tolman (1948). The term *'cognitive map'* is often interpreted as referring to a broad-based model of the general thoughts or thinking of an individual. In practice, a cognitive map tends to constitute a *more or less* accurate (valid and reliable) representation of an individual's perception of reality *with regard to a particular domain*. Indeed, the modelling accuracy (validity, reliability, robustness, sensitivity) of maps can vary considerably. According to Eden (1992) it depends principally on the adequacy of the cognitive theory underlying the modelling carried out (and the extent to which that modelling is a good reflection of the theory) and on the method of knowledge elicitation employed in the generation of the map (Eden considers the second *proviso* particularly significant in view of Weick's aphorism that we do not know what we think until we articulate it, the implication being the possibility that the act of cognitive articulation - upon which cognitive mapping depends - may somehow modify - even corrupt - cognition in its 'purer' pre-articulated state). Whilst Eden emphasizes the *elicitation* of knowledge, in practice, the *representation* of knowledge can pose an equally significant problem for the researcher - though elicitation and representation are closely linked (Kirakowski, 1988).

"'Cognitive mapping' ... [consists of] ... explicating the concepts which practitioners rely on to make sense of the practice in which they are engaged - that is, [of] describing and reporting the framework of assumption, beliefs and ideas which practitioners develop' (Reed, 1985, p. 141, in Howells, 1995, p. 887).

The notions of 'mapping' and 'map' in a *cognitive* context warrant some reflection. Are they merely useful metaphors for the act of explicating and representing the intended, target and, later, actual, explicated cognitive set ... OR ... is the cognizers' knowledge/information set actually encoded in the form of maps to begin with such that cognitive mapping constitutes something of a meta-mapping activity?[15] Does this matter? ...

> Geometrical shapes are particularly easy to spot among the stars of the night sky. The largest and most famous are the Great Square of Pegasus, the Summer Triangle...and the Great Circle...you can also find smaller and less obvious groupings; for example...four stars within Lyra, the Harp, form a neat little parallelogram. But keep in mind that no matter how real these images may seem, they are only illusions caused by the placement of certain stars in three-dimensional space. You could never go the Big Dipper, for instance, for it just doesn't exist (Mammana, 1994, p.38).

Huff (1990) draws a direct comparison between the mapping of managerial and organizational cognition and the science of geographical cartography. Whilst organizationally-relevant mental representations held by one or more (key) individuals can certainly be conceptualized in terms of 'terrain to be charted', it is important to realise that cognitive maps differ *significantly* from conventional (geographical, astronomical and other) *spatial* maps - firstly, in terms of the metaphysical and dynamic nature of the territory covered,

[15] Note that this differs from the 'nature of the relation of thinking to its object' debate referred to earlier in that it is a question of the *nature* of mental representation rather than the *existence* of mental representations.

secondly, in terms of their unusual and, effectively, indeterminably approximative 'snapshot in time' relationship to that virtual and volatile territory and thirdly, of course, in terms of their usage (intended usage is *the* major determinant of that which is crucial and that which is incidental in a map). That said, Huff (*ibid.*) does provide a good introduction to cognitive mapping methodology and its possible applications. Huff describes mapping in 'purposeful' terms...

- Firstly, mapping which assesses attention, association and the significance of concepts.
- Secondly, taxonomic maps which show the relationship between broad concepts and more specific sub-categories.
- Thirdly, causal maps that show influence, causality and system dynamics.
- Fourthly, maps of the structure of arguments and conclusions.
- Fifthly, maps that specify schemata, frames and perceptual codes.

Knowledge elicitation *techniques* are many in both number and kind. The intuitively obvious procedure by which cognition might be elicited is enticingly simple: *why not merely ask individuals to report their cognitions*? The main problem with this approach is that many cognitions are not conscious but pre-conscious or un-conscious and thus not directly amenable to report by the individual (see Nisbett and Ross, 1980, in Baron and Byrne, 1984). Moreover, where they are amenable to report, they may be prone to editing (for example: rationalization) by the individual reporting them or to various demand characteristics of the research. Taylor (1979, in Chelune, 1979) lists some noteworthy aspects of the 'self-disclosing message' of relevance here. They may be summarized as:

1. its 'informativeness' (appropriateness of breadth or depth of information disclosed - objectively and with regard to its effectiveness in meeting both discloser's and elicitor's goals);
2. its truthfulness or 'normativeness' - which may be tempered by its reward or outcome value;
3. its 'voluntariness' or ease of elicitation.

A number of more formalized, alternative methods of knowledge/information elicitation have been developed by the cognitive psychologists in an attempt to address these problems in their own discipline. They include, for example:

> *personal constructs, q-sorts, cognitive taxonomic interviews, verbal protocols, repertory grids, semantic differentials, pick any methods, phenomenological interview, questionnaire survey methods, laddering interviews, free or triadic sorting and narrative semiotics* ....

... *almost all* of which may be analyzed using some form of *content analysis* and *at least some* of which may be analyzed using *additional or alternative qualitative and quantitative analyses*. (The final graphical, mathematical or other presentation of the structure and content of the elicited cognitive set and any attendant statistics constitutes the representational aspect of the mapping exercise.)

Yet whilst each procedural option has the potential to provide a rich data set, most are highly interpretative and thus arguably, still problematic - if not with regard to construct validity, then with regard to other forms of validity and reliability[16] .. notwithstanding attempts to provide evidence to the contrary (for a number of examples, see Huff, 1990). (Representations of elicited cognitions may also be said to be more or less valid and reliable, depending on the appropriateness, sensitivity and robustness of representational techniques adopted and, indeed, the care and accuracy with which representational techniques are used.)

There is at present, in fact, considerable ongoing debate regarding the usage if not the value of the *whole range* of cognitive mapping techniques currently available to the organizational researcher. In 1990, Huff (*ibid.*) suggested that enthusiasm for the new paradigm was in danger of over-reaching its level of procedural if not methodological sophistication at the time. Several years later, it still appears that relatively little has been written about the *technical aspects* of specifying and studying cognition in organizations. A number of authors (Schneider an Angelmar

[16] See Nunnally (1981) for a discussion of the constructs: 'validity' and 'reliability'.

(1993) and Walsh (1995a), for example) have, however, made some useful contributions to progressing the issue. These latter authors offer non-exhaustive but substantive taxonomic overviews of existing research on managerial and organizational cognition, together with a structured analysis of the methodological issues as a guide to future research. Whilst other researchers may not agree entirely with the suggestions offered (see, for example: Schneider and Angelmar (*ibid.*) versus Langfield-Smith (1992)), the analytical frameworks presented do help to clarify the ongoing debate by clearly delineating the important issues for debate .. and are therefore, of themselves, useful contributions to that debate.

Meanwhile, it seems that no one mapping method is considered to be any better than any other - though some may be found to be relatively more suited to the particular research objectives of particular cognitive studies, than others. Walsh (1995a - after Jick 1979, Lurigio and Carroll, 1985 and Brown, 1992) suggests 'triangulation' (essentially the simultaneous application of several mapping methods) as a means of ensuring valid and reliable mapping - though he agrees that this approach is not practicable - or even desirable - in all cases. It may, of course, be the case that 'there isn't one way of measuring these entities that is more true than another [and that] that which is generally adopted is only more *convenient*' (Pirsig, 1974, p 267).

Pirsig's observation regarding the issue of *means* of measurement may well extend to the issue of *extent* of measurement, that is, to the question of **how much cognition**...

'A map of the world that does not include Utopia is not worth even glancing at' (Wilde, cited by O'Toole, in O'Kelly *et al*, 1995, p.7)...

Most 'cognitive mappers' would probably consider 'cognitive Utopia' to be the ('computer-speak'-) 'real-time' representation onto the furthermost outpost of the mindset's realm, that is (ir)relevant to the research question at hand. Consequently, they would probably view the application of Wilde's notion of a valuable map to cognitive maps as a *'tad'* excessive - if only in terms of its impracticability.

... So ... how much *is* enough? For practical purposes, the answer must be that which extends *usefully*, to the boundaries of the problem space being addressed by the mapping exercise[17].

...and so to the final issue of **contingencies**... Of course, thinking does not occur in a vacuum, the way in which people think depends on who they are, what they are thinking about and the context in which they are doing their thinking. Thus content, intra-individual context and extra-individual context must each be

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[17] 'have we enough information to usefully address a problem? if 'yes', then be satisfied - if 'no', then get some more' (de Chernatony, 1997, personal communication).

considered in both eliciting and representing cognitive sets (see, for example, Kitchin, 1996).

3.7 COGNITION IN THE CONTEXT OF THE PRESENT RESEARCH

3.7.1 Managerial scripts for product innovation management

The central focus of the second part of the present research is that of the nature and effects of managers' beliefs and understanding regarding the manner in which the process of transforming product innovation ideas into marketable products is best managed, that is:- regarding effective product realization *behaviour*.

It follows therefore that:

1. cognition in the context of the present study, is most appropriately operationalized in terms of the *behavioural algorithm*: ***'script** for the product realization process'* held by an organization's owner-manager, managing director or other ***manager*** having greatest authority over and responsibility for innovation within the organization.
2. the *valid* and *reliable* elicitation and representation of managerial knowledge and belief constitutes a key methodological issue for the present study.

3.7.2 Choice of mapping method for the present study

The important issues determining the choice of mapping method for the present study are: (i) the research question to be addressed and any particular considerations which pertain to it and (ii) the production of a valid an reliable data set - while the more general issues to be considered in designing the study are: (iii) practicability with regard to administration and analysis and (iv) the preferences of the investigator.

(Note: cognitive mapping in relation to innovation has been negligible until very recently - see Swan and Newell, ibid.).

(i) the research question to be addressed and any particular considerations which pertain to it

The research question to be addressed is the extent and nature of the link between managerial cogntion on product innovation management, product innovation management practice and product development performance[18]. Two key considerations pertain: (i) in order that the object of the research question might be adequately assessed, completeness and compatibility of measurement of the first two variables is essential; (ii) (it follows

[18] The notion of the **existence** of a link between cognition and innovation being generally accepted (see section 3.5 of the present text), the present research focuses ***specifically*** on ***managerial*** cognition and ***product*** innovation ***practice*** and ***performance***.

that) ''knowledge how'' is to be the primary focus of the cognitive mapping exercise.

In pondering the impact of this research question and these particular considerations, on choice of mapping method for the present study, **the first thing to note is the fact that a very definite investigative agenda is very strongly suggested for it, by the international innovation literature**. The literature may be divided into two themes in this regard.

The first theme is based on its prescriptions on structuring the product realization process. In this regard, the literature prescribes and describes an idealized product realization process, consisting of a large and definitive set of very clearly delineated activities: idea generation, initial concept screening, preliminary market and technical assessments, detailed market research, business/financial analyses, prototype/sample development, in-house product testing, customer field testing, trial sell, trial production or test of facilities, pre-commercialization business analysis, production start-up, formal launch planning and formal launch (see, for example, Booz, Allen and Hamilton, 1982 cited by Hart and Craig, 1993, in Baker, 1993, also: Cooper and Kleinschmidt, 1986 and Hart, 1996).

The second theme is based on more general, definitive principles of product innovation management (for a recent review and taxonomy of the literature's substantial set of general principles of effective product innovation management, see Calantone, Di Benedetto and Haggblom, 1995). Important principles include (with references additional to primary citations included in Calantone *et al*, 1995): awareness of, familiarity with and utilization of new technologies (Mc.Donough and Barczak, 1992); customer orientation (Teresko, 1993) and market orientation (Dougherty, 1990, Athuahene-Gima, 1995); ability to meet the needs of the market with new technologies (Gruenwald, 1992); varied sources of ideas (von Hippel, 1988, Rubenstein, 1994); formalised approach to idea generation (Majaro, 1988, Sokol, 1992/3); experience (Hurst and O'Kelly, 1995); well developed capabilities and competencies (again, Hurst and O'Kelly, 1995); adequate and appropriate resourcing (Cooper and Kleinschmidt, 1988, Walker, 1993, Rosenberg and Thomas, 1993); openness toward risk taking (Abetti and Stuart, 1988, Pidgeon *et al*, 1992); clarity of goals (Maidique and Zirger, in Hart, 1996); systematic approach (Thamia and Woods, 1984) with good pre-planning (Wind, 1982, Day, Weitz and Wensley, 1990, Thomas, 1993) and co-ordination (Spitz, 1977, Henry and Walker, 1991, Bart, 1993); specific screening criteria (Constantineau, 1993, de Bretani, in Hart, 1996); well defined procedures and use of formal models and techniques as appropriate, for example: product life cycle models (Smallwood, 1973, Wind *et al*, 1981, Cordero, 1990, Mahajan and Wind, 1992); use of metrics (Green and Wind, 1975, Griffin, 1993); encouragement of ideas - including incentives (Capon, 1992); tolerance of mistakes (Himmelfarb, 1992); early prototyping (Slade, 1993); efficiency, proficiency, attention to detail and quality (Besford, 1987, Ram, 1989, Wheelwright and Clark, 1992, Murray *et al*, 1992) with regular performance checking (Brignall and Fitzgerald, 1991); clarity of roles with specific responsibilities and authorities clearly assigned to specific individuals (Chakrabarti, 1974, Tushman and Nadler, in Hart, 1996); top management commitment, support and involvement (Krausher, 1985, Duerr, 1986, Hershock *et al*, 1994); a flexible, interdisciplinary approach with co-operation and specialized skills (Sands, 1983); cross-functional teams (Bingham and Quigley, 1990, Henke *et al*, 1993, Hershock *et al*, 1994); effective communication - especially between technical and marketing groups (Gupta and Wileman, 1988, Souder, 1988); inter-organizational networking (Hise *et al*, 1980, Hakansson, 1987, O'Malley, 1992, Rochford and Rudelius,1992, Tidd, 1995); well-planned, appropriate and extensive market research and testing (Garbutt, 1989, Thomas, 1992, Valentin, 1993) and test marketing (Wind, 1982); timing and timely scheduling of development work (Hollins and Pugh, 1990). See also: Pressman and Wildavsky, 1974, Cooper and Kleinschmidt, 1987, 1990 and 1993 and Edgett, Shipley and Forbes, 1992.

When combined, these two themes make up that which may, in effect, be viewed as a more or less exhaustive, definitive, idealized or *generic* 'knowledge how' *skeletal template or **'map'** for 'crafting' the product realization process*[19]. It should, however, be noted that to date, theorists have made no significant attempt to formally, properly and systematically collate the two at a theoretical level; though, on the other hand, practitioners are faced with the challenge of doing so at a very practical level on an ongoing basis. Perhaps the present research presents an opportunity to redress (to at least some extent) the theorists' oversight in a grounded theory way. Afterall, as Schank and Abelson (1977, in Walsh, 1995a) assert, any knowledge structure theory or model must eventually make a commitment to a particular content (in the present case, content configuration) ... Walsh's subsequent review of the rest of the cognitive structure/content literature suggesting that the converse must also be true).

Clearly, the adoption of the innovation literature's 'generic *'knowledge how'* script' for innovation management as a research agenda for the present study would be advantageous in that it would contribute enormously to ensuring the investigation's complete coverage of the two key aspects of

[19] ... ***based on present knowledge*, that is** ...
(indeed, following the well-founded tradition of cartographers of old, we would probably do well to 'flag' the perimeter of this finite set - however apparently comprehensive - with the cautionary note that though it is certainly extensive: ***'beyond here there [may well] be dragons'***)

product realization behaviour (that is: key tasks and the key dimensions of their execution) - and is thus clearly justified. It is, however, important to note that whilst this literature would seem to suggest that *all* product development activities and *all* principles of product innovation management apply to some extent at least, to *all* product innovation initiatives, it may well be the case that the *significance* of *any particular one* of these to any particular product development initiative undertaken by the firm may well depend on the type of product development initiative being undertaken *vis-à-vis* the significance of the undertaking to the firm, for example: new product development versus old product development.

Nevertheless, the mapping method chosen for the present *initial, exploratory* study should be capable of (at least adequately reflecting - but preferably *directly incorporating*) the **entire** generic 'knowledge how' script of the innovation management literature - albeit customized, as appropriate, for the purposes of the present study[20].

The second thing to note is something of an epi-phenomenon of the first. Within cognitive research, scripts normally present (and are analysed) in the form of a simple, constant, set procedure, comprised of a series of clearly delineated tasks to be executed simply and sequentially. The general

[20] In any case, to paraphrase Sun Tzu 'These activities and principles of good practices should, in theory, be at the very least, familiar to every manager' (*cf.* Page 16 of The 1995 Clavell edition of 'The Art of War': 'These five heads should be familiar to every general').

overall impression of latter day product realization practice formed thusfar would seem to indicate that this is unlikely to be the case for those managerial scripts for product realization to be mapped and analysed in the context of the present research, however. As already indicated throughout the present text thusfar, most product development theorists have now abandoned early simple, sequential models of product realization in favour of a significantly more variable and oft-times reduced (as circumstances dictate) parallel processing perspective that is more ecologically valid (given the hugely varied nature of today's product development work - most of which is, afterall, normally carried out under conditions of considerable time and budgetary constraint). Thus latter day managerial scripts for product realization may be (arguably) most appropriately construed in terms of that which in computer programming terms would be referred to as a set of ***'sub-routines'*** - a set of executable 'mini-procedures' (some core, some elective; again, not-necessarily-sequential in nature) nested within and together comprising the overall procedure, each of which may be 'called' and 'executed' in varying configurations and to a greater or lesser extent as necessary/appropriate within any given development undertaking. It is important to point out that the generation of normative data for Irish industry on the extent, the call configurations or even the procedural details of these sub-routines is ***not*** the aim of the present study. The primary aim is, rather, that of gaining some insight into the extent and manner in which principles of effective product innovation management are incorporated into managers' conceptualizations of these 'sub-routine clusters' as **<u>facilitators of their</u>**

effective execution - both as individual behavioural algorithms and as part of the larger overall product realization script, thus enabling characterization of the *overall* script in these terms, too. This aim is, of course, more in keeping with latter day characterizations of organizational strategic and process management in terms of the development of competencies and capabilities through the crafting and ready-ing of process elements (discussed earlier in the present text - see Chapter One).

The significance of the fact that the present research calls for a review of the manner in which 'scripts' are conceptualized within cognitive research (at least within an organizational setting) should not be underestimated. Attention is drawn to the fact that the effective management of the present research problem space and, indeed, many if not most contemporary research problem spaces, calls for the evolutionary:

1. expansion of present conceptualizations of the nature of the script construct to accommodate *larger scale and more complex activities* than previously addressed;
2. re-casting of behavioural algorithms in the sense of stepwise procedures to one of *'call and execute' sub-routines*;
3. returning to the original notion of 'script as behaviourally oriented schema' - incorporating *task descriptors (characteristics) as well as task listings*.

Final note:

March and Simon (1958) state that:

> ... because of the limits of human intellective capacities in comparison with the complexities of the problems that individuals and organizations face, rational behaviour calls for simplified models that capture the main features of a problem without capturing all its complexities. (March and Simon, 1958, p. 169).

The same is true of the limits of research capacities and so, for practical purposes, the primary focus of the present study as an initial exploratory investigation is necessarily confined, in the first instance at least to an exploration of 'knowledge how' in the area of application.

Figures 3.1 and 3.2 do, however, provide some indication of the manner in which the 'knowledge how' of the generic product innovation management script can be combined with relevant 'knowledge what'. These figures are based on adaptations of the taxonomic data presentations of West (1992).

Figure 3.1: Some examples of the combinations of 'knowledge how' and 'knowledge what' which characterize the Innovation Process (based on taxonomic data presented by West, 1992)

knowledge how	*knowledge what*
1. Strategy formulation:	market, technical, company
2. Idea Generation/Gathering:	customer/user and technical
3. Idea Screening:	market, financial and company
4. Concept Development:	customer/user and technical
5. Business Analysis:	market, technical, company
6. Product/Process Development:	customer/user
7. Testing: Small-scale Implementation:	product/process performance
8. Full implementation:	product/process performance

Figure 3.2: A Taxonomy of Information Sources by Content Characteristics (after West, 1992)

	Volume	Access	Completeness	Objectivity	Cost	Uniqueness
Competitors	low	low	low	high	low	low
Technical Journals	high	high	low	high	low	low
Customers	high	low	high	low	high	moderate
Product Analysis	high	high	low	high	low	low
Technical Staff	low	high	high	low	high	high
Non-technical Staff	high	high	low	low	low	moderate
Research Institutions	low	high	high	low	moderate	moderate
Specialists in Innovation	low	high	high	low	high	moderate

(ii) the production of a valid an reliable data set

It should be noted that whilst the adoption of a predetermined research agenda for a cognitive mapping exercise is not unprecedented, the adoption of one which is so comprehensively defined *a priori* is quite unusual. In deciding to adopt this type of research agenda to frame the elicitation of managerial cognition on product realization, careful consideration must be given to the quality of the datasets which will eventually be generated by it. There is, for example, the possibility that demand characteristics may be introduced into the study - effecting the generation of contaminated data sets. That said, the fact that this particular predetermined agenda is one that is significantly pre-defined and pre-pared, may, conceivably, cause it to be perceived in an excessively negative manner as an inappropriately 'closed agenda of convenience' that may not be capable of accurately capturing the *truly* salient aspects of either the product realization process or cognition on it. The adoption of the proposed agenda may, however, be justified on the basis that the coverage offered may be shown to be not only extensive as indicated earlier in the present text - but also enormously valid and reliable given the fact that it is grounded in the outputs of extensive, ecologically valid research that is methodologically robust and based on a substantive and reliable source. Surely, this would ***ensure*** rather than prevent valid capture of the most salient issues. Indeed, in this respect, the research agenda proposed for the present study, may, in fact, far surpass those used in many cognitive studies - many of which are based on bold conjectures following an *ad hoc* literature search or the suggestions of a small and perhaps unrepresentative focus group. Moreover, the agenda need not necessarily be an entirely closed one. It may be (easily) extended to *prompt for* any additional information a firm may deem it appropriate to provide.

(iii) practicability with regard to administration and analysis

A review of the available mapping techniques, indicates that no one technique presents itself as entirely and unreservedly suited to the purposes or proposed research agenda of the present study. The main problem would seem to lie in the definition of the problem space to be mapped (as described in the section of the present text entitled *'the research question to be addressed and any particular considerations which pertain to it'*). Normally, cognitive mapping techniques are based on the notion of collating the constituent elements of a two-dimensional mapping space *where the same set of elements are presented on each axis*. In the present case, different sets of elements would be presented on each axis. (Again, the prime objective of the mapping exercise of the present study is the estimation of linkage of **principles** of effective innovation management to the various **activities** of the product realization process.) The situation is something akin to requiring a multi-factor version of a single-factor test in statistics. Happily, there is one set of mapping techniques which may be **adapted** to meet the needs of the present study, namely: *causal* mapping techniques. This set of techniques would, by no means, constitute an 'obvious' choice, however. Causal mapping techniques - as the appellation would seem to imply, are normally used to elucidate *causal connections* amongst cognitive elements. The object of the present study is the elucidation of *associations* but not necessarily *causal relationships* amongst cognitive elements. Causal mapping techniques do, however, present an interesting option for the present study insofar as they would be facilitative of the collation of the *non-equivalent* constituent element sets of a two-dimensional mapping space. Indeed, that of Bougon, Weick and Binkhorst (1977) would seem particularly useful in this regard ...

Adoption and adaptation of the two-dimensional Bougon *et al*'s type grid mapping technique is justified not only because it readily facilitates the casting of the proposed investigative agenda and the completion of the proposed analyses of the present research ... the development of Bougon *et al*'s mapping technique has been well documented and the technique itself has been well received and widely used by researchers working in the area of managerial cognition. Clearly, the intended customization of the methodology (that is: its adoption for the explication of 'not-necessarily-causal' connectivity amongst independent matrix elements) may have implications for its perceived and/or actual validity and reliability as a cognitive mapping methodology. The implications are arguably slight, however, given: (i) the fact that causal connectivity is arguably just a specific case of general connectivity and that any test of causal connectivity is, therefore, necessarily, a *de facto* test of general connectivity (this renders the proposed customization inherently valid); (ii) the *a priori* case made by the international literature for the validity of the set of elements to be used to frame the mapping matrix for the present study and the dichotomous clustering of these elements along the two axes of the matrix. Matrix elements will be discussed in chapter four of the present text.

3.7.3 Choosing an appropriate method of map analysis

The key considerations in choosing an appropriate method of map analysis for the present study are: (i) the ***nature of the cognitive structure to be analysed and those particular considerations*** (as discussed extensively, in earlier sections of the present text) and (ii) the ***potential scope, intended purpose*** and ***required outputs*** of the analysis...

Earlier (in section 3.2) attention was drawn to the fact that cognitive scripts are known to vary along the two dimensions of *structure* and *content* (see Walsh, 1995a, for a review of the relevant literature). Clearly, it follows that, for completeness, the maps of managerial scripts for the product realization process generated in the context of the present study, must be explored along *both* of these dimensions.

At a general level, Langfield-Smith and Wirth (1992) propose that the structure and content of **cognitive maps** vary along three dimensions. The first source of variability is referred to as *'the existence or non-existence of elements'*. This is where the range of elements regarded by one (or more) individual(s) as being relevant to a domain may differ from the range of elements that are regarded as relevant by (an)other individual(s). The second source of variability is referred to as *'the existence and non-existence of beliefs'*. This is where (an) individual(s) may hold certain beliefs regarding the inter-relatedness of relevant elements that (an)other(s) may not. The third source of variability is referred to as *'identical beliefs held with differing strengths'*. This is where a number of individuals may hold the same belief regarding the inter-relatedness of specific map elements where but one (or more) individual(s) hold(s) the belief more strongly than (the) other(s).

(The Langfield-Smith and Wirth framework is accompanied by a proposed series of mathematical formulae for the quantification of each source of variance.)

Elsewhere, and more specifically, with regard to cognitive scripts, Galambos (1986, in Galambos, Abelson and Black, 1986) describes four features of **action oriented schemata** (scripts), namely: the *distinctiveness*, *centrality*, *standardness* and *sequence* of the actions which make up the scripts for various activities. The term *'distinctiveness'* is used as an indicator of whether an action occurs in one or many different activities (or scripts), *'centrality'*: the importance of an action to any given activity (or script) or to the overall set of activities (or scripts) being studied, '*standardness*': the frequency with which an action features in any given activity (or script) or in the overall set of activities (or scripts) being studied and '*sequence*': the sequential positioning of an action within a given activity (or script) or across the overall set of activities (or scripts) being studied.

Clearly, these analytical tools have the potential to meet the intended purpose of generating general characterizations of both managerial scripts for product innovation management (the first required output) and product innovation practice (the second required output), which are compatible and amenable to further analysis. Moreover, the closely corresponding complementarity of the independently developed, analytical frameworks of Langfield-Smith and Wirth, Galambos and a third - that of Axelrod (1990, in Huff, 1990)[21], is suggestive of their validity and reliability.

When combined with the prescriptive investigative agenda of the international innovation literature, these analytical tools (once adapted to fit the modified script and Bougon grid concepts used in the present study) complete the cognitive research framework - and, indeed, the necessarily corresponding product innovation practice research framework - for the second study of the present research.

[21] For example: there is close correspondence between Langfield-Smith and Wirth's 'existence of elements' and Galambos' 'distinctiveness'; Langfield-Smith and Wirth's 'existence of beliefs' and Galambos' 'standardness'; Langfield-Smith and Wirth's 'differing strengths of beliefs' and Galambos' 'centrality'.

CHAPTER FOUR

Statement of and Test Specification for a Model of Managerial Cognition and Product Innovation Practice and Performance

4.1 INTRODUCTION

Golledge *et al* (1985) and Kitchin (1996) argue that the validity of cognitive research may be called into question on the grounds that cognitive perspectives tend to represent general positions rather that formally presented - and therefore 'testable' - models[1]. As Warr (1980, in Chapman and Jones, 1980) observes, the term 'model' has acquired many meanings and generates much confusion. Many detailed characterizations are possible, including, for example: scientific, mathematical, material, iconic, uniform, difform, micromorphic, macromorphic but, again, as Warr (*ibid.*) observes, of more fundamental significance is type of characterization that is attributed to Hesse (1963, 1966 and 1967, in Edwards 1967). Hesse distinguishes between so-called 'model-1' models which, in effect, constitute limited or provisional theories and 'model-2' models which draw on but exist separately from theories. Hesse would probably categorize the model of cognition and product innovation practice and performance proposed in the context of the present research as a model-2 in that it exploits some system that is already reasonably well known and understood (that is: managerial cognition) in order to explain the less well-established system under investigation (product innovation practice and performance).

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[1] on the other hand...
'The man responsible for Post-It Notes said: "If I knew what I was doing, it wouldn't be research".', Bayley (1991, p.3) ... then, of course, there are the post-modernists ...

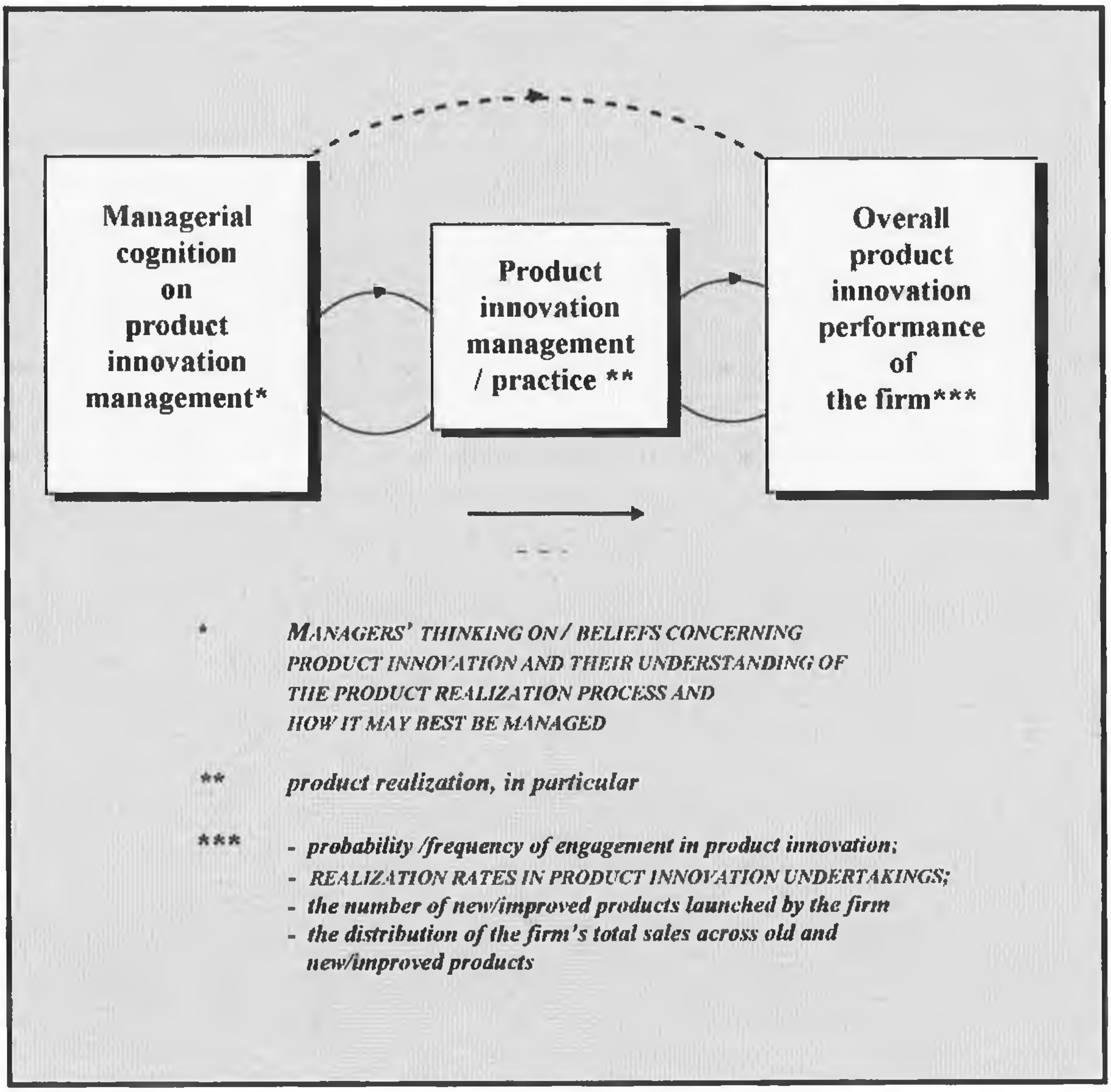
4.2 OUTLINE STATEMENT OF THE MODEL

The model of cognition and product innovation practice and performance proposed in the context of the present research - and which would form the basis of Study Two - may be stated as follows:

The beliefs and understanding of those manager(s) having greatest authority over, responsibility for (and familiarity with) product innovation within the organization, regarding the manner in which the process of transforming product innovation ideas into marketable products is best managed, constitute a significant factor in the final product innovation performance of the firm - particularly in relation to rates of realization of product innovation ideas, the most likely mode of influence being via the product realization practices of the firm (the general link between cognition and innovation being already argued elsewhere and the link between organizational practice and performance being widely accepted as formally proven).

... see Figure 4.1 for a slightly more elaborated description of the model but note that it is the above statement of the model which constitutes the object of the present study ...

Figure 4.1 Proposed model[2] of managerial cognition and product innovation practice and performance



[2] extended version

Underlying the model is the supposition that **a case may be made for the role of managerial cognition as a *significant* factor in product innovation practice and performance, if ...**

... not necessarily as might normally be stated: a substantial proportion of the observable variability in any reasonable measure of practice and/or performance across firms can be accounted for by differences in managerial cognition on *any significant aspect* of practice *and/or* performance - *ceteres paribus* ...

... but, rather more correctly, given the fact that where two or more phenomena are linked, one or more of these phenomena do not necessarily determine the rest (as Goldstein (1989) observes:

> There is no form of ... analysis that can supply you with [definitive, objective] information about causation ... Although some academic disciplines ... use a technique called *causal analysis*, causality can only be inferred based on ... non-statistical [best guesses] Goldstein (1989, p. 96-97))

... such that ...

... a reasonable level of co-variance is found in evidence amongst:

(i) the beliefs and understanding of those manager(s) having greatest authority over, responsibility for (and familiarity with) product innovation within the organization, regarding the manner in which the process of transforming product innovation ideas into marketable products is best managed, (ii) the product realization practices of the firm and (iii) the final product innovation performance of the firm ...

On first viewing, the model proposed may appear both overly simple and intuitively obvious.

It should be borne in mind, however, that this impression would be, largely, an artefact of the level of description used in the summary presentation of the present model and the fact that the more general case for a link between cognition and innovation in general, may itself be viewed as both self-evident and intuitively obvious (... also, easily argued from a theoretical standpoint and empirically: essentially if not extensively made (for relevant citations, see again section 3.5 of the present text)).

Moreover, it is an undeniable fact that, time and time again, that which appears to be the most 'overly simple', 'intuitively obvious', 'self-evident' ... even 'somewhat proven' idea, notion, scientific model or popularly held belief, has been shown, on reflection, re-consideration, re-formulation-or-refinement and re-examination, to constitute, or be capable of generating, one or more valid, interesting and, indeed, useful, testable propositions, the further exploration of which has been frequently found to bring fresh illumination to the broader issues they reflect:- sometimes when accepted ideas, notions, models or beliefs are re-cast as (initial or new-form) testable hypotheses (whether form and/or intended test and/or test setting is initial or revised) exceptions to commonly accepted general rules may be found, one or more (real or potential) (extended) applications of the rules may be indicated, or, the more general notions, themselves, may be substantively disproven (as in the oft-cited (so much so that the original source is now obscured) case of the psychological experiment designed to test the notion that the more people gathered at the scene of an accident, the more likely an accident victim is to receive required attention. In fact, the converse of this popularly held belief was found to be true.)

The research which gave rise to the model was, fundamentally, **an early, *exploratory* investigation** in relation to a very specific application area (the product innovation practices and performance of Irish industry), that is to say...

> [it] is the type of research that is involved in tackling a new problem/issue/topic about which little is known, so the research idea cannot at the beginning be formulated very well. The problem may come from any part of the discipline; it may be a theoretical research puzzle or have an empirical basis. The research work will need to examine what theories and concepts are appropriate, developing new ones if necessary, and whether existing methodologies can be used. It obviously involves pushing out the frontiers of knowledge in the hope that something useful will be discovered. (Phillips and Pugh, 1994, p. 49).

(Of course, it may ultimately, also be classified as '*testing-out*' research, insofar as it proceeds by testing the applicability and usefulness of, firstly, product realization practice theory[3], then cognitive theory, in relation to product innovation performance. 'In this type of research we are trying to find the limits of previously proposed generalizations...Does the theory

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[3] such as it is...

apply at high temperatures? In new technology industries?...' (Phillips and Pugh, *ibid.*, p. 49/50).

Moreover, should such testing out research ultimately generate a solution path for addressing low innovation performance levels, it may also be classified as *'problem-solving'* research...

> In this type of research, we start from a particular problem 'in the real world', and bring together all the intellectual resources that can be brought to bear on its solution (Phillips and Pugh, *ibid.*, p. 50)).

Models proposed in the context of early, *exploratory* research constitute the 'starting-points' for research. They normally appear largely obvious, simple and general - and, indeed, often are so, of necessity. The cognition, practice and performance model proposed here is presented in a deceptively simple and obvious manner, however. Each individual variable is *highly complex* and it is, therefore, necessary to examine each in considerable detail (both individually and in relation to each other) before attempting to introduce additional considerations - principally, in order to pin-point the key focal points of each variable. Additional/alternative factors and mechanisms of determination may easily be introduced at a later stage.

4.3 A TEST SPECIFICATION FOR THE MODEL

4.3.1 Introduction: general hypothesis[4] and a statement of the scope, purpose and outline of the test specification

The **general hypothesis** underlying the test specification for the model was that a reasonable amount of co-variance would be found to be in evidence across the cognitive, practice and performance data gathered in the course of testing, that is: amongst: (i) the beliefs and understanding of those manager(s) having greatest authority over, responsibility for (and familiarity with) product innovation within the organization, regarding the manner in which the process of transforming product innovation ideas into marketable products is best managed, (ii) the product realization practices of the firm and (iii) the final product innovation performance of the firm ... as operationalized and tested, *ceteres paribus.*

For completeness, the test specification covered the full cognition, practice and performance model.

[4] Specific hypotheses are indicated implicitly throughout the test lists/schedules which follow.

The purpose of the test specification was to facilitate the establishment of:

(i) the level and variability of product innovation performance characterizing the test sample,

(ii) the degree and nature of commonality and difference in cognitive datasets generated by the study,

(iii) the relationship between the cognitive data and performance data generated by the study;

(iv) the degree and nature of commonality and difference in practice datasets generated by the study,

(v) the relationship between cognitive, practice and performance datasets.

This purpose could be met through the proposal of:

(i) a study design;

(ii) a research instrument plus administrative procedures;

(iii) suggested analyses, methods, procedures and tooling

(iv) an initial test case for the model.

4.3.2 Study Design

A quasi-experimental design was the obvious choice for the test of the model and the comparison of relatively better and poorer product innovation performers along its dimensions, given that product innovation performance was the key defining focus of the study (to be henceforth referred to as Study Two).

A priori random assignment of study participants to experimental conditions[5] would be impossible - by definition and purely non-experimental research would be something of a hit-and-miss affair in relation to performance levels represented (necessary representation of the population's performance range could not be guaranteed).

A quasi-experiment is defined by Yaremko *et al* (1982) as:

> A refinement of the naturalistic observation study in which changes in the independent variable occur in nature and not by the experimenter's manipulation, but which incorporates as many principles of scientific control as possible under the circumstances. (Yaremko *et al*, 1982, p.186).

[5] above-average (, average) and below-average product innovation performers

Details of the general plan of the study, including the number, selection and arrangement of its independent and dependant variables and suggested test cases, sampling strategy, recommended controls for potentially confounding variables and proposed analyses (methods, procedures and tooling) are provided in sections 4.3.3 through 4.3.5 of the present text.

4.3.3 Development of a research instrument to test the model

4.3.3.1 Introduction

The first step in developing a research instrument is careful review and refinement of general construct / variable definitions with reference to their interrelationships and psychometric properties (that is: their effective operationalization for testing purposes).

The second step consists of specifying, piloting and finalizing presentation formats and procedures...

4.3.3.2 Key concepts

Concept definition is: 'a metascientific activity, having much the same relation to science proper as a piece of scaffolding has to a building which is under construction' (Caws, 1965 in Zaltman, 1982, p 77).

Concepts may be expressed in very general or very specific terms. This notion is referred to as the level of abstraction or degree of specificity of definition.

Meaning may be determined by signification (the pragmatists' approach) or practical application (the operationists approach).

Concepts tend to be value-laden constructs and as such, may be characterized as being either constants or variables, the former referring to concepts having a value which does not change over time or across objects or observations (at least with the context of a given problem space), the latter referring to concepts having values which can change over time or across objects or observations.

The 'correctness' of any given representation of a concept is referred to as its 'validity'. Concept correctness or validity is held to vary along eight dimensions. These are:

1. face - the degree to which a concept appears, at face value, to be represented;

2. observational - the degree to which a concept is reducible to observations;

3. content - the extent to which a given operationalization is representative of a concept about which generalizations are to be made;

4. criterion-related (that is: predictive - the degree to which present values predict future values and concurrent - the extent to which any one representation relates to other representations of the same concept);

5. construct (that is: convergent - the degree to which two attempts to measure the values of the same concept through maximally different representations are convergent, discriminant - the extent to which any one concept representation differs from any other and nomological - the extent to which predictions relating to a particular concept are confirmed when tested using a particular representation);

6. systemic - the degree to which a concept enables the integration of previously unconnected concepts and/or the generation of a new conceptual system;
7. semantic - the degree to which a concept has a uniform semantic usage;
8. control - the malleability of a representation and its power to influence representations of other variables.

(See Yaremko *et al*, 1982 and Zaltman, Pinson and Angelmar, 1973, for example).

Almost all organizational research is based on the exploration of the 'hypothetical construct' and 'intervening variable' (see Taylor, 1986) - a researcher's idea, that is represented by a concrete operation in a form that is capable of assuming two or more values (see Schwab, 1980 cited by Stablein in Clegg *et al*, 1996). The nature of the exploration is reciprocally defined by, in particular, its purpose - but also its intended audience, architect and data. Traditionally its purpose has been held to be the representation of some aspect of an objective reality (see, for example, Lakatos, 1965 also cited by Stablein in Clegg *et al*, *ibid.*). Today it is held to be the representation of someone's conceptualization of some aspect of an objective reality (!) such that, ultimately its concepts may be held to be, after Pirsig: 'definitions, selected on the basis of their convenience in handling the facts' (Pirsig, 1974, p. 267).

Within the context of the present test specification this meant operationalization of key variables as follows ...

(i) The overall product innovation performance of the firm

It was decided that the performance variable 'the overall product innovation performance of the firm' would be best operationalized at three levels[6], that is:

i. probability/frequency of engagement in product innovation activity: measured in terms of *the number of product innovation projects initiated since 1990*, as the primary objective in measuring this dimension of product innovation performance was that of obtaining an estimate of number of product innovation undertakings initiated by Irish owned firms that was: (i) currently valid, (ii) controlled for the possible effects of the generalized upsurge in awareness of and

[6] Single-item measures are not generally considered to be 'good' measures of a construct - particularly in the context of exploratory research as is the present case.

interest in innovation in Ireland since 1990 and (iii) allowed sufficiently for development time.

ii. realization rate in product innovation undertakings, measured in terms of: the proportion[7] of product innovation projects undertaken by the firm for the period 1990 to 1996 which culminated in the successful transformation of product innovation idea to realized marketable products ... with a supplementary review of innovation projects undertaken by the firm which were *not* completed, to ascertain firstly, whether these projects were still ongoing or whether they had been terminated and, secondly, the reason(s) why *terminated* projects had been abandoned or 'killed' ... in order to establish the extent to which realization rates obtained constituted *final* estimates of the *realization* as opposed to the *realization-with-adjustment-for-the-effective-screening-power* of the product realization process as practiced.

iii. final overall product innovation output performance, measured in terms of: (a) the actual number of new/improved products launched by the company from 1990 to date and (b) the distribution of the firm's total sales for 1996 across the four main product innovation categories of: products essentially unchanged from 1993 to 1996;

[7] (better than absolute value as it allows for different product life cycles and development rates, *et cetera*)

products subject to minor change from 1993 to 1996; products significantly changed from 1993 to 1996; completely new products.

(ii) Managerial cognition

Following from chapter three, the cognitive variable, 'managerial cognition on product innovation management', would be operationalized in terms of the *content* and *structure* of cognitive maps of the domain 'effective product realization management' held by the individual having greatest authority over, responsibility for (and familiarity with) product innovation within the organization.

Data on this variable would be elicited using: a two dimensional grid mapping technique (adapted from Bougon *et al*, 1977) - reflecting those key activities and key factors characterizing the product realization process.[8]

Activities identified (on the basis of an extensive review of the literature - sources as referenced in chapters one through three) as core, key, definitive and fundamental to the product realization process, were: concept screening, early marketing activities

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[8] that is: essential even in the most reduced product innovation process
- *cf.* The findings of Study One

(preliminary market assessment, market research), product *(prototype / sample)* design and development and product testing.

Key factors in the optimization of the product innovation process[9] [10] (for principal sources, see section 3.7.2 of the present text), identified on the basis of an extensive review of the literature, were: new technologies; the marketplace; customer orientation; integration of the needs of the market with technological opportunities available to fulfil those needs; full use of both internal and external sources of ideas; experience; capabilities; resources; risk taking, in general and accepting and minimizing financial risk, in particular; cognizance and control of complexity (e.g. of task or design); clarity of goals; formalization; control; co-ordination; pre-planning; reducing uncertainties, in general; formal specifications; detailed/precise; specifications; specific screening criteria; well defined procedures - documented if possible; use of formal models and techniques (e.g. lead users, focus groups, product life cycle models); use of metrics; discretionary use of output-based management and time-based management (not necessarily mutually exclusively) as appropriate; incentives; encouragement of ideas; tolerance of mistakes; time

[9] even the most reduced process (*cf.* The findings of Study One)
[10] utilized as appropriate

constraints; budgetary constraints; flexible resourcing; early prototypes; running tasks in parallel; proficiency; efficiency; cost-efficiency; regular performance checking; detail; quality; clarity of roles; a designated project leader or team; specific responsibilities and authorities clearly assigned to specific individuals; discretionary use of rigid team structures / flexible team structures and concentration of power / decentralization, as appropriate; top management commitment, support and involvement; leadership quality; shared values; teamwork; co-operation; few opposing factions within the firm; interdisciplinary approach; specialized skills; cross-functional teams; job rotation across projects; use of both consultative style communication and command style communication as appropriate (and not necessarily mutually exclusively) with effective communication between marketing and technical personnel; inter-organizational networking; external consultations (direct outsider involvement); participative decision-making.

(iii) product realization practice: the manner in which the product realization process is routinely managed by the firm

It was decided that the product realization practice variable should be operationalized in terms of: (i) the completeness and (ii) the composition of a company's prototypical product realization process - *vis-à-vis* the recommendations of the international innovation literature. The basis of assessment would be a two dimensional practice profile *audit* grid corresponding exactly to the two dimensional cognitive *mapping* grid described earlier. Congruent operationalization of the two variables would be essential to the purposes of present study which included evaluation of the degree and nature of consistency/inconsistency in cognition and practice.

> *Note:* *The time period 1990 to 1996 would be used throughout to control for the possible effects of the generalized upsurge in awareness of and interest in innovation in Ireland from 1990 to the time of testing.*

4.3.3.3 Dynamics: a note on propositions, association, causality, explanation and prediction

Propositions constitute (formal) specifications of (functional) relationships between or amongst concepts. They may be explicit or implicit, general or specific, directional or non-directional. Technically, a simple proposition linking two concepts at any level constitutes a theory - though in practice only a collection of two or more inter-related propositions which act as partial or complete explanations of an event is considered a theory as such - as Zaltman (1982) observes.

Weick and Bougon, (1986, in Sims *et al*, 1986) observe that there are just four ways in which organizational concepts relate within a given problem space (or model of that problem space or theory concerning that problem space). Concepts may be: (i) similar to or (ii) different from each other. They can occur (iii) simultaneously or (iv) at different times. Thus they may be characterized as identities, serialities, correlates or cause-and-effect-relations.

Causality may be posited (if not 'proven') at two distinct levels, one macro, one micro. The former is commonly referred to as the *molar* level, whilst the latter is commonly referred to as the level of *micromediation* (both after Cook and Campbell, 1979). At the molar level, causality is posed in general terms for large and complex entities, whilst micromediation provides something of a stepwise refinement of the molar specification in that it specifies the causal connections at the micro level of these entities. This is important as much - highly polarized - philosophical debate surrounds the issue of whether causal assertions are truly meaningful at the molar level where the ultimate micromediation is undetermined (the primary concern being the assertion of potentially spurious causal connections). Non-spuriousness means that the relationship between the cause and the caused variables is not the result of their relationship to a common third variable. There are a number of ways of determining non-spuriousness, for example: the statistical technique of partial correlation.

> Even when causal sequences are established as regards [explanations of the present or the past], there is not much reason to expect that they will hold in the future, because the relevant facts are so complex that unforseeable changes may falsify our prediction (Russell, in Handy, 1985, p. 418).

A note on the non-spuriousness of surrogative measurement...

The axiomatic approach to modelling may be summarized, after Nunnally (1981), as the establishment of a correspondence between an empirical relational system and a formal relational system so that the elements and the relationships amongst the elements of the one may be taken to represent the other. It is important to note, with regard to measurement, that a distinction is sometimes made between measures derived from direct association (which Ellis (1960, in Nunnally, *ibid.*) denotes as associative measurement) and measures based on a mathematical relationship (which Meinong (1914, also in Nunnally, *ibid.*) denotes as surrogative measurement). As both require a sound theoretical relation with the extensive property, neither may be deemed to be, of themselves, generative of spurious relations amongst variables. The present research makes use of both.

Propositions, association, causality, explanation and prediction in the model of managerial cognition, product innovation practice and performance

As indicated in section 4.2 of the present text, it was considered that, generally speaking, a case could be made for the <u>*role*</u> of managerial cognition as a key factor in *product innovation* practice and performance, if a reasonable level of co-variance is found in evidence amongst: (i) any reasonable measure of the beliefs and understanding of those manager(s) having greatest authority over, responsibility for (and familiarity with) product innovation within the organization, regarding the manner in which the process of transforming product innovation ideas into marketable products is best managed, (ii) any reasonable measure of any significant, pertinent aspect of the product realization practices of the firm and (iii) any reasonable measure of any significant aspect of the final product innovation performance of the firm - *ceteres paribus*.

(Of course, given that the link between organizational practice and performance in general had already been demonstrated empirically (see, for example: Cooper and Kleinschmidt, 1986 and, of course, the findings of study one presented in chapter two of the present text), it would not be strictly necessary to incorporate measures of links with *both* practice *and* performance.[11])

If it was found that cognition did, indeed, play a role in product realization practice/performance, *the* ***significance of the role*** could be established by examining the degree of statistical significance of the degree of co-variance of cognition and practice/performance data observed - either alone or in relation to other previously investigated factors. Finally, if it was found that cognition does indeed play a *significant* role in product innovation practice and performance, *the* ***nature of the role*** could be established by examining two- and three-way co-variances observed at each *level* of operationalization of each of the variables measured.

[11] '*Experto credite*' - trust one who has proven it - Virgil, Aeneid, VI 726, the Oxford Classical Texts

It was clear that evidence of the role, significance of role and nature of role were, all three, inextricably linked - and, that it followed, therefore, that the three would have to be investigated in tandem.

4.3.3.4 Contingencies: facilitating the 'factoring out'/checking(-and-measurement) of potentially confounding variables

Following an extensive review of the literature, quite a few contingencies / potentially confounding variables (extraneous variables that vary systematically with the key variables under investigation, potentially destroying the internal validity of an investigation and rendering valid inference impossible) were identified. For example:

1. With regard to performance, Ali (1994) suggests that: 'A firm ... will be more likely to innovate in an industry ... with [substantial] competitive activity' (Ali, 1994, p.58).
2. Regarding practice *and* performance, Schumpeter (1950) asserts a positive association between firm size and innovative *activity*, whilst Indik (1965) observes that: 'The size of the organization ... influences ... *organizational processes* such as those relating to communication, control, task specialization and co-ordination.' (Indik, 1965, cited by Payne and Pugh, in Warr, 1985, p 364) ...and... an investigation by Yap

and Souder (1994) into the correlates of product innovation success and failure in small entrepreneurial high-technology firms generated a set of factors which differed from those associated with success and failure in larger firms.

Some - in fact, ***most*** contingencies / potentially confounding variables identified pertained principally to cognition and/or practice and/or performance, though a small number of additional more general considerations were included - as shown in Table 4.1.

Table 4.1 Potentially important contingencies/controls

	cognitive variable	practice variable	performance variable	more generally
COMPANY VARIABLES				
age of firm		•	•	
industry/product type		•	•	
product lifecycles		•	•	
markets as competitive influence: predominantly domestic or export?		•	•	
size of firm		•	•	
Q-mark or ISO9000		•		
extent and nature of external linkages (Universities, multi-national companies and government agencies)		•	•	
annual/current product innovation budget		•	•	
distribution of sales across different product innovation categories		•	•	
learning curve - loose index: numbers of new and old product innovation undertakings initiated, completed, abandoned or 'killed'		•	•	
reasons for not completing uncompleted product innovation undertakings initiated		•	•	
proficiency in carrying out product innovation activities - loose index		•	•	
PERSONAL VARIABLES				
position/role in company	•			
age	•			
gender?	•			
academic/professional education/training	•			
work experience: electronics, project management, general management, product innovation	•			
OTHER, MORE GENERAL CONSIDERATIONS				
valid time frame				•
company's current level of product innovation activity				•
commensurablity of measures				•

Each contingency / potentially confounding variable would have to be either controlled for (made constant across groups through sample manipulation) or measured in the course of the study for co-variate analysis at a later stage.

4.3.3.5 Putting it all together - 1. Format and 'gameplan'

Having clarified research goals and objectives and specified the model, its concepts, dynamics, and control contingencies, a decision had to be take in regard to the vehicle to be used for eliciting the data required for the study.

Notwithstanding the scale of the model (ultimately incorporating approximately five hundred data points), its highly structured nature seemed to lend itself to a substantially larger range of options than would have otherwise been possible. Structured interviews, card sorts, grid visuals and questionnaires, *et cetera*, each seemed to present as potentially equally suitable means of data elicitation. As each was considered in turn, however, it became apparent that structure could compensate for scale to a certain extent only and a structured, paper-based questionnaire format eventually presented as the only ***really*** practicable option.

Of course, questionnaires do have a number of advantages which make them a popular research tool (see Rooney, 1992). They ensure almost absolute consistency in data prompting [12] - thus providing greater uniformity across measurement occasions/situations than other techniques (for example: unstructured interviews), they permit anonymity which may enhance validity and reliability of response, they allow time for considered responses, they enable flexible (direct or indirect) and easy distribution to a large number of people simultaneously, they generate data which are (usually) more easily analyzed and interpreted than those generated by other techniques (for example: interview data).

The principal disadvantage associated with questionnaires is that an overly 'fixed' structure may be viewed as either an overly restrictive constraint on respondents or, indeed, a potential source of the introduction of 'demand characteristics' into the study. The careful sourcing of items would, however address these concerns.

In considering the questionnaire option, it was, of course, important to realise, that sometimes existing questionnaires (published or unpublished) can meet research requirements reasonably well. A review

[12] sometimes questionnaire items can be left open to interpretation to at least some degree - sometimes deliberately so, sometimes not

of the literature[13] indicated that this was not so in the present case and, therefore, a custom built questionnaire would have to be constructed.

Questionnaire construction followed the following steps, after Rooney (1992)...

1. the pool of potential questionnaire items was prepared to cover the three key variables and the various contingency/control variables identified earlier
2. item response formats (for example: yes/no, true/false, rating scales, forced-choice, open response) were selected
3. the likely frame of reference of the prospective respondents was delineated
4. questionnaire items were drafted
5. a data summary sheet was prepared
6. draft items were prepared, reviewed, critiqued and revised as appropriate
7. draft questionnaire copy was assembled for design

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[13] 'On-the-off-(and, sometimes, off-off-)chance, (guides to) long-shots with a view to possible adaptation' included, for example: the Forfas/EU innovation survey questionnaire, the 'Oslo Manual' framework and questionnaires, the Mental Measurements Yearbooks, NFER and Saville and Holdsworth catalogues, The Psychological Corporation's Occupational Assessment Catalogues, The Watson-Glaser Critical Thinking Appraisal, The Minnesota Importance Questionnaire, The Work Environment Scale, The Learning Styles Questionnaire, The Jackson Personality Inventory, The Managerial and Professional Profiler Questionnaire, the Climate for Innovation Measure and The Kirton Adaption-Innovation Inventory (all either too general or too narrowly specific - see, for example: Nunnally, 1981, Hunter and Roberts, 1989, Conoley and Kramer, 1989, Walsh, 1995b and the Psychological Corporation, 1995).

8. an administrative procedure was drafted and supporting documents / document[14] templates prepared for design
9. a draft timeplan was generated for: (i) piloting the questionnaire and its proposed administrative procedure (distributing/administering to / review by a test group) (ii) modifying it as appropriate and (iii) finalizing it.

4.3.3.6 Putting it all together - 2. Design for Presentation in an administerable format

In the immortal words of Aicher: 'Design is critical', (Aicher, in Rea, 1995, p 15).

Following the advice of Sless (1996) on 'better information presentation', the final design presentation made use of lessons from the fields of general design (for example: Jones, 1979/80), information design methods and technique (for example: Sless, 1978), ergonomics (for example: Nielsen, 1993) and from consultation with a design communications specialist.

The first consideration was that of the ergonomic demands inherent in the presentation of approximately five hundred data prompts. The main problem to be addressed would be the potential for respondent fatigue.

[14] description of study to be used in soliciting subjects, cover note, instruction sets, reminder note, acknowledgement note

'User-friendliness' would be an essential pre-requisite for the design solution. Schreiber (1985) defines user-friendliness in terms of *ease* of use. Structure would be the key to managing scale and facilitating ease of use in the present case - but structuring would have to be minimal and carefully managed so as to avoid introducing demand characteristics into the study.

The second consideration followed from the first. It was that...

> Every part of a [design solution] relates to every other part by a definite, logical relationship of emphasis and value, predetermined by content. It is up to the [designer] to express this relationship clearly and visibly, through type sizes and weight, arrangement of lines, use of colour, photography, etc.. The [designer] must take the greatest care to study how his work is read and ought to be read. (Tschichold, 1995, p.67).

The most critical aspect of the present design brief was that the design solution should not dictate the final cognitive map content/structure. Thus, in the present case, the designer (that is: the researcher) would also have had to 'take the greatest care to study how his/her work' ought *not* to be read.

Boorstin (in Novosedlik, 1996) argues that the image has supplanted the word as the primary vehicle of communication. This notion is echoed by Kalman in his comment that: 'after fifteen or twenty years in the profession I discovered that design is just a language and the real issue is what you use that language to do' (Kalman, in Cullen, 1996, p.10).

Ultimately, Tschichold was to provide the solution path:- Tschichold's approach to meaning is not from the element up but from form in BUT with the philosophy that **the subject must be seen as given the task of *de- and re-* constructing the final presented form.**

The final design solution consisted of employing layout and type:

1. for clarity and legibility and to show hierarchy, congruity of only the most general aspects of cognition, practice and performance - just to the required extent, remaining cognizant of the danger of overstepping the limits and generating demand characteristics;

2. to facilitate *user-friendly* data elicitation and prevent respondent fatigue.

Two print versions were prepared. One featured the 'practice audit' first, whilst the other lead with the 'cognitive audit'. This would provide the basis for 'control' of possible 'order effects' in administering the same generic matrix as both a cognitive mapping and practice mapping instrument. A copy of the latter is included in the present text as Appendix B.

4.3.3.7 Putting it all together - 3. Piloting and finalizing the Questionnaire

Piloting is described by Yaremko *et al* (1982) as:

> A small-scale investigation that precedes a more complete research project. Its primary purpose is to determine whether certain techniques and procedures will be effective and feasible. It also is conducted to permit control of the power of the research by determining whether selected levels of an independent variable are too similar or dissimilar, and by estimating variability in order to determine a sample size (Yaremko *et al*, 1982, p. 174).

In the present case, the first part of the definition was the main concern. Piloting proceeded as follows...

Firstly a small-scale, expert-based, pre-pilot, concept screening study was conducted in the form of four separate, informal meetings with four members of Dublin City University's academic staff with expertise in research design and/or product innovation. Two were affiliated to the Business School and two to the School of Engineering[15]. After an initial briefing, the structure and content of the draft research instrument were discussed and reviewed. A number of revisions were suggested - interestingly, all related to format and none to content. Next, the feasibility of a mailshot was discussed. The researcher's primary concern in regard to an indirect delivery of the research instrument was that it might facilitate managers who might wish to attempt reconciliation of cognition and practice responses. It was generally agreed that a personal visit would be the only reliable way of ensuring that this did not happen. Finally, possible test case groups were discussed. The key criterion for the test set was generally considered to be characterization by a baseline and, thereafter, a reasonably variable level of product innovation activity. Irish-owned electronics firms were generally deemed to be most appropriate.

When the series of meetings was concluded, comments were reviewed and the research instrument was revised. Also: a full list of all Irish-

[15] (the latter two were chosen also on the basis that from the outset hi-tech industries such as electronics seemed a potentially good test case for the model given the generally held association between them and the phenomenon to be studied (product innovation))

owned electronics firms currently trading was compiled by the researcher and a proposed test sample (based on product type) was prepared for discussion at a follow-up meeting with one of the academics from the School of Engineering, in the course of which likely above-average, average and below-average product innovators were identified.

Following revision of the research instrument, a small-scale, practitioner-based, pre-pilot study was conducted in the form of separate, semi-formal meetings with the managers of two companies operating in the suggested test case area - both also having considerable *personal experience* in both electronics and product innovation project work. One was the manager of a telecommunications company and had eight years product innovation / project management experience. The other was self-employed in the computer hardware/software systems solutions area and had ten years product design experience. Firstly, the research instrument was tested. Early respondent fatigue indicated that further adjustments to the formats of cognitive and practice matrices was needed in order to increase 'user-friendliness'. The feasibility of a mailshot was also debated with 'practitioners' and the researcher's concerns in relation to an indirect delivery of the research instrument were discussed. It was concluded that the inclusion of a note underlining the normality of at least some dissonance in cognition and practice responses in subjects' instruction sets would constitute a sufficient measure to prevent reconciliation of cognition and practice responses and that, therefore, a personal visit was probably not absolutely necessary.

After the meetings, comments were reviewed and the research instrument was again revised.

Following further revision of the research instrument, a third and final, small-scale, postal-based, main pilot study was conducted with the assistance of the practitioners involved in the second stage study. Returned questionnaires and follow-up conversations with participants revealed that: (i) revised matrices had worked well; (ii) a small number of very minor final adjustments to the instruction set were needed; (iii) adoption of a mail shot strategy was viable.

4.3.3.8 Putting it all together - 4. Finalizing the Administrative Procedure

The final nine-point, administrative procedure for the questionnaire study consisted of ...

1. finalizing choice[16] of test case ensuring a complete-as-possible listing of all companies in the general target area
2. reviewing/delineating required key characteristics of target individuals for the study in order to facilitate their identification
3. nominating specific target companies
4. ’phoning target companies to: (i) identify target individuals, (ii) describe the study generally to these individuals and (iii) solicit the involvement of target companies/individuals in the study
5. executing targeted mailshot, with: (i) balanced usage of the two print versions of the questionnaire to control for order effects and (ii) enclosure of return stamped addressed envelopes to facilitate response
6. scheduling first (second and subsequent, if necessary) follow-up call(s) and reminder calls as appropriate
7. checking returned questionnaires (with follow-up calls as necessary[17])
8. distributing acknowledgement notes
9. scheduling and making ‘de-briefing’ ’phone-calls.

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[16] see earlier footnote
[17] for example: in the case of partial or unclear responses to questionnaire items

4.3.4 Proposed analyses[18]

4.3.4.1 Introduction: exploratory data analysis and inferential testing

Data analysis is normally construed in terms of: (i) exploratory data analysis and (ii) inferential testing. Exploratory data analysis is a term used to describe the process of obtaining a characterization of sample data ...

Its primary focus is the univariate analysis of key variables. Descriptive statistics and graphics are used to summarize measures of the dataset's central tendency, spread and primary clusters. Inferential testing is a term used to describe the process of applying statistical procedures to a data set, in order to enable general statements (inferences) about a population to be made on the basis of the information in a sample from that population.

It was decided that data analysis for Study Two could most usefully proceed in three highly focused stages: (i) preliminary analysis of individual model components; (ii) inter-component analyses; (iii) evaluation of the overall model.

[18] Though not mentioned explicitly in this section, contingencies/controls identified earlier in section 4.3.3.4 of the present text, should be considered throughout. For example: in the course of carrying out preliminary data analysis on company performance profiles, checking for evidence of generally, substantively, relatively higher/lower performance levels in companies representing the *a priori* designated above-and below-average performing sample strata respectively would, obviously, be important.

4.3.4.2 Preliminary analysis of individual model components

For the purposes of Study Two, performance measures would, of course, be quite straightforward and would, therefore, require just minimal preliminary analysis. As suggested in chapter three of the present text, the evaluative frameworks of Langfield-Smith and Wirth (1992) and Galambos (in Galambos *et al*, 1986) were considered a suitable basis for a preliminary analysis of both the cognitive and practice data sets - the purpose of which would be that of generating general characterizations of both managerial scripts for product innovation management and product realization practice - or, more specifically, that of establishing the degree and nature of commonality and difference in structure and content amongst cognitive and practice maps generated.

The performance variable

The overall aim of the preliminary analysis of product innovation performance would be that of ascertaining the general level and variability of product innovation performance (all three dimensions) across firms participating in the study.

The specific objectives of the analysis would therefore be chiefly the assessment of:

1. frequency of engagement in product innovation projects in general, overall and in relation to various types of initiative and above-average and below-average performers
2. realization rates for the overall test group and above-average and below-average performers - with type of initiative breakdowns for unrealized initiatives
3. reasons for abandoning or killing unrealized product innovation initiatives
4. number of new/improved products launched over the period 1990-1996 - overall and by above-average and below-average performers
5. distribution of total sales for 1996 across the four main product categories.

It would, of course, also be important to cross-check performance data for stratified groups - in order to estimate their validity - before proceeding with any further analysis and to check data on realization and reasons for abandoning/killing product innovation initiatives not completed - in order to estimate the extent to which poor product realization rates might be linked, in practice, with *'screeningly effective'* as opposed to *'realizationally poor'* product realization process.

The cognitive variable

Again, following from chapter three, the overall aim of the preliminary data analysis of the cognitive variable would be that of measuring (for the full test set and above- and below- average performers as appropriate), cognitive map completeness[19], structure and content in terms of ...

1. the variability and range of elements included (corresponding to Langfield-Smith and Wirth 's existence/non-existence of **elements** and to Galambos' standardness index, in terms of rate of occurrence values being zero versus at least one);
2. the variability of beliefs and strength of beliefs concerning the **interrelatedness** of map elements, that is: activity/principle combinations (corresponding to Langfield-Smith and Wirth 's existence or non-existence of **beliefs** and Galambos' distinctiveness (of principles across scripts), standardness (of principles across script activities) and centrality (of principles: firstly, to individual activities, secondly, to the overall product realization script).

[19] Throughout the test specification, the term 'completeness' is used to refer to completeness/complexity, after the use of the term by Eden *et al*, 1992 **but not** Langfield-Smith and Wirth, 1992.

The specific objectives of the analysis would be, chiefly, the assessment of (again, for the full test set and above- and below- average performers as appropriate):

1. the total number of elements characterizing elicited maps
2. prevalence of activities and principles
3. the extent and strength of patterns of activity/principle linkages characterizing these maps
4. the distinctiveness of activity/principle combinations observable across maps
5. the incidence or standardness of principles across the overall product realization script
6. the overall centrality of each principle
7. the centrality of each principle for each of the four activities
8. particularly significant principles
9. most consistent activity/principle combinations across all managers
10. patterns of linkage which most clearly distinguish between above- and below- average performers
11. activity/principle combinations unique to and common to all managers of above-average performing firms
12. the effects of contingent variables
13. a rough indication of the principal areas of correspondence of cognitive map characteristics and the recommendations of the relevant international innovation literature.

The practice variable

Again, following from chapter three, the overall aim of the preliminary data analysis of the practice variable would be that of measuring (for the full test set and above- and below- average performers as appropriate), practice profile map completeness, structure and content in terms of:

1. the variability and range of elements included (corresponding to Langfield-Smith and Wirth's existence/non-existence of **elements** and to Galambos' standardness index, in terms of rate of occurrence values being zero versus at least one);
2. the variability of activity/principle combinations in practice (corresponding to the cognitive measure of beliefs concerning the **interrelatedness** of map elements, and, of course, also to Langfield-Smith and Wirth's existence or non-existence of **beliefs** and Galambos' distinctiveness (of principles across scripts), standardness (of principles across script activities) and centrality (of principles to the overall product realization script (findings of the pilot study regarding potential subject response fatigue meant that centrality to *individual* activities in *practice* would not be measured:- as practice is measured chiefly as a mechanism of determination, a general indicator type macro measure was deemed sufficient ... to that end, secondary operationalization of the practice variable would have to be

carried out in terms of (an) additional data prompt(s) aimed at isolating those key activities and recommended principles which, in the opinion of survey respondents, were particularly significant in ensuring that product innovation initiatives undertaken by their companies were successfully carried through to the point of generating a marketable product.

The specific objectives of the analysis would be, chiefly, the assessment of (again, for the full test set and above- and below- average performers as appropriate):

1. the total number of elements characterizing elicited maps
2. prevalence of activities and principles
3. the extent and strength of patterns of activity/principle linkages characterizing these maps
4. the distinctiveness of activity/principle combinations observable across maps
5. the incidence or standardness of principles across the overall product realization script
6. the overall centrality of each principle
7. particularly significant principles
8. most consistent activity/principle combinations across all firms

9. patterns of linkage which most clearly distinguish between above-and below-average performers
10. activity/principle combinations unique to and common to all managers of above-average performing firms
11. the effects of contingent variables
12. a rough indication of the principal areas of correspondence of cognitive map characteristics and the recommendations of the relevant international innovation literature.

4.3.4.3 Inter-component analyses

Firstly, the relationship between managerial cognition and company performance would be tested by correlating key cognitive indices (map size or completeness (total number of elements), number of principles characterizing individual product realization activities and overall standardness and centrality across maps of each of the sixty-four principles recommended by the international innovation literature) with the key performance index: realization - or, more specifically, the proportion or percentage of product innovation ideas successfully transformed into marketable products over the period 1990-1996 - the primary focus of the study (note that proportion/percentage realization rates constitute a more equitable basis of comparison across companies than absolute number of successfully transformed ideas which co-vary with variable numbers of initiatives, *et cetera*).

Secondly, the degree of correspondence between managers' cognitive maps and companies' practice profiles would be assessed based on binary correspondence indices, cognitive data having first been converted from interval to nominal by recoding values less than five as zero and values equal to or greater than five as one.

Thirdly, the relationship between organizational practice and performance would be assessed in terms of: (i) the association between rate of realization and process completeness, practice proficiency and number of principles characterizing individual activities, (ii) the association between reasons given for abandoning/killing projects and poor proficiency ratings for individual activities, ratings of significance of each of the sixty-four principles in practice, in general and the standardness of each of the recommended principles, in practice.

4.3.4.4 Evaluation of the overall model

Finally, the full cognition, practice and performance model would be approximatively evaluated by co-correlating cognitive map principle centrality, practice profile principle standardness and the percentage realization rate index of product innovation performance.

*Note: all tests to be based on **raw data** unless otherwise stated.*

4.3.4.5 Data analysis procedures and tooling

The investigation of: (i) interesting points; (ii) patterns of relationship and (iii) difference effects, across overall and above- and below- average performer, cognitive, practice and performance data sets would be conducted using the usual suite of descriptive and inferential statistics.

In all cases, therefore, a statistic would be calculated on the basis of the null hypothesis (that the data generated in the course of the study were not due to the effects of independent variables tested / relationships amongst variables test (as predicted by the alternative/experimental hypothesis:- see section 4.3.1 for a statement of the general hypothesis underlying Study Two)) but, rather, due to those chance fluctuations in data which are due to the effects of other unknown/unspecified variables.

The foundations of mathematical statistics were laid between 1890 and 1930 and the principal groups of techniques for analyzing numerical data were established during the same period (see, for example, Porter, 1986). Publication of algorithms for data analysis dates from the famous textbook of Whittaker and Robinson (1924). The classical work established a mathematical framework, couched in terms of random variables, the mathematical properties of which could be described. Fisher's work on testing a null hypothesis against data, modelling random variation using parameterized groups, of estimating parameters to maximize the amount of information extracted from the data and of summarizing the precision of these estimates with reference to the information content of the estimator, set much of the context for future development. Much of this work was made more formal and more mathematical by, for example, Neyman, Pearson and Wald - ultimately culminating in the generation of today's suite of statistical procedures for hypothesis testing, interval estimation and statistical decision theory (see Thisted, 1988).

In practice 'the applicable methods have [always] been the currently computable ones' (Thisted, *ibid.*, p.3).

Non-parametric measures of centrality and dispersion, tests of association and difference (specifically: Spearman's rho, the Mann-Whitney U-test for independent groups and Chi-Square with Phi/Cramer's V/Fisher's Exact

Test based on cross-tabulation of (reduced) data[20]) would cover most of the requirements of the present study where data generated would be largely nominal and interval in type and the usual population assumptions required for parametric methods (see Greene and D'Oliveira, 1982) could probably not be made.

Tooling has always constituted a crucial factor for statistics - tool quality and availability frequently constituting an enabling or limiting factor in statistical analysis (for an overview of the history of development of statistical tooling, see Rooney, 1989). Until recently, evaluative reviews were surprisingly sparse, however. It is important to realize that today's widespread availability of automated tooling for data analysis that is both powerful and *apparently* reasonably user-friendly, has - as Chambers (1981) predicted - precipitated much uninformed, unguided and simply incorrect data analysis and so, the amateur data analyst must proceed with caution.

The present test specification relied mainly on: (i) 'SPSS (Statistical Package for the Social Sciences) for Windows, release 6.1 (24 June, 1994)' - a user-friendly statistical package with a good range of robust data manipulation, transformation and analysis techniques and graphing facilities

[20] Descriptions of each of these tests may be found in most statistical handbooks, for example: Yaremko *et al*, 1982, Greene and D'Oliveira, 1982, Kanji, 1993 and the hardcopy if not on-line documentation supporting most statistical software packages - for example: that which supports the SPSS package.

and related on-line and paper-based manuals; (ii) Yaremko *et al* (1982), Greene and D'Oliveira (1982), SPSS on-line documentation, Kirakowski and Rooney (1988) and Rooney (1992) handbooks for statistical analysis ... as guides.

Finally, it is important to realize that data resulting from any study can be said to be partially accounted for by the effects of the main variables under investigation, partially by error due to measuring instruments, individual variation, confounded effects (that is: the presence of one or more extraneous variables that vary systematically with the key variables under investigation, destroying the internal validity of an investigation and rendering valid inference impossible).

The minimization of error is, of course, a primary goal for researchers. Strategies used in pursuing this goal include, for example: checking the validity and reliability of research instruments used, checking the credentials and stratification validity of sample sets used.

The statistic calculated on the basis of the null hypothesis determines whether the null hypothesis can be rejected as incorrect and the alternative hypothesis accepted as correct insofar as it is statistically supportable OR whether the null hypothesis is to be retained - in which case, the alternative hypothesis cannot be accepted.

In the case of the null hypothesis being rejected, it is useful to know whether it has been barely rejected or whether it has been substantively rejected. To this end the following conventions are generally adopted by statisticians based on probability level 'p':

- $0.5<p<1.00$: not significant, the null hypothesis is retained, there is no statistically significant difference/relationship between/amongst groups/variables

- other values: significant - to the extent indicated, the null hypothesis is rejected, the alternative hypothesis is accepted with the indicated level of confidence, for example: $0.01<p<0.05$: significant (at $p<=.05$), the alternative hypothesis is accepted with ninety-five per cent confidence

... and so, with regard to the output of the analysis, it would have to be borne in mind that the statistical significance of test statistics obtained would be reflective of the level of both effect (model fit) and error (residual effects) inherent in the data - and that results obtained should be assessed accordingly (see Chow, 1996).

The present researcher's training in and experience of a number of varied research settings, teams, projects, data sets and analyses[21] has led her to understand that generally, anything in the range $0<=p<=0.4999$ is worth at least cursory examination in the context of preliminary work - particularly the sometimes overlooked values in the range 0.3 through 0.4.

The objective is open-minded, meaningful interpretation of the data gathered.

This may, of course, ultimately necessitate, at times, the simultaneous use of a variety of probability levels in interpreting various aspects of any particular dataset. Where the 'cut-off point' of $0<=p<=0.4999$ is maintained, there can be no reasonable objection to this approach ***providing care is taken to ensure that, in all cases, specific probability levels used***

[21] (... a number of specific examples of learning contexts: undergraduate training in research, experimental design and applied statistics - U.C.C.; observation of a number of senior researchers at work (in particular: while working with the Human Factors / Human-Computer Interaction research groups, U.C.C. and Loughborough, U.K. (ESPRIT and other projects), Statistics Laboratory staff, U.C.C. (wide range of datasets relating to small-, medium- and large-scale national and international medical, zoological, agricultural, epidemiological, sport and other research projects) and the C.E.C.'s DG XII / EUREC Agency's senior committees and associated research groups including those based at the National Micro-Electronics Research Centre, U.C.C. and ISPRA / ISES / Conphoebus, Italy (renewable energies research)); discussion with a number of Irish, European and American academics with a particular interest in the theory and practice of data analysis (not just applied statisticians but also both pure and applied researchers in a broad range of 'application areas') and personal experience in assisting in and independently analyzing a broad range of data sets and reviewing, assessing and discussing the analyses of others (including, of course, those encountered in D.C.U.'s Business School) - *cf.* Section 6.2's subsection: *'Reality Testing' the present work*))

are flagged when reporting the findings of research data interpreted in this way.

In significance testing, both the focus of testing and the robustness, sensitivity and underlying assumptions[22] of prospective tests are important *a priori* considerations.

It is also important to be cognizant, *a posteriori'ly,* of effect size[23], sample size, statistical power and alpha level - all of which are closely linked[24] (see, for example: Rosenthal and Rubin, 1985, Tukey, 1991) ... and to take great care in interpreting any interactive effects observed (Dawes, 1990 and Rosnow and Rosenthal, 1991).

In hypothesis testing, the danger of 'Type I (or alpha) Error' (the rejection of a true null hypothesis when it should not have been rejected) and 'Type II (or beta) Error' (failure to reject a false null hypothesis when it should have been rejected) would also have to be borne in mind as the former could lead to the erroneous claim of an observed effect when there was, in fact, none and the latter may lead to the erroneous claim of no observed effect when there actually was one.

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[22] particularly in cases where the use of parametric tests is being considered

[23] (though small effect size does not necessarily imply unimportant results:- 'one needs to calibrate the magnitude of an effect by the benefit possibly accrued from that effect' (Tukey, 1991, cited by Judd *et al*, in Spence *et al* 1995, p. 438)

[24] for example: with small sample sizes, an increase in power may be worthwhile - despite the slight increased risk of rejecting a true null hypothesis

In ***computer-assisted*** significance testing, it would also important to bear in mind that 'bugs [can be] as common in [even the best] PC stat packages as they are on a June day in Maine' - as Raskin (1989, p.104) observed.

These final considerations, in particular, do, of course, beg the question of why, if there's so much 'hedging', we should use statistics at all - but, as Goldstein (1989) observes:

> Statistics give us a way to measure our uncertainty. We lack definite answers, but we know which outcomes are most probable and how much confidence we can place in predictions [and, afterall, the] use of statistics guards against certain prevalent [inferential] fallacies and biases. (Goldstein, 1989, p.96).

4.3.5 Suggested test case: the Irish-owned electronics industry (key considerations)

Introduction

As reported in section 4.3.3.7, possible test cases for the model were discussed in the course of the expert-based, pre-pilot, concept screening study for the research instrument. The key criteria for the test set was characterization by a reasonable baseline and, thereafter, a reasonably variable level of product innovation activity.

In regard to a reasonable baseline level of activity, 'high-tech' firms presented as an obvious choice: 'A firm ... will be more likely to innovate in an industry ... with [substantial] competitive activity' (Ali, 1994, p.58 - as cited earlier).

Irish-owned electronics firms were generally deemed to be a potentially appropriate test group and expert commentary on a list of all Irish-owned electronics firms currently trading, revealed that companies could be quite readily characterized as above-average, average and below-average product innovators - suggesting a reasonably variable level of product innovation activity within the proposed test group.

Product innovation in the Irish-owned electronics industry

The electronics industry is a rapidly changing technology driven industry. It has been central to the success of the outward looking industrial policy adopted by the Irish government in the 1960s. Thirty years on, government policy has evolved. Following the publication of the Telesis report in 1982, government support began to focus in a particular way on the development of the *indigenous* electronics industry and on the encouragement of *research and development* activities within these companies (*cf.* The Department of Industry and Commerce Report, 1989).

It is perhaps surprising, therefore, to find that today, despite substantial growth in the number of indigenous companies, the Irish electronics industry continues to be significantly dominated by multi-national companies, set up principally as manufacturing operations for *products conceived and designed in other countries* - and that the industry *as a whole* continues to be characterized by relatively poor *overall* innovation performance (see Madden, 1993).

A sectoral analysis of *product* innovation performance formed part of the Irish innovation survey, referred to earlier (Fitzgerald and Breathnach, 1994). Cumulative product/process development incidence estimates for the combined electrical and electronic equipment industries - Irish and foreign owned provided were not of sufficient specificity to constitute useful indicators of performance for the purposes of the present study - but one of the co-authors of the 1994 report on the survey, kindly isolated updated product performance data for those Irish-owned electronics firms which participated in the study. These data indicate that eighty percent of participating firms engage in product innovation activity, that incremental product innovation accounts for an average twenty percent of the industry's sales and that seventeen percent is accounted for by significantly changed or completely new products (Breathnach, 1996, personal communication).

On first viewing, these observations would seem to conflict substantially with those of Madden (*ibid.*). It should be borne in mind, however, that Madden refers to 'innovation performance' in its broadest sense whilst the Irish innovation survey refers to two very specific indices of *product* innovation, namely: (a) (likelihood of) engagement in product innovation initiatives and (b) proportion of sales accounted for by new or improved products.

It is also important to bear in mind that these latter indices represent just the start and end points of that which is quite a lengthy and involved product realization process and as such, must be viewed as offering just a limited, general assessment of the overall product innovation effort of Irish electronics firms. For example: the extent to which the 'initiative index' accounts for the final 'outcome index' is not determined. Indices based on sales figures are likely to be confounded by post launch marketing or environmental effects. Thus an organization's claim that a large proportion of its sales is accounted for by new or improved products may, at first, seem to suggest an effective overall product innovation effort on the part of the organization - yet this index may well reflect the combined effects of: (a) a small proportion of product innovation effort resulting in products that are disproportionately well received by the consumer, (b) a large proportion of product innovation effort resulting in products that significantly less well received, (c) a possibly not insignificant proportion of non-productive product innovation effort, that is: product innovation initiatives which were prematurely abandoned/terminated (some, perhaps, appropriately, some, perhaps, not so)- thus never actually generating a marketable product. In failing to differentiate between the three, a sales based index may thus not only mask the effects but also the very existence of a significant amount of development effort which is at best, under-exploited - at worst, particularly in the case of abandoned projects, wasted.

Clearly, the most that could be concluded from these indices would be that they supply evidence that the phenomenon to be researched (product innovation) is sufficiently prevalent in the indigenous Irish electronics industry so as to render it a useful test case for the present study.

Measuring product innovation performance in electronics firms

As indicated in chapter one of the present text, there is no one generally accepted metric with which the overall product performance of the firm may be evaluated, though the Hart and Craig and PDMA papers discussed in that chapter, certainly offer insight into product innovation performance as a generic multi-dimensional concept which may be measured in a variety of ways.

Recent research by Loch, Stein and Terwiesch (*ibid.*) cited earlier in section 1.3 of the present text, would seem to be particularly relevant to the present test case, however ... firstly, in terms of their separate treatment of process and output metrics and, secondly, in basing their work in the field of electronics, for Loch *et al* claim to have identified a number of key indices of development process and output performance of particular relevance to electronics firms.

As indicated in section 1.3 of the present text, Loch *et al*'s indices are problematic at a number of levels, however: from both a theoretical and a pragmatic perspective.

Nevertheless, when 'critically' considered, they do serve as a sort of general check and confirmation of the commensurability of the present model, research instrument and proposed test case.

In this regard, it worth noting that the best of Loch *et al*'s metrics appear to be adequately covered in the present study's research instrument.

Levels of analysis of product realization for electronics firms

It is of tantamount importance to clarify the *level of analysis* of product realization scripts for the *electronics* industry intended in the context of the present study as the term 'product realization' is generally viewed in electronics as being more-or-less synonymous with technical development.

In general, electronics products are designed to meet a particular application requirement - for example: a security system. They consist of plastic or sheet metal printed board assemblies (PBAs) of interconnected electronic components which interface with the outside world through input/output devices which usually contain their own set of electronic sub-assemblies. *Technical* product realization proceeds at three levels: (i) system design, (ii) board/sub-assembly design, (iii) component design. Normally, system requirements are interpreted by a system designer for a board developer who in turn works with a component designer. It is generally considered that systems are relatively easy to design, that boards and sub-assemblies are somewhat more difficult and as component design very often involves the 'core' technology, its development usually requires substantial time and effort.

The fact that product realization in electronics is generally viewed as being more-or-less synonymous with technical development is hardly surprising, given the fact that technical development in electronics is so complex, lengthy and involved.

The subject matter of the present study is somewhat broader, however. Thus, whilst it is, most certainly, intended that *technical development* should be examined in the course of the present research[25], it must be made clear that it is to be represented in the present study only as *a cumulative subset of* (and therefore, together with the rest of) *the broader product realization process*.

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[25] (as product prototype/sample development)

Suggested sampling strategy - including additional controls

A required sample size: 'n' of n >= six was indicated by:

- a subjectively determined conservative estimate of the objectively undetermined total population size of approximately one hundred and twenty firms;
- a preferred ninety-nine per cent target confidence interval ({(2.57 for ninety-nine per cent confidence) x ([29: standard deviation of performance output index for secondary data set (a pilot equivalent as the pilot n was very small)] / [12: ten per cent of estimated total pool])});
- requirements for the necessary preliminary data analyses and inferential statistical analyses: n per group >= 3 deemed adequate.

The desirability and possibility of cluster sampling featuring above-average, average and below-average product innovation performers *or* above- and below- average product innovation performers (and, of course, controlling for contingency variables identified by focus and elimination (representation and classification being the alternative option)) was indicated earlier by elementary data analysis of the secondary data set and expert profiling of industry performance patterns (performance criteria: cross-checked expert opinion and official statistics on overall product innovation outputs - quantitative and qualitative - and realization success rates).

Finally, as previously stated, the target respondent within the target firm was to be the person with greatest authority over, responsibility for (and familiarity with) product innovation in target company.

CHAPTER FIVE

Results of a test of the proposed model of

managerial cognition and product innovation practice and performance

(using Irish-owned electronics firms as test case)

5.1 INTRODUCTION AND GUIDE TO CHAPTER FIVE

The results of the test of the proposed model carried out in the context of the present research are presented following the usual conventions, as follows ...

Initially, the final sample set, respondents and response rate are described (see section 5.2). Then, each of the model's key component variables is examined individually: overall test group data is considered and data for above- and below- average product innovation performance group is compared and contrasted (see section 5.3). Next, key inter-component / inter-group / multi-variate / inferential analyses are presented (see section 5.4). The findings of a review of contingencies/controls and other points of interest follow (see section 5.5). Finally, a summary of key findings and conclusions and an overall evaluation of the full model is presented (see section 5.6)

It is worth noting that the main analyses presented in section 5.3 are quite detailed and are intended to be considered as introductory, standalone presentations for each individual model component. These presentations may, of course, be considered in relation to one another - but this is awkward and all key inter-component / inter-group / multi-variate / inferential analyses are, in any case, presented in a more accessible, useful/meaningful and conclusive form in section 5.4.. (Having examined the findings presented in section 5.4, the reader may, of course, wish to 're-view' particular subsections of section 5.3 which may be relevant to points of particular interest in section 5.4.)

5.2 FINAL SAMPLE SET, RESPONDENTS AND RESPONSE RATE

Initially, a 3 x 3 (three groups x three companies) nine-company / above-average, average and below-average group sample was attempted, firms being selected and approached in accordance with the criteria set out in chapter four of the present text. Two of the companies approached declined to participate in the study and one other failed to complete and return the questionnaire. All three belonged to the 'average' group which was subsequently 'dropped' as: (i) a replacement group could not be found in the time available; (ii) an above-average and below-average group comparison had already been indicated as adequate for meeting the requirements of the study (see final subsection of section 4.3.5 of the present text); (iii) the ninety-nine per cent target confidence interval could be met by an overall final sample size of six.

Thus the final sample set consisted of six Irish-owned electronics firms, three of which were considered above-average product innovation performers, three as below-average product innovation performers.

A preliminary check of companies' responses to section one of the questionnaire confirmed a sufficient level of satisfaction of the test case and testing criteria set out in chapter four of the present text. There was, for example: (i) evidence of at least some level of interest in engagement in product innovation activity in the time period covered across all companies participating in the study; (ii) sufficient inter-group difference and intra-group similarity in general to suggest the validity of both group characterization and membership; (iii) a sufficient level of compatibility of companies targeted to ensure a reasonable (consistent) basis of comparison (for example: all companies had been founded in the early- to mid- eighties and principal product lines were matched across groups (one above-average, one below-average control systems company, one above-average, one below-average lighting company, one above-average, one below-average power supplies company). Also: the required minimum three members per group was confirmed.

Though 'job titles' as such varied somewhat across individual respondents within these companies, the key criterion of 'person with the greatest responsibility/authority for and familiarity with product innovation within the company' was consistently met across all subjects and all subjects were experienced in product innovation, electronics, project management and general management. Additional information is provided in section 5.5 of the present text.

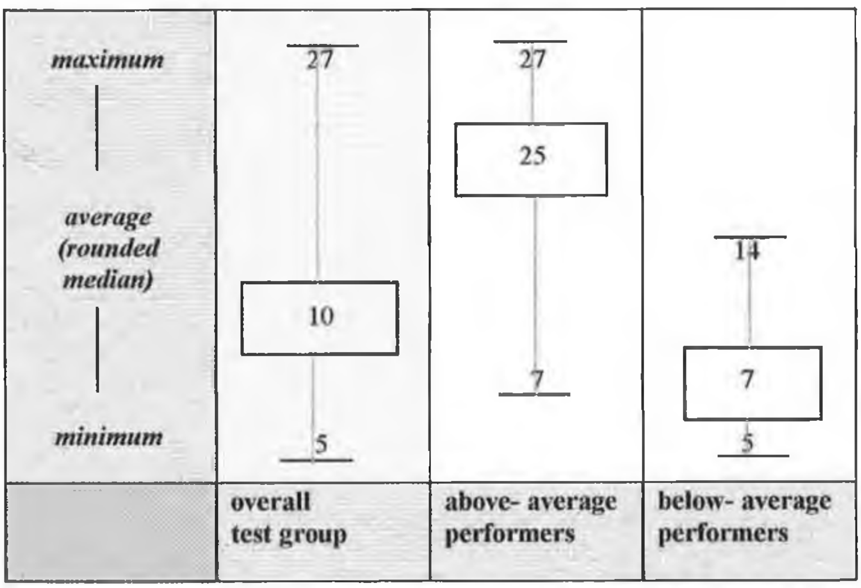
5.3 PRELIMINARY DATA ANALYSIS FOR EACH OF THE MODEL'S KEY COMPONENT VARIABLES

5.3.1 Preliminary analysis of performance data

The variability of product innovation performance data (all three dimensions) observed across firms participating in the study is summarized in Table 5.1 and Figures 5.1 through 5.10 ...

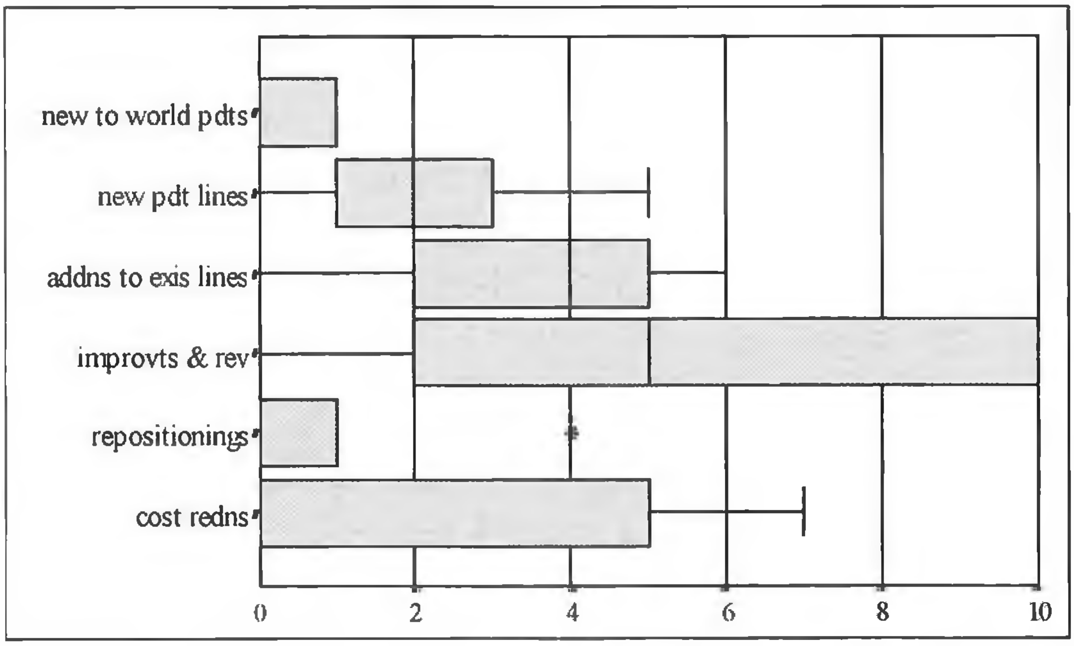
Data gathered on **frequency of engagement** in product innovation activity, measured in terms of the number of product innovation projects *initiated* since 1990, is summarized for the overall test group and above- and below- average performers, in Table 5.1.

Table 5.1 Frequency of engagement in product innovation activity



The graphic suggests a marked difference in levels of product innovation activity across above- and below- average performers. Indeed, the value of *all* summary statistics are higher for the above- average group. The statistical significance of differences observed was tested using a Mann-Whitney U-Test. The test statistic ($U=1.5$) was found to be significant at $p <= .10$ (directional estimate $n1=3$, $n2=3$, above-average group > below- average group). Breakdowns of these data across the various types of product development initiatives, are presented, firstly, for the overall test group in Figure 5.1 and, then, for above- versus below- average performers in Figure 5.2.

Figure 5.1 Frequency of engagement in various types of product innovation activity 1990-1996: overall test group



The 'improvements and revisions' category certainly dominates the rest in Figure 5.1. Generally, the relative concentrations of the innovation effort across the various product categories are as one might expect. The 'new to world' product category does seem to warrant special mention, however. Whilst summary statistics for this latter category may be interpreted as 'low but not unreasonable when compared with other product innovation categories', it must be said that, as six-year summary statistics, for a high-tech industry sample, values observed do seem surprisingly - indeed, arguably, appallingly low.

Figure 5.2 Frequency of engagement in each type of product innovation 1990-1996: above- versus below- average performers

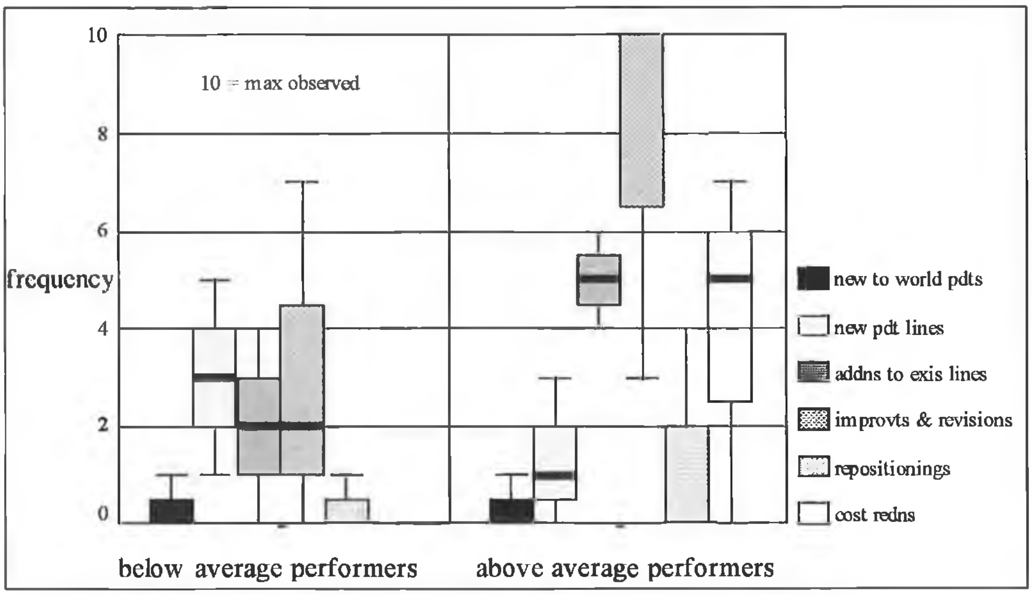
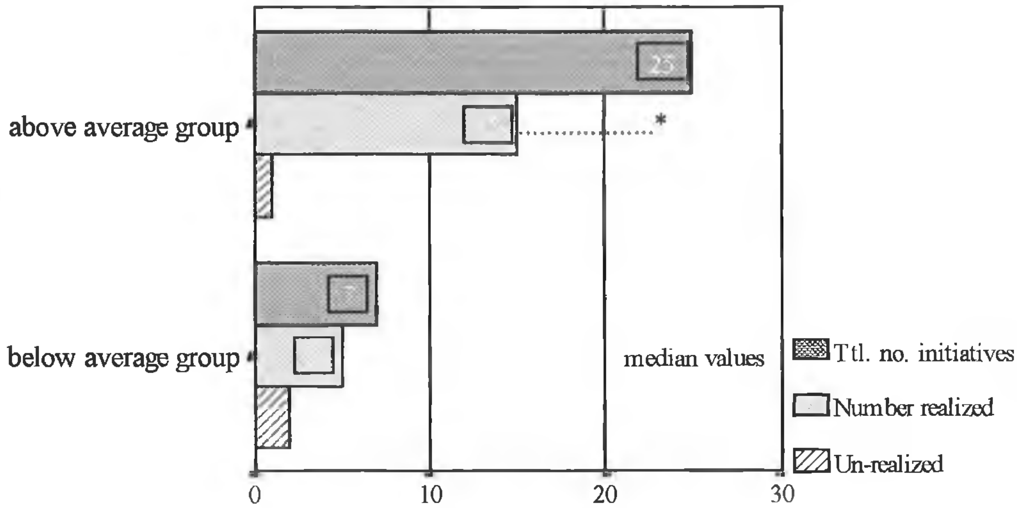


Figure 5.2 suggests quite a lot of variability in 'frequency of engagement' data across above- and below- average groups for *almost all* product categories. The Mann-Whitney U-test was used to assess the statistical significance of differences indicated. Test statistics, corrected for ties, indicated the greatest difference in relation to **additions to existing product lines** with z significant at $p <= .04$, directional estimate: above-average performers > below- average performers. A slightly less statistically significant difference was indicated for **improvements & revisions to existing products** and **cost reductions** (both significant at $p <= .06$, directional estimate, above-average performers > below- average performers). Statistically significant differences were also indicated for the **new product lines** category at $p <= .13$, directional estimate, this time with above-average performers < below- average performers, however.

Patterns of productivity observed across above- and below- average performer groups are summarized in Figure 5.3, in terms of total numbers of product innovation projects (i) initiated, (ii) completed[1] and (iii) abandoned or killed.

[1] note: a number of initiatives on-going for some companies

Figure 5.3 Patterns of product innovation productivity observed across above- versus below- average performers

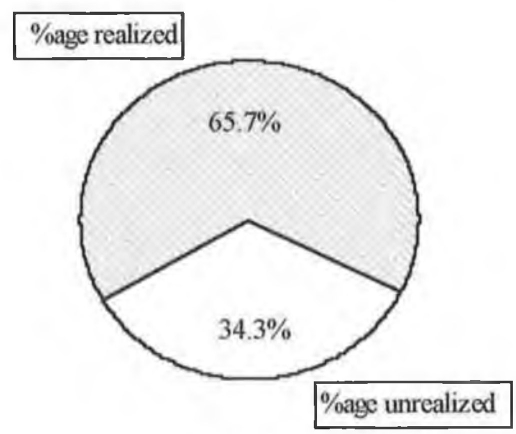


(* : n.b. a number of initiatives are ongoing for some cases)

The statistical significance of differences observed between above- and below-average performers was tested using a Mann-Whitney U-Test. Number of initiatives was covered earlier in terms of the equivalent 'frequency of engagement in product innovation' (statistically significant differences having been indicated). The test statistic for the **number of realized initiatives** was also found to be significant, at **p<=.02** (directional estimate with correction for ties, **above-average group > below- average group**). (A more detailed examination of 'number of realized initiatives' records for above- and below- average performers, indicated statistically significant differences in relation to additions to existing product lines (p<=.02), improvements and revisions to existing products (p<=.035) and cost reductions (p<=.06), in particular (directional estimate, with correction for ties as appropriate, above-average group > below- average group).) Differences in the number of unrealized initiatives were found to be not very significant (p<=.42, directional estimate with correction for ties, above-average group < below-average group, this time).

Figure 5.4 summarizes the realization rate dataset for the overall test group, in terms of *percentage* of product innovation projects ***initiated and successfully realized*** by each group for the period 1990-1996. When examining this graphic, it should be borne in mind, that a number of projects initiated over the period are *still ongoing*.

Figure 5.4 Product innovation realization rates for the period 1990-1996: summary statement for the overall test group



(note: a small number of initiatives are ongoing for some cases)

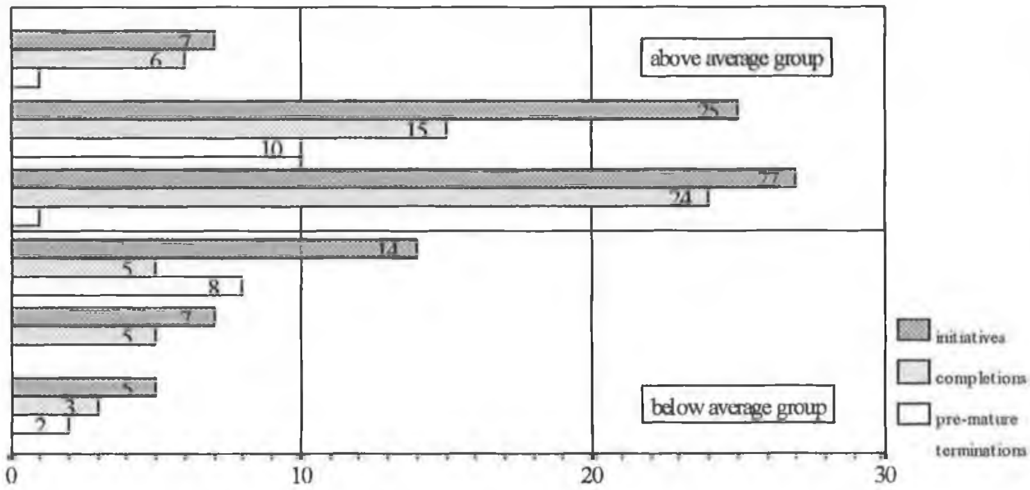
In general, realization rates seem quite good. The Figure 5.4 graphic should not be over-interpreted, however. Earlier in the present text, it was suggested that there are occasions when *non*-realization may be not be such a bad thing ...

For example: a product innovation project may be terminated because poor prototype development (too rushed, insufficient or ineffective communication between marketing and technical personnel, et cetera) leads to prototype rejection by potential customers. The project team may overly-/mis- interpret market demand for a poorly designed prototype as rejection of the original product idea and abandon the project instead of trying another design. Contrast this scenario with one in which a project is terminated because an idea simple doesn't work in practice - perhaps because at the time of attempted development, the core technology isn't yet sufficiently advanced to enable realization of the original idea. In this case valuable resources may be (temporarily - until the technology catches up?) re-allocated to more 'realizable' projects.

Moreover, a number of projects initiated over the period, still ongoing - as stated earlier.

Thus, the Figure 5.4 graphic should be interpreted as an output index only. Summarial performance profiles of individual cases presenting within above-average and below-average groups are presented in Figure 5.5.

Figure 5.5 Product innovation performance profiles of individual cases within above- and below- average performing groups



Total number initated, completed, abandoned/killed: 1990 to date
(note: a number of initiatives are ongoing for some cases)

These individual case data are quite interesting in view of their enormous variability both across and within groups.

Given the variability of initiative, completion and non-completion data - both across and within groups, an examination of differences in the *percentage* as well as *number* of product innovation initiatives successfully completed by above- and below- average performers for the period seemed in order. This was done, using a Mann-Whitney U-Test. The test statistic yielded was found to be somewhat, though not very much less statistically significant than that which had been obtained for the *number* of product innovation initiatives successfully completed across groups at p<=.09 with correction for ties (directional estimate , above-average group > below- average group).

It is interesting to find that, in general, these data summaries are not at all suggestive of a perhaps intuitively expected 'general learning curve' in relation to frequency of engagement in innovation initiatives and general likelihood of a firm's realizing its product innovation ideas.

Indeed, whilst a regression co-efficient of r-squared = 0.8397 is obtained when regressing *total number* of product innovation initiatives on *total number* of projects successfully completed, a regression co-efficient of r-squared = *just* 0.01306 is obtained when regressing total number of product innovation initiatives on *percentage* of projects successfully completed.

Figure 5.6 presents a general summary of the differential rates of *non-realization* observed *overall*, across the various categories of product innovation initiative[2].

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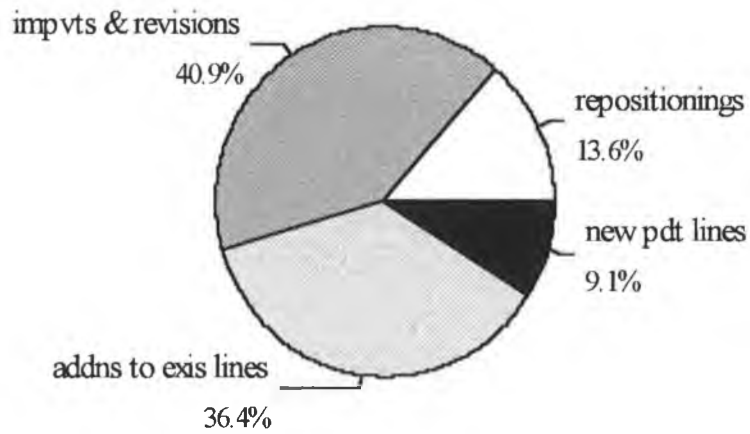
[2] Note: the graph represents non-zero-percentage categories only.

Figure 5.6 Unrealized initiatives - 'type of initiative' breakdowns for overall test group



note 1: 0% observed for remaining product categories
note 2: ongoing initiatives are not represented in the analysis

The full set of product categories consisted of: new to world products, new product lines, additions to existing lines, improvements and revisions to existing products, repositionings and cost reductions.

The statistical significance of differences observed across above- and below-average groups for *various types of initiative* was assessed using The Mann-Whitney U-Test. Test statistics obtained, when corrected for ties, indicated the greatest difference to be in relation to the 'improvements and revisions to existing products' and 'repositionings' categories ($p<=.35$, directional estimate, above-average performers > below- average performers, in both cases). Any differences observed across other categories of product innovation initiative were found to be statistically *in*-significant.

Figure 5.7 profiles the reasons cited by companies for abandoning or killing projects.

The reader's attention is drawn to the fact that statistics presented should not be overly interpreted - particularly in terms of 'value judgements' as it is almost impossible to ascertain whether the decision to abandon a project based on any one of the factors cited, is ultimately a (necessary-and-)good or (necessary-and-)bad one.

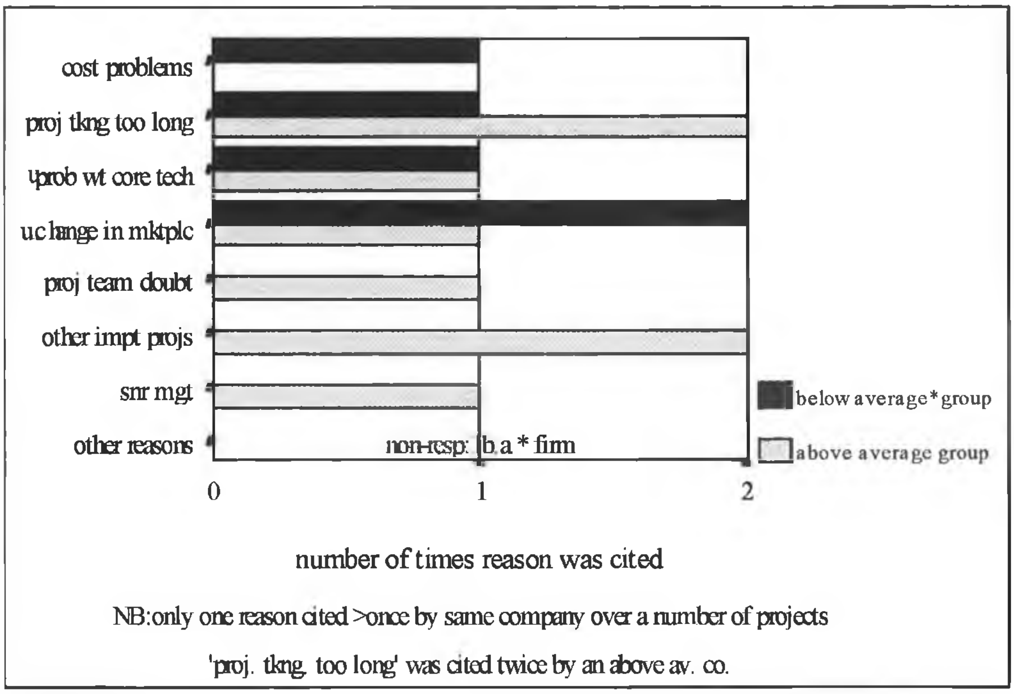
For example:

a problem with core technology

may necessitate the temporary abandonment of a perfectly good and ultimately workable and profitable product innovation idea *or*

precipitate the early abandonment of a product innovation idea which, having been fully realized, may not have performed very well in the marketplace.

Figure 5.7 Reasons given for abandoning/killing unrealized product innovation initiatives



The most frequently cited reasons for abandoning/killing projects were: 'project was taking too long' (cited mostly by the above- average group), 'unanticipated change in marketplace' (cited mostly by the below- average group), and 'other important project(s) competing for the same resources' (cited only by the above- average group).

Just thirty-seven per cent commonality in reasons cited for abandoning/killing projects was evident across above- and below- average performing groups.

Those citations which were common to both groups were: 'project was taking too long', 'problems with core technology' and 'unanticipated change in marketplace'.

The most marked difference between groups was found in relation to 'other important project(s) competing for the same resources' (for which the Chi-Square likelihood ratio was statistically significant at $p<=.05$). Figures for 'unanticipated change in marketplace' were generally associated with lower project completion rates, suggesting that relatively poorer product realization performance was more likely to be due to poor proficiency in / inadequate marketing activities rather than the filtering power of the product realization process as practised.

On 'eyeballing' the associated data, three particularly noteworthy observations were made:

1. Problems of cost, time, core technology, unanticipated changes in the marketplace and other projects competing for the same resources, tended to be associated with the vetoing of both new product development and old product development initiatives.

2. New product development efforts (new to world products, new product lines or additions to existing product lines) tended to be 'shelved' in favour of old

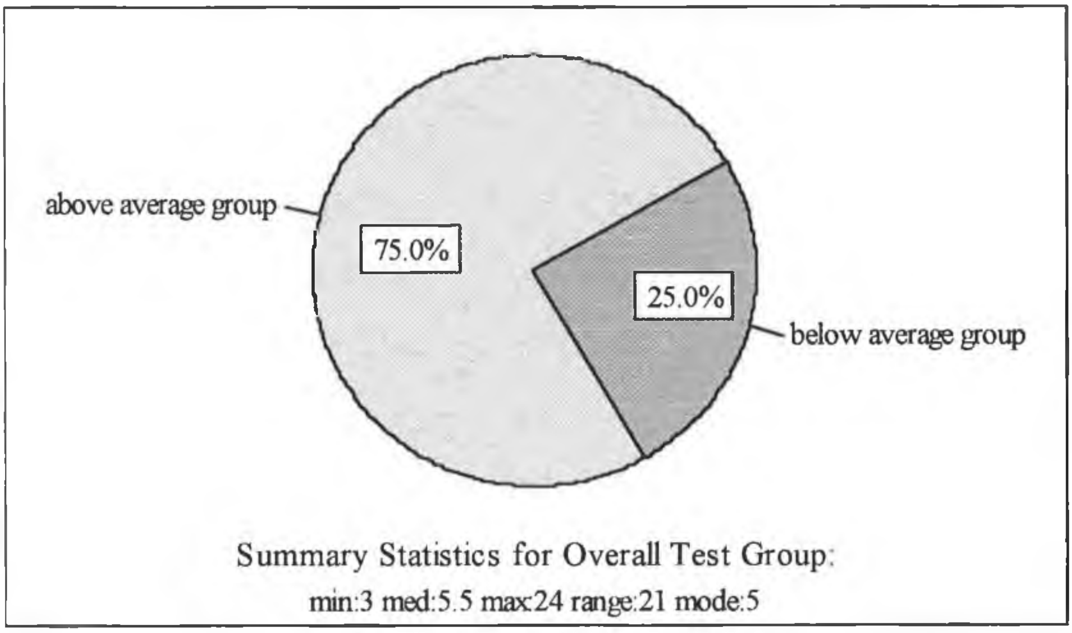
product development initiatives (improvements or revisions to existing product lines, repositionings, cost reductions), where projects were competing for the same resources ... this is particularly interesting in view of the fact that the problem of projects competing for the same resources was cited by the above-average performing group only, thus indicating that above-average performance can still mean considerably below capacity (new product development is, afterall, an important index of innovative capacity).

3. Associations amongst cited reasons for abandoning/killing product innovation initiatives and various aspects of product innovation practice are explored in section 5.4.3 of the present text.

Analysis of data on final overall product development output performance, yielded the following results...

Figure 5.8 summarizes overall test group data on the number of new/improved products launched over the period 1990-1996 and provides a general indication of the comparative performance of above- and below- average performers.

Figure 5.8 New/improved products launched over the period 1990-1996: proportion generated by above- average and below- average groups - on average



The annotated summary boxplot graphics for above- and below- average performers, provided in Figure 5.9, show, amongst other things, that most of the variability in the overall dataset noted in Figure 5.8, is accounted for by the above- average group ... but much more significantly, that the new/improved product launch profiles of the above-average and below-average groups are, in fact, in effect, wholly distinctive.

Figure 5.9 New/improved products launched since 1990: detailed summary statistics for above- and below- average performers

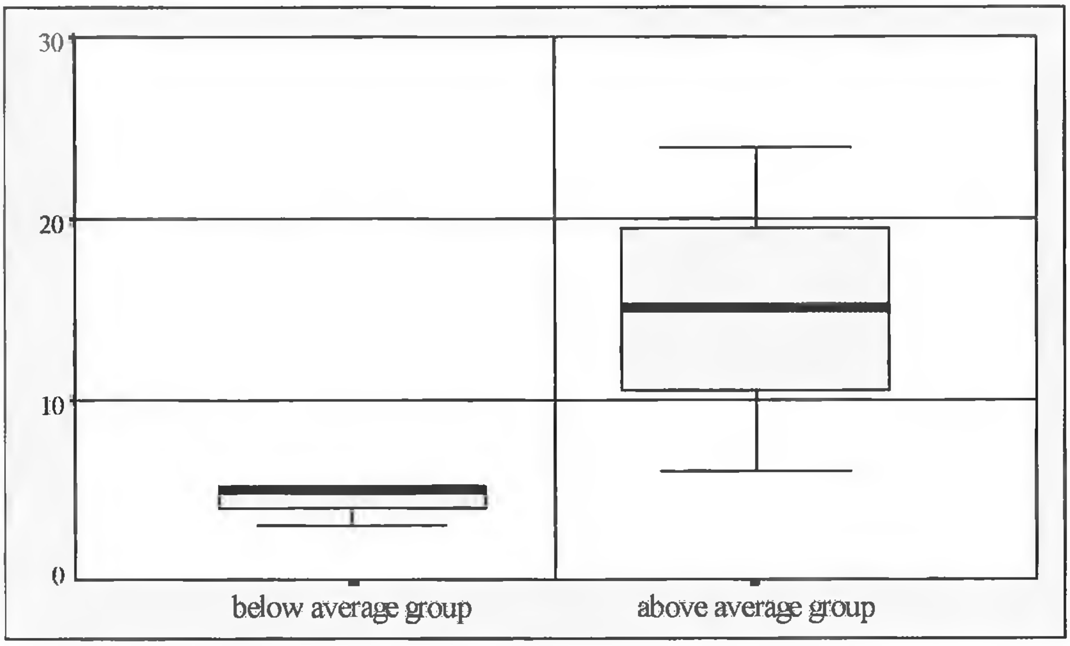
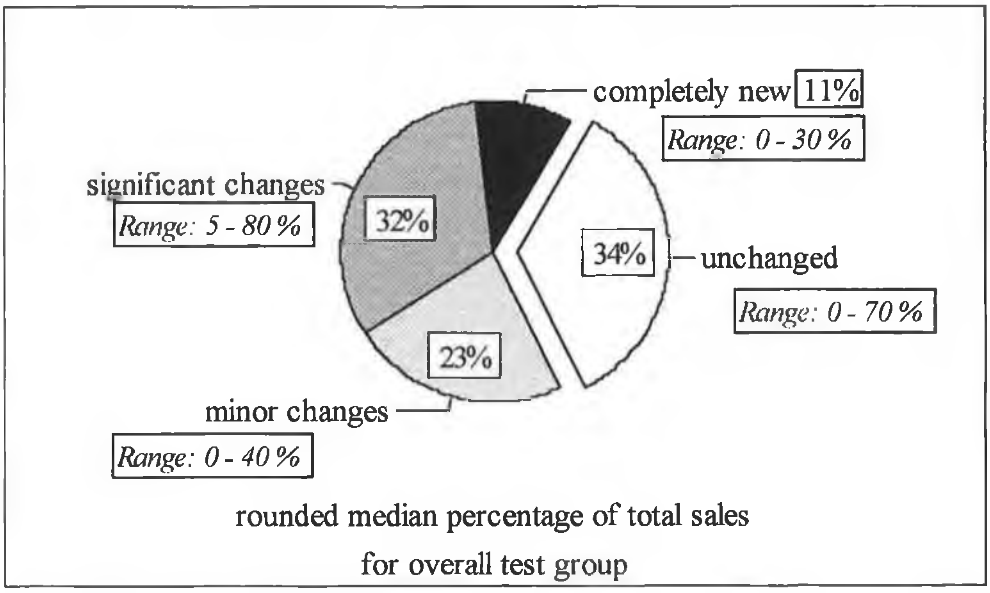


Figure 5.10 provides a summary of overall test group data on the distribution of total sales for 1996 across the four main product development categories. In reviewing this chart, it is important that chart *range* annotations be borne in mind as there was considerable variability in individual case data for each category in evidence right across the data set, that is: both across *and within* above- average and below- average groups. In the unchanged category, for example, an average of thirty-four per cent was recorded, but a figure as low as zero per cent was observed in one below- average and one above- average case and a figure as high as seventy per cent was observed in one below- average case. Similarly, in

the significant changes category an average of thirty-two per cent was recorded but the lowest figure observed was just five per cent in one above- average case whilst a high of eighty per cent was observed in one below- average case. With regard to the minor changes category, an average of twenty three per cent was recorded with a low of zero per cent in one below- average case and a high of forty per cent in one below- average and one above- average case. Again, in the completely new category, a minimum of zero per cent was observed in one below-average case and a maximum of thirty per cent was observed in one above-average case, though the average recorded was eleven per cent.

Figure 5.10 Distribution of total sales for 1996 across the four main product innovation categories



Notwithstanding the variability of within-group data, between-group data did appear to be slightly relatively more variable and therefore the Mann-Whitney U-test was used, to assess the statistical significance of differences observed across above- and below- average groups for each product category. Despite the variability of within-group data, all test statistics, with correction for ties as appropriate, were found to be at least somewhat statistically significant as follows: unchanged: p<=.33, minor changes: p<=.18, significant changes: p<=.07 and completely new: p<=.25 (directional estimate, n1=3, n2=3, above-average group > below- average group with the exception of the most significant, 'significant changes' category).

These Figures should be interpreted with caution as: (a) the p<=.33 showing for the 'unchanged' category probably includes a 'recently changed' error component in the case of above- average performing group data; (b) statistical significance in the minor changes and completely new categories is probably accounted for by the fact that both featured in all above- average sales breakdowns but just sixty-six per cent of below- average breakdowns, rather than relatively more strongly in all above- average and relatively less strongly in all below- average firms; (c) the direction of statistically significant difference observed in the significant changes category may be overly interpreted as being suggestive of a justifiable underlying tendency, in the below- average group, to favour making significant changes in lieu of engaging in completely new product development. In sum, few generalizations can be extrapolated from such highly variable data.

5.3.2 Preliminary analysis of managerial cognition data

Analysis of the structure and content of cognitive maps elicited in the course of the study, across all firms participating in the study and across above- and below- average product innovation performing firms, yielded the following results ...

Firstly, Table 5.2 shows the total number of elements (activities x principles) which were found to characterize elicited maps.

Table 5.2 The total number of elements which were found to characterize cognitive maps for the full test group and for managers of above- and below- average product innovation performing firms

	minimum	median	maximum	range
managers of above-average firms	196	204	228	32
overall test group	*81*	*200*	*236*	*155*
managers of below-average firms	81	155	236	155

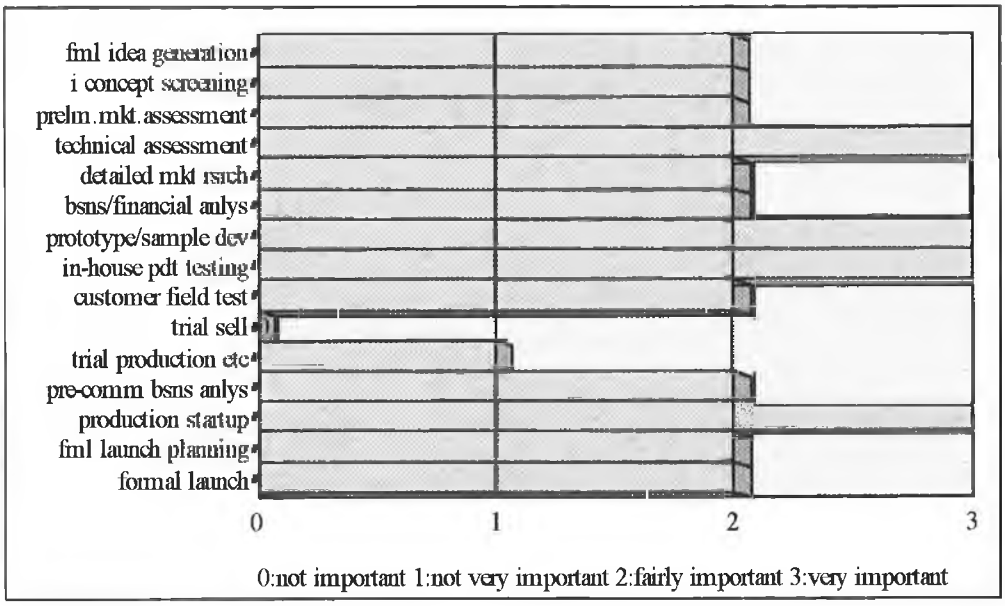
The statistical significance of differences observed across the maps of managers of above- and below- average performing firms was tested using the Mann-Whitney U-Test. Results indicated a somewhat statistically significantly higher number of elements in the maps of managers of above-average performing firms (Mann-Whitney U, corrected for ties, yielded a z value statistically significant at $p<=.25$, directional estimate).

In general, each activity and each principle featured at least once in the cognitive maps of at least one manager participating in the study and all activities and most (sixty-four per cent) principles featured in all maps, the exceptions being: external sources of ideas, risk taking, accepting financial risk, co-ordination, specific screening criteria, use of metrics, output based management, incentives, running activities in parallel, efficiency, clarity of roles, a designated project leader or team, rigid team structure, flexible team structure, concentration of power, decentralization, top management commitment, support and involvement, leadership quality, shared values, cross-functional teams, job rotation across projects, command style communication and inter-organizational networking.

Activities ...

A one-hundred per cent prevalence of the four key product realization **activities** targeted in the study was observed across elicited maps, that is to say: no product realization activity was found to have been omitted by any respondent. This was hardly surprising, though, in view of the fact that together, these four activities constitute *the* most essential definition of the product realization process possible. An important corollary to this is, therefore, that, in the preliminary section of the questionnaire, where managers had been asked to consider the more detailed fifteen activity model, all activities characterizing this broader, more complete model were shown to be considered important by all managers with the exception of trial production and trial sell. Technical assessment, prototype/sample development, in-house product testing and production start-up were each considered particularly important. ... see Figure 5.11.

Figure 5.11 The perceived importance of individual product innovation activities (modal values for overall response set)

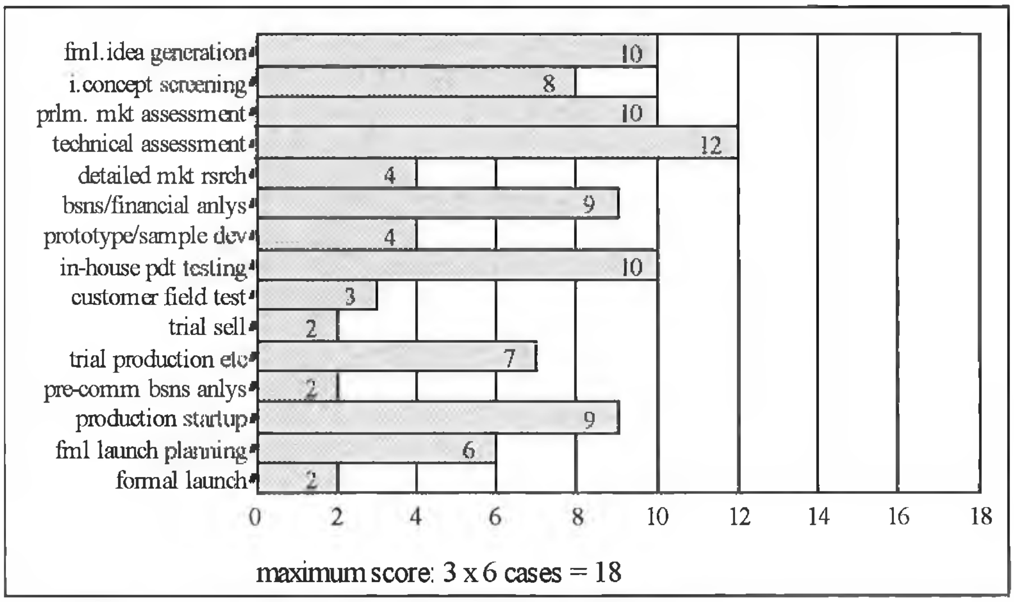


Differences in above- and below- average performers' characterizations were analyzed using the Mann-Whitney U-Test (test statistics were corrected for ties as appropriate).

The most statistically significant differences were found in relation to: **formalized idea generation** ($p<=.10$), **preliminary market assessment** ($p<=.16$), **detailed market research** ($p<=.05$), **in-house product testing** ($p<=.16$), **trial sell** ($p<=.18$) and **formal launch planning** ($p<=.10$), ratings of greater importance being assigned by *above-* average performers in each case and technical assessment ($p<=.06$), prototype/sample development ($p<=.16$) and pre-commercialization business analysis ($p<=06$), ratings of greater importance being assigned by *below-* average performers in each case.

In general, technical assessment was considered to be the most essential activity <u>in product innovation undertakings characterized by significant time and/or budgetary constraints</u>. Formalized idea generation, preliminary market assessment and in-house product testing were also considered to be of relatively greater importance than the rest in such circumstances - see Figure 5.12.

Figure 5.12 How essential each product innovation activity was deemed to be under significantly time&/budget constrained development conditions



The statistical significance of differences observed across above- and below-average performers was tested using a Mann-Whitney U-Test (with correction for ties as appropriate). Test statistics indicated statistically significant differences for: **formalized idea generation** ($p<=.09$, above-average group > below-average group), **preliminary market assessment** ($p<=.09$, above-average group > below-average group), **detailed market research** ($p<=.05$, above-average group > below-average group), **business/financial analysis** ($p<=.13$, above-average group > below-average group), **in-house product testing** ($p<=.09$, above-average group > below-average group), **trial sell** ($p<=.05$, above-average group > below-average group), **production start-up** ($p<=.13$, above-average group > below-average group) and initial concept screening ($p<=.16$, below-average group > above-average group) ... all directional estimates.

Principles ...

Incidence was high for almost all **principles** - as indicated by perceived significance rating assignments, of n>0. Analysis of the overall dataset for the overall test group indicated that each principle featured at least once for most managers, though **experience, capabilities, resources** and **clarity of goals** seemed to be particularly prevalent.

Subsequent separate analysis of above- and below- average performers showed that just one-out-of-three above- average performer maps exhibited any instance of zero-incidence and that this related to just three principles, namely: **use of metrics, decentralization** and **job rotation across projects** but that two-out-of-three below- average performer maps exhibited instances of zero-incidence, one in relation to just three principles, namely: **running activities in parallel, job rotation across projects** and **command style communication,** but the other in relation to twenty-two of the sixty-four principles, namely: external sources of ideas, risk taking, accepting financial risk, co-ordination, specific screening criteria, use of metrics, output based management, incentives, running activities in parallel, efficiency, clarity of roles, a designated project leader/team, rigid team structure, flexible team structure, concentration of power, decentralization, top management commitment, support and involvement, leadership quality, shared values, cross-functional teams, job rotation across projects, command style communication and inter-organizational networking.

Activities x Principles ...

An outline impression of the *extent* of activity/principle linkages characterizing elicited maps is presented in Table 5.3 for the overall test group and above- and below- average groups.

Table 5.3 Outline impression of extent of activity/principle linkages observed in cognitive maps: number of principles found to characterize each activity

minimum *average (median)* *maximum* *range*	above- average group	overall sample set	below- average group
initial concept screening	17 **51** 59 42	17 **52.5** 63 46	20 **54** 63 43
early marketing activities	59 **61** 64 5	14 **60** 64 50	14 **45** 64 50
prototype/sample design/development	59 **59** 64 5	26 **59** 64 38	26 **41** 63 37
product testing	25 **51** 59 34	15 **35.5** 59 44	15 **21** 46 31

Table 5.3 indicates that: (i) the greatest number of linkages - on average - was to be found in relation to early marketing activities (in the case of the above average group only), (ii) the least number of linkages - on average - was to be found in relation to product testing (in the case of the below- average group only) and (iii) variability across maps, *in general*, was found to be greatest in relation to early marketing activities.

The statistical significance of differences observed across above- and below-average groups was assessed using the Mann-Whitney U-Test. Test statistics, when corrected for ties, indicated a statistically significantly *higher* number of linkages in the cognitive maps of managers of *above-* average firms in relation to **product testing**, in particular ($p<=.06$, directional estimate) but also in relation to **early marketing activities** ($p<=.19$, directional estimate) and **prototype/sample design and development** ($p<=.14$, directional estimate). A higher number of linkages was indicated for the managers of *below-* average firms in relation to concept screening only ($p<=.25$, directional estimate).

Table 5.4 provides a more detailed breakdown of linkages observed across elicited maps. Based on modal linkage indicators for raw data which has been recoded dichotomously (0:0, >0:1), it highlights the points of commonality and difference across above- and below- average groups.

Table 5.4 Specific activity/principle linkage patterns[3] differentially characterizing overall test group, above-average performer group and below-average performer group

MODAL linkage indicators for Cognitive Maps **BOTH** = indicated for both groups **NEITHER** = indicated for neither group **HIGH** = above- average or 'high' performers only **LOW** = below- average or 'low' performers only	**concept screening**	**early marketing activities**	**prototype/ sample design & development**	**product testing**
new technologies	BOTH	HIGH	BOTH	NEITHER
the marketplace	BOTH	BOTH	HIGH	NEITHER
customer orientation	BOTH	BOTH	BOTH	LOW
integration of the needs of the market with technological opportunities available to fulfil those needs	BOTH	BOTH	HIGH	NEITHER
internal sources of ideas	BOTH	HIGH	BOTH	LOW
external sources of ideas	BOTH	BOTH	BOTH	NEITHER
experience	BOTH	BOTH	BOTH	BOTH
capabilities	BOTH	BOTH	BOTH	BOTH
resources	BOTH	BOTH	BOTH	BOTH
risk taking	LOW	BOTH	HIGH	NEITHER
accepting financial risk	LOW	BOTH	HIGH	NEITHER
minimizing financial risk	LOW	BOTH	BOTH	HIGH
complexity (e.g. of activity or design)	BOTH	BOTH	BOTH	BOTH
clarity of goals	BOTH	BOTH	BOTH	BOTH
formalization	LOW	BOTH	BOTH	LOW
control	LOW	BOTH	HIGH	BOTH
co-ordination	LOW	BOTH	BOTH	HIGH
pre-planning	LOW	BOTH	BOTH	HIGH
reducing uncertainties	BOTH	BOTH	BOTH	HIGH
formal specifications	BOTH	BOTH	BOTH	BOTH
detailed/precise specifications	BOTH	BOTH	BOTH	BOTH
specific screening criteria	BOTH	BOTH	HIGH	BOTH
well defined procedures - documented if possible	BOTH	BOTH	BOTH	BOTH
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)	LOW	BOTH	HIGH	BOTH
use of metrics	NEITHER	LOW	NEITHER	BOTH
output based management	LOW	BOTH	BOTH	HIGH
time based management	LOW	BOTH	BOTH	HIGH
incentives	LOW	HIGH	HIGH	NEITHER
encouragement of ideas	BOTH	HIGH	BOTH	NEITHER
tolerance of mistakes	BOTH	HIGH	BOTH	NEITHER
time constraints	BOTH	HIGH	BOTH	HIGH
budgetary constraints	BOTH	BOTH	BOTH	HIGH
flexible resourcing	BOTH	HIGH	BOTH	BOTH
early prototypes	HIGH	BOTH	HIGH	BOTH
running activities in parallel	BOTH	HIGH	BOTH	HIGH
proficiency	BOTH	BOTH	BOTH	BOTH
efficiency	BOTH	BOTH	BOTH	HIGH
cost-efficiency	BOTH	BOTH	BOTH	HIGH
regular performance checking	HIGH	BOTH	BOTH	HIGH
detail	BOTH	BOTH	BOTH	BOTH
quality	BOTH	BOTH	BOTH	BOTH
clarity of roles	BOTH	BOTH	BOTH	HIGH
a designated project leader or team	BOTH	BOTH	BOTH	HIGH
specific responsibilities and authorities clearly assigned to specific individuals	BOTH	BOTH	BOTH	BOTH
rigid team structure	BOTH	HIGH	HIGH	HIGH
flexible team structure	BOTH	BOTH	BOTH	HIGH
concentration of power	LOW	BOTH	BOTH	HIGH
decentralization	NEITHER	BOTH	BOTH	NEITHER
top management commitment, support and involvement	BOTH	HIGH	BOTH	HIGH
leadership quality	BOTH	HIGH	BOTH	HIGH
shared values	BOTH	BOTH	BOTH	HIGH
teamwork	BOTH	BOTH	BOTH	HIGH
co-operation	BOTH	BOTH	BOTH	BOTH
few opposing factions within the firm	HIGH	BOTH	BOTH	HIGH
interdisciplinary approach	BOTH	HIGH	BOTH	HIGH
specialized skills	BOTH	BOTH	BOTH	BOTH
cross-functional teams	BOTH	BOTH	BOTH	HIGH
job rotation across projects	NEITHER	NEITHER	NEITHER	HIGH
consultative style communication	BOTH	BOTH	BOTH	HIGH
command style communication	HIGH	HIGH	HIGH	HIGH
effective communication between marketing and technical personnel	BOTH	BOTH	BOTH	LOW
inter-organizational networking	NEITHER	HIGH	HIGH	NEITHER
external consultations (direct outsider involvement)	BOTH	HIGH	HIGH	BOTH
participative decision-making	BOTH	BOTH	BOTH	BOTH

[3] (modal indicators)

Out of a total possible two-hundred and fifty-sixty linkages, one-hundred and sixty-two linkages and eighteen non-linkages were found to be common to above- and below- average groups. Thus seventy per cent commonality in mapping was observed. Forty-four common links were found in relation to concept screening, forty-seven in relation to early marketing activities, forty-nine in relation to prototype/sample design and development and twenty-two in relation to product testing. ***Fifty-nine additional linkages were found in the above-average group only*** and seventeen additional linkages were found in below-average group only.

Regarding the distinctiveness of activity/principle combinations observed across cognitive maps, **no** principle was found to feature *just once* across all maps, all above-average group maps or all below-average group maps. Median incidence Figures for each principle across the overall product realization script did, however, suggest some within-group evidence of distinctiveness in the *below*-average group only, specifically, in relation to: incentives, early prototypes, few opposing factions within the firm, inter-organizational networking and external consultations (direct outsider involvement).

Table 5.5 presents breakdowns of the incidence or **standardness** of principles across elicited maps for above- and below- average groups.

Table 5.5 Summary breakdown of the standardness of principles across the four activities of elicited cognitive maps for managers of above- and below- average product innovation performing firms (median incidence)

Cognitive Maps — *median incidence; maximum value in each cell = 4, corresponding to the four activities represented*	managers of above average firms	managers of below average firms
new technologies	3	2
the marketplace	3	2
customer orientation	3	3
integration of the needs of the market with technological opportunities available to fulfil those needs	3	2
internal sources of ideas	3	2
external sources of ideas	3	3
experience	4	4
capabilities	4	4
resources	4	4
risk taking	3	2
accepting financial risk	3	2
minimizing financial risk	3	3
complexity (e.g. of activity or design)	4	3
clarity of goals	4	4
formalization	3	2
control	3	2
co-ordination	3	3
pre-planning	3	2
reducing uncertainties	3	2
formal specifications	4	3
detailed/precise specifications	4	3
specific screening criteria	4	3
well defined procedures - documented if possible	4	2
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)	3	2
use of metrics	2	3
output based management	3	3
time based management	3	3
incentives	2	1
encouragement of ideas	3	2
tolerance of mistakes	3	2
time constraints	4	2
budgetary constraints	4	2
flexible resourcing	4	2
early prototypes	4	1
running activities in parallel	4	2
proficiency	3	4
efficiency	3	3
cost-efficiency	3	2
regular performance checking	3	2
detail	3	4
quality	3	4
clarity of roles	4	3
a designated project leader or team	4	3
specific responsibilities and authorities clearly assigned to specific individuals	4	3
rigid team structure	4	2
flexible team structure	4	3
concentration of power	2	3
decentralization	2	2
top management commitment, support and involvement	4	2
leadership quality	3	2
shared values	3	3
teamwork	3	3
co-operation	3	3
few opposing factions within the firm	3	1
interdisciplinary approach	3	2
specialized skills	4	4
cross-functional teams	4	3
job rotation across projects	2	0
consultative style communication	4	3
command style communication	2	0
effective communication between marketing and technical personnel	3	4
inter-organizational networking	2	1
external consultations (direct outsider involvement)	4	1
participative decision-making	4	4

In general, median standardness values throughout Table 5.5 appear notably higher and less variable across principles in the above-average group.

The statistical significance of differences observed across above-average and below-average groups was tested using Chi-square likelihood ratios. Test statistics were found to be particularly statistically significant in relation to the standardness of thirty (forty-seven per cent) of the sixty-four principles:

- **detailed/precise specifications, consultative style communication and command style communication** (above-average group > below-average group); quality (below-average group > above-average group) ... all statistically significant at p<=.05

the marketplace, integration of the needs of the market with technological opportunities available to fulfil those needs, formalization, reducing uncertainties, well defined procedures - documented if possible, budgetary constraints, flexible resourcing, early prototypes, proficiency, detail, few opposing factions, inter-organizational networking and **external consultations (direct**

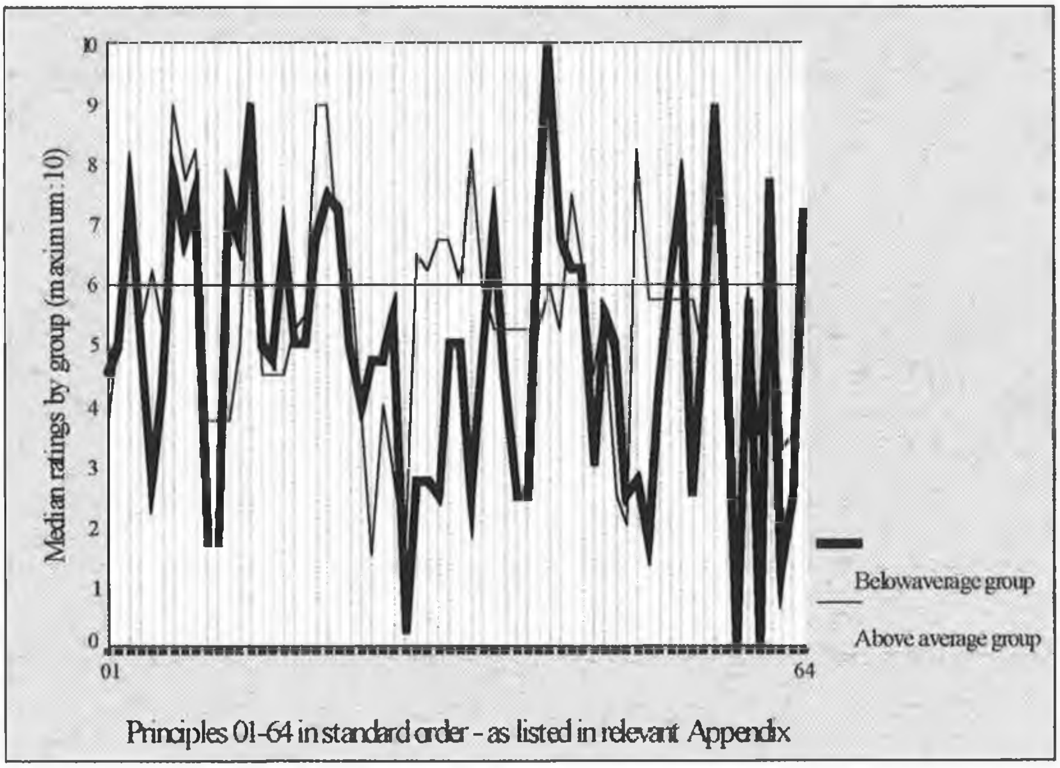
outsider involvement (above-average group > below-average group in each case) and complexity (below-average group > above-average group) ... all statistically significant at p<=.10

- **internal sources of ideas, experience, capabilities, resources, minimizing financial risk, clarity of goals, formal specifications, cost efficiency, regular performance checking, rigid team structure, concentration of power** and **leadership quality** (above-average group > below-average group in each case)... all statistically significant at p<=.20.

Figure 5.13 and Tables 5.6 through 5.9 summarize cognitive map centrality observed across above- and below- average performing groups ...

Firstly, Figure 5.13 (which is - and is intended to be used simply as - a *very rough advance sketch* of profiles suggested by the data) indicates quite clearly that the cognitive maps of managers of above- and below-average firms differ considerably in their respective points of emphasis.

Figure 5.13 Cognitive Map Centrality: Summary of median significance ratings observed for each principle over all four product realization activities for above- and below- average performers



Note: the Appendix referred to in Figure 5.13 is Appendix C.

Table 5.6 presents profiles outlined in Figure 5.13 in a more accessible form ...

Table 5.6 Overall cognitive map centrality: above- and below- average group breakdowns of median relevance ratings for each principle over all four product realization activities

MEDIAN *strengths of principle/activity linkages observed across Cognitive Maps*	over all four activities	
AA = above- average performers BA = below- average performers	AA	BA
new technologies	3.75	4.5
the marketplace	5.25	5
customer orientation	7	7.5
integration of the needs of the market with technological opportunities available to fulfil those needs	5.25	5
internal sources of ideas	6.25	2.75
external sources of ideas	5.25	4.25
experience	9	7.75
capabilities	7.75	6.75
resources	8.25	7.5
risk taking	3.75	1.75
accepting financial risk	3.75	1.75
minimizing financial risk	3.75	7.5
complexity (e.g. of activity or design)	5	6.75
clarity of goals	8.25	9
formalization	4.5	5
control	4.5	4.75
co-ordination	4.5	6.75
pre-planning	5.25	5
reducing uncertainties	5.5	5
formal specifications	9	6.75
detailed/precise specifications	9	7.5
specific screening criteria	6.25	7.25
well defined procedures - documented if possible	6.25	5
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)	4	4
use of metrics	1.5	4.75
output based management	4	4.75
time based management	2.75	5.5
incentives	1.5	0.25
encouragement of ideas	6.5	2.75
tolerance of mistakes	6.25	2.75
time constraints	6.75	2.5
budgetary constraints	6.75	5
flexible resourcing	6	5
early prototypes	8.25	2.5
running activities in parallel	6	5
proficiency	5.25	7
efficiency	5.25	4.5
cost-efficiency	5.25	2.5
regular performance checking	5.25	2.5
detail	5.25	7
quality	6	10
clarity of roles	5.25	6.75
a designated project leader or team	7.5	6.25
specific responsibilities and authorities clearly assigned to specific individuals	6.25	6.25
rigid team structure	4.5	3
flexible team structure	5.5	5.5
concentration of power	2.5	5
decentralization	2	2.5
top management commitment, support and involvement	8.25	2.75
leadership quality	5.75	1.75
shared values	5.75	4.25
teamwork	5.75	6.25
co-operation	5.75	7.5
few opposing factions within the firm	5.75	2.5
interdisciplinary approach	4.75	5
specialized skills	8.25	9
cross-functional teams	6.25	5.25
job rotation across projects	1	0
consultative style communication	6	5.75
command style communication	3.5	0
effective communication between marketing and technical personnel	7.5	7.75
inter-organizational networking	3.25	1.25
external consultations (direct outsider involvement)	3.5	2.5
participative decision-making	6.25	7.5

The statistical significance of differences observed across above- and below-average groups was tested using the Mann-Whitney U-Test. Test statistics, corrected for ties as appropriate were found to be particularly statistically significant in relation to:

- customer orientation (generally considered more important by the *below*- average group, p<=.023, directional estimate)
- integration of the needs of the market with technological opportunities available to fulfil those needs (generally considered more important by the *above*- average group, p<=.016, directional estimate)
- quality (generally considered more important by the *below*- average group, p<=.025, directional estimate)
- encouragement of ideas (generally considered more important by the *above*-average group, p<=.06, directional estimate)
- top management commitment, support and involvement, (generally considered more important by the *above*- average group, p<=.06, directional estimate)
- few opposing factions within the firm (generally considered more important by the *above*- average group, p<=.07, directional estimate).

It was interesting to find that the *above-average group* also showed statistically significantly higher ratings for the relevance of: **external sources of ideas, formal specifications, well defined procedures -documented if possible, incentives,**

tolerance of mistakes, time constraints, early prototypes, regular performance checks, a designated project leader/team, rigid team structure, shared values and command style communications - all statistically significant at p<=.20, whilst the *below- average group* emphasised, instead, the relevance of: **complexity, clarity of goals, formalization and the use of metrics** - again, all statistically significant at p<=.20.

As noted earlier, all activities were considered important by all managers.

The importance of three principles was emphasised in particular[4], specifically: **clarity of goals, detailed/precise specifications** and **quality**. Nevertheless, no individual principle was considered by <u>all</u> managers to be particularly significant in relation to ALL four activities - though some were considered by all managers to be especially important in relation to one or more specific activities.

Those principles which were assigned a significance rating of nine or ten out of ten by *<u>all</u>* managers are indicated in Table 5.7 together with the particular activity/activities in relation to which these ratings were assigned.

[4] that is: were rated particularly relevant

Table 5.7 Principles identified by *all* managers as particularly significant

PRINCIPLES IN RELATION TO WHICH A SIGNIFICANCE RATING OF 9 OR 10 WAS ASSIGNED BY ALL MANAGERS PARTICIPATING IN THE STUDY IN RESPECT OF ONE OR MORE SPECIFIC ACTIVITIES - AS INDICATED	
experience	prototype/sample design and development, product testing
complexity (e.g. of activity or design)	product testing
clarity of goals	early marketing activities and product testing
formal specifications	early marketing activities and prototype/sample design and development
detailed/precise specifications	early marketing activities, prototype/sample design & development and product testing
specific screening criteria	product testing
well defined procedures - documented if possible	product testing
early prototypes	early marketing activities
quality	prototype/sample design and development
a designated project leader or team	concept screening
effective communication between marketing and technical personnel	early marketing activities, prototype/sample design and development

It was interesting to find that just over half of the principles featuring in Table 5.7, were highlighted in relation to one activity only (detailed/precise specifications being the most notable exception - highlighted in relation to three) ... and that whereas one principle only was highlighted in relation to concept screening, five were indicated for early marketing activities and prototype/sample design and development and six were indicated for product testing. Table 5.8 presents a very detailed breakdown of strengths linkages observed in the product realization matrix. Median ratings are presented for each group and each activity x principle combination.

Table 5.8 Summary of activity/principle linkages observed: median strengths of linkages observed in above-average performer and below-average performer groups

MEDIAN strengths of principle/activity linkages observed across Cognitive Maps for each individual activity	concept screening		early marketing activities		prototype/sample design and development		product testing	
AA = above- average performers BA = below- average performers	AA	BA	AA	BA	AA	BA	AA	BA
new technologies	1	5	5	0	7	10	0	0
the marketplace	7	10	5	10	8	0	0	0
customer orientation	8	9	5	10	8	9	0	10
integration of the needs of the market with technological opportunities available to fulfil those needs	5	10	8	10	8	0	0	0
internal sources of ideas	8	1	8	0	8	9	0	10
external sources of ideas	7	1	7	6	7	3	0	0
experience	8	10	8	1	9	10	10	10
capabilities	8	10	9	8	8	10	8	4
resources	8	10	9	7	8	10	8	10
risk taking	0	6	6	1	6	0	0	0
accepting financial risk	0	6	5	1	5	0	0	0
minimizing financial risk	0	8	5	10	5	9	5	0
complexity (e.g. of activity or design)	5	7	5	7	5	10	9	10
clarity of goals	6	9	10	9	8	10	10	10
formalization	0	4	5	8	5	8	0	3
control	0	10	5	8	5	0	8	10
co-ordination	0	7	5	8	5	9	2	0
pre-planning	0	10	5	9	8	9	8	0
reducing uncertainties	4	10	5	9	8	9	8	0
formal specifications	6	10	10	9	10	9	10	4
detailed/precise specifications	6	10	10	9	10	9	10	10
specific screening criteria	5	6	5	8	5	0	10	10
well defined procedures - documented if possible	5	4	5	8	8	9	10	10
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)	0	2	5	8	3	0	8	3
use of metrics	0	0	0	6	0	0	3	3
output based management	0	5	8	7	8	7	2	0
time based management	0	10	5	9	5	8	2	0
incentives	0	1	5	0	3	0	0	0
encouragement of ideas	8	1	8	0	8	10	0	0
tolerance of mistakes	8	1	8	0	8	10	0	0
time constraints	7	8	7	0	8	5	6	0
budgetary constraints	6	8	7	9	8	5	7	0
flexible resourcing	5	1	7	0	8	9	5	5
early prototypes	8	0	10	9	10	0	8	5
running activities in parallel	2	9	5	0	6	9	5	0
proficiency	3	7	5	3	8	5	8	10
efficiency	3	7	5	3	8	5	8	0
cost-efficiency	3	7	5	3	8	5	7	0
results performance checking	6	0	5	3	8	9	8	0
detail	3	7	6	8	8	10	8	10
quality	3	10	8	10	9	10	8	10
clarity of roles	3	5	5	9	8	8	8	0
a designated project leader or team	10	9	8	6	8	5	8	0
specific responsibilities and authorities clearly assigned to specific individuals	6	9	7	8	8	6	8	10
rigid team structure	3	2	5	0	5	0	5	0
flexible team structure	7	10	5	7	8	5	5	0
concentration of power	0	6	5	5	3	5	5	0
decentralization	0	0	4	5	3	5	0	0
top management commitment, support and involvement	10	6	9	0	10	5	10	0
leadership quality	7	2	6	0	8	5	10	0
shared values	6	2	6	7	7	5	8	0
teamwork	6	10	5	7	8	5	8	0
co-operation	6	7	5	7	8	8	8	10
few opposing factions within the firm	7	0	5	7	8	5	3	0
interdisciplinary approach	3	8	5	0	8	10	5	0
specialized skills	8	10	9	7	8	9	8	10
cross-functional teams	6	9	5	1	8	8	6	0
job rotation across projects	0	0	0	0	0	0	3	0
consultative style communication	[illegible]	10	6	8	8	6	8	0
command style communication	4	0	5	0	3	0	8	0
effective communication between marketing and technical personnel	8	7	10	10	10	10	0	10
inter-organizational networking	0	0	5	0	8	0	0	0
external consultations (direct outsider involvement)	2	10	5	0	3	0	5	3
participative decision-making	5	1	7	10	6	8	6	6

Clearly, Table 5.8's exposition is extremely 'information intensive'. Whilst all of this information is, of course, germane to the overall analysis, it is that *set of points of particularly statistically significantly differing strengths of activity/principle linkages across above-average performer and below-average performer groups*, that is of greatest interest. For clarity, those points of particular interest are presented in a separate supplementary table: Table 5.9.

Table 5.9 Points of particularly statistically significant difference in relevance ratings observed across the cognitive maps of managers of above- and below- average performing firms

* indicates test statistic statistically significant at p<=.10, directional estimate ** indicates test statistic statistically significant at p<=.05, directional estimate (based on Mann-Whitney U-Test test statistic corrected for ties as appropriate, in all cases) AA /BA indicates direction of difference (source of higher rating: AA=above- average group and BA=below- average group)	**concept screening**	**early marketing activities**	**prototype /sample design and development**	**product testing**
new technologies		* aa>ba	** ba>aa	
customer orientation				** ba>aa
integration of the needs of the market with technological opportunities available to fulfil those needs	* ba>aa			
internal sources of ideas	* aa>ba	* aa>ba		**ba>aa
experience	* ba>aa	* aa>ba		
capabilities			** ba>aa	
resources			** ba>aa	
minimizing financial risk	** ba>aa			
control	**ba>aa			
pre-planning	* ba>aa			
reducing uncertainties	* ba>aa			
output based management				* aa>ba
time based management	** ba>aa			* aa>ba
incentives		* aa>ba		
encouragement of ideas	* aa>ba	* aa>ba	** ba>aa	
tolerance of mistakes			** ba>aa	
time constraints				** aa>ba
budgetary constraints				** aa>ba
early prototypes			**aa>ba	
running activities in parallel				** aa>ba
proficiency			* aa>ba	* ba>aa
efficiency			* aa>ba	
detail			* ba>aa	
quality	** ba>aa	* ba>aa	* ba>aa	* ba>aa
clarity of roles				** aa>ba
a designated project leader or team				** aa>ba
rigid team structure				* aa>ba
flexible team structure				* aa>ba
decentralization				
top management commitment, support and involvement	** aa>ba	* aa>ba	* aa>ba	**aa>ba
leadership quality			* aa>ba	**aa>ba
teamwork	* ba>aa		* aa>ba	
few opposing factions within the firm				* aa>ba
interdisciplinary approach				* aa>ba
specialized skills				* ba>aa
cross-functional teams				** aa>ba
job rotation across projects				* aa>ba
consultative style communication	** ba>aa			* aa>ba
effective communication between marketing and technical personnel				**ba>aa
command style communication				* aa>ba
inter-organizational networking			* aa>ba	
participative decision-making		** ba>aa	* ba>aa	

In total, fifty-nine statistically significant differences in ratings by managers of above- and below- average firms were observed. Thirty-three of these occurrences related to statistically significantly higher ratings by managers of above- average firms and twenty-six related to statistically significantly higher ratings by managers of below- average firms. Thirteen differences related to concept screening, eight to early marketing activities, fifteen to prototype/sample design and development and twenty-three to product testing. The greatest number of statistically significant differences were observed in relation to quality which, perhaps surprisingly, received consistently higher ratings from the below- average group across all four activities but particularly in relation to concept screening. Next were encouragement of ideas and top management commitment, support and involvement (the former being rated higher by the above- average group than the below- average group in relation to both concept screening and early marketing activities and by the below- average group in relation to prototype/sample design and development; the latter being rated consistently higher by the above- average group in relation to early marketing activities and prototype/sample design and development but particularly in relation to concept screening). **An inspection of the various matrix configurations presenting across the overall dataset, produced a number of key final observations - as summarized in Tables 5.10 through 5.12.** Firstly, Table 5.10 lists both the activity/principle combinations that are most consistently rated across all managers participating in the study and the activity/principle combinations which constitute the most consistently differentially rated across the above- and below-average groups - and which, therefore, most clearly distinguish between the above- and below- average group ...

Table 5.10 Points of closest correspondence and greatest difference in the cognitive maps of above- and below- average groups

most consistently rated activity/principle combinations (linkages and non-linkages) across all or almost all managers	**concept screening:** decentralization (non-linkage for all but one below-average group manager who rated it 6) **prototype/sample design and development:** effective communication between marketing and technical personnel (linkage of 10 common to all but one below-average group manager who rated it 7) **product testing:** clarity of goals, detailed/precise specifications (in each case, linkage of 10 common to all but one above-average group manager who assigned a rating of 8) new technologies, the marketplace, integration of the needs of the market with technological opportunities available to fulfil those needs, external sources of ideas, risk taking, accepting financial risk, incentives, encouragement of ideas, tolerance of mistakes, decentralization (unless otherwise stated, non-linkages common to all but one manager - the exception usually being the same one case from the above- average group)
linkages which are most consistently differentially rated and which, therefore, most clearly distinguish between above- and below-average groups	**concept screening:** control, pre-planning, time based management (consistently rated zero by the above-average group and 10 by the below average group) **early marketing activities:** internal sources of ideas and experience (consistently rated 8 by the above-average group and zero by the below average group) **prototype/sample design and development:** early prototypes (consistently rated 10 by the above-average group and zero by the below average group) **product testing:** customer orientation, internal sources of ideas, effective communication between marketing and technical personnel (consistently rated zero by the above-average group and 10 by the below average group) top management commitment, support and involvement, leadership quality (consistently rated 10 by the above-average group and zero by the below average group)

A total of fourteen points of extreme consistency and eleven points of extreme *in*-consistency were identified.

All of the points of extreme consistency were found to relate to either concept screening, prototype/sample design and development or product testing. None related to early marketing activities. Most consistencies related to *non*-linkages. Indeed, just three extremely consistent linkages featured. Five of the points of extreme *in*-consistency related to linkages which were consistently extremely highly rated by the *above-* average group but consistently assigned ratings of zero by the *below-* average group - the converse being true of the remaining six.

Table 5.11 provides a listing of matrix linkages unique to and common to all above-average group maps.

In total, a not insignificant **thirty-four** combinations unique to and common to all above-average group maps were identified. Thirteen of these were identified in relation to early marketing activities, thirteen in relation to prototype/sample design and development and eight in relation to product testing. None were isolated for concept screening.

Table 5.11 Combinations *unique* to and *common* to the cognitive maps of *all* managers of above-average performing firms

	concept screening	early marketing activities	prototype /sample design and development	product testing
the marketplace			✓	
integration of the needs of the market with technological opportunities available to fulfil those needs			✓	
risk taking			✓	
accepting financial risk			✓	
control			✓	
specific screening criteria			✓	
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)			✓	
incentives		✓	✓	
encouragement of ideas		✓		
tolerance of mistakes		✓		
time constraints		✓		✓
budgetary constraints				✓
flexible resourcing		✓		
early prototypes			✓	
running activities in parallel		✓		✓
clarity of roles				✓
a designated project leader or team				✓
rigid team structure		✓	✓	✓
flexible team structure				✓
top management commitment, support and involvement		✓		
leadership quality		✓		
interdisciplinary approach		✓		
cross-functional teams				✓
command style communication		✓	✓	
inter-organizational networking		✓	✓	
external consultations (direct outsider involvement)		✓	✓	

Finally, overall indications regarding the extent to which practitioners' cognitive map characterizations correspond with the recommendations of the relevant international innovation literature are generally quite good - though correspondence is not complete.

Table 5.12 provides a rough indication of the main areas of correspondence (based on an average (median) significance rating of five or more on the eleven-point scale[5]) which was observed for each recommended principle over the four product realization activities examined, in above- and below- average performers.

[5] Five was used as the cut-off point as this was the mid-point on the rating scale used.

Table 5.12 A rough indication for above- and below- average groups of the principal areas of correspondence of cognitive map characterizations and the recommendations of the relevant international innovation literature

Points of correspondence of managers' maps and the recommendations of the international innovation literature	Principles receiving an average rating of >=5	
AA = above- average performers BA = below- average performers	AA	BA
new technologies		
the marketplace	*	*
customer orientation	*	*
integration of the needs of the market with technological opportunities available to fulfil those needs	*	*
internal sources of ideas	*	
external sources of ideas	*	
experience	*	*
capabilities	*	*
resources	*	*
risk taking		
accepting financial risk		
minimizing financial risk		*
complexity (e.g. of activity or design)	*	*
clarity of goals	*	*
formalization		*
control		
co-ordination		*
pre-planning	*	*
reducing uncertainties	*	*
formal specifications	*	*
detailed/precise specifications	*	*
specific screening criteria	*	*
well defined procedures - documented if possible	*	*
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)		
use of metrics		
output based management		
time based management		*
incentives		
encouragement of ideas	*	
tolerance of mistakes	*	
time constraints	*	
budgetary constraints	*	*
flexible resourcing	*	*
early prototypes	*	
running activities in parallel	*	*
proficiency	*	*
efficiency	*	
cost-efficiency	*	
regular performance checking	*	
detail	*	*
quality	*	*
clarity of roles	*	*
a designated project leader or team	*	*
specific responsibilities and authorities clearly assigned to specific individuals	*	*
rigid team structure		
flexible team structure	*	*
concentration of power		*
decentralization		
top management commitment, support and involvement	*	
leadership quality	*	
shared values	*	
teamwork	*	*
co-operation	*	*
few opposing factions within the firm	*	
interdisciplinary approach		*
specialized skills	*	*
cross-functional teams	*	*
job rotation across projects		
consultative style communication	*	*
command style communication		
effective communication between marketing and technical personnel	*	*
inter-organizational networking		
external consultations (direct outsider involvement)		
participative decision-making	*	*

Correspondence between cognitive map content and the recommendations of the international innovation *literature* was estimated to be greater-than-fifty-per-cent for both above- and below- average groups:- sixty-nine per cent in the case of the above average group, leaving a shortfall of thirty-one per cent and fifty-eight per cent in the case of the below average group, leaving a shortfall of forty-two per cent.

Correspondence was *estimated* to be *poorest* (but again, note that this was just *on average*) across *both groups* in relation to: new technologies, risk taking, accepting financial risk, control, use of formal models and techniques, use of metrics, output based management, incentives, rigid team structure, decentralization, job rotation across projects, command style communication, inter-organizational networking and external consultations (direct outsider involvement).

5.3.3 Preliminary analysis of routine product realization practice data

Analysis of the structure and content of practice profile maps elicited in the course of the study, across all firms participating in the study and across above- and below- average product innovation performing firms participating in the study, yielded the following results ...

Firstly, Table 5.13 shows the total number of elements (activities x principles) which were found to characterize practice profile maps obtained.

Table 5.13 The total number of elements which were found to characterize practice maps for the full test group and for above- and below- average product innovation performing firms

	minimum	median	maximum	range
above-average firms	78	83	110	32
overall test group	*78*	*88*	*110*	*32*
below-average firms	81	93	100	19

The statistical significance of differences observed across the practice maps of above- and below- average performing firms was tested using the Mann-Whitney U-Test. Differences observed were *not* found to be statistically significant (Mann-Whitney U-Test, test statistic significant only at $p<=.42$, directional estimate).

Each activity and almost all principles featured at least once for at least one firm (the exceptions being concentration of power and decentralization).

Activities ...

A one-hundred per cent incidence of the four key product realization **activities** targeted in the study was observed across practice profiles gathered, that is: no product realization activity was found to have been omitted by any respondent. This was not surprising, however, in view of the fact that together, these four activities constitute *the* most essential definition of the product realization process possible - as noted elsewhere in the present text.

An important corollary to this is, therefore, that, in the preliminary section of the questionnaire, where respondent firms had been asked to consider the more detailed fifteen activity model, routine product realization practice across all companies surveyed in the course of the present study, was found to be (reportedly[6]) characterized by *no less than nine* of the fifteen tasks which make up the more complete product realization practice model of the product innovation literature ... and that elsewhere in the preliminary section of the questionnaire, where firms had been asked to consider another common seven activity model, routine product realization practice across all companies surveyed in the course of the present study, was found to be (reportedly[7]) characterized by all seven activities - as shown in Table 5.14.

[6] that is: routine practice as characterized by managers and not separately checked for reasons of impracticability within the time/budget-confined context of the present study

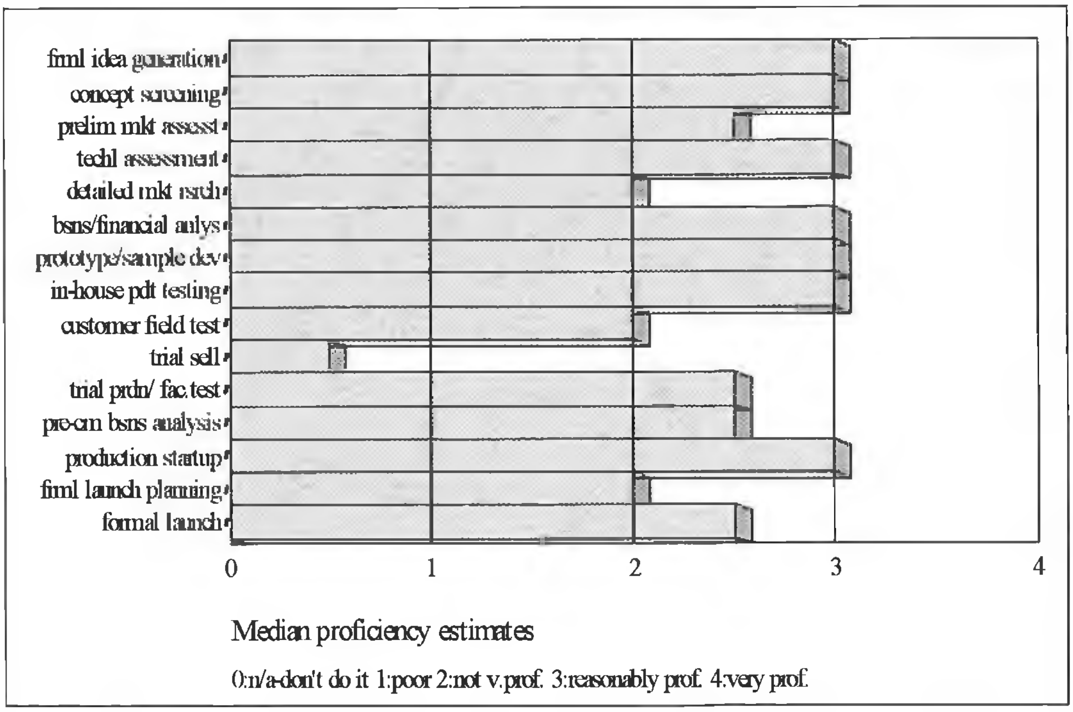
[7] again, that is: routine practice as characterized by managers and not separately checked for reasons of impracticability within the time/budget-constrained context of the present study

Table 5.14 The number of activities found to characterize routine practice

	Above- average performers			Below- average performers		
	minimum	median	maximum	minimum	median	maximum
FIFTEEN activity model of the product realization process used in Study One	*13*	*14*	*15*	*9*	*15*	*15*
SEVEN activity model of the product realization process developed for Study Two	*7*	*7*	*7*	*7*	*7*	*7*

It should be noted, however, that the reported proficiency with which each activity is executed is quite variable (as shown in figure 5.14 - based on the fifteen activity model).

Figure 5.14 Managers' estimates of their firms proficiency in carrying out each product development activity



Median proficiency estimates for the below- average group suggested reasonable proficiency across the board. The above- average group estimates were more variable and, generally, lower, however.

The statistical significance of differences observed across groups was tested using the Mann-Whitney U-Test. The greatest difference was indicated in relation to <u>customer field testing</u> ($p<=.035$, with correction for ties, directional estimate, with higher proficiency estimates for the below- average group). Production start-up estimates were also found to differ statistically significantly (p<=.06, with correction for ties, directional estimate, with higher proficiency estimates for the below- average group); also: initial concept screening (p<=.10, with correction for ties, directional estimate, with higher proficiency estimates for the above- average group), trial sell (p<=.12, with correction for ties, directional estimate, with higher proficiency estimates for the below- average group), in-house product testing (p<=.16, with correction for ties, directional estimate, with higher proficiency estimates for the above- average group) and business/financial analysis (p<=.25, with correction for ties, directional estimate, with higher proficiency estimates for the below- average group).

A probability level of p<=.40 was estimated in relation to the remaining activities (directional estimate again, with test statistic corrected for ties), with higher proficiency estimates for the below- average group throughout, with the exception of idea generation, technical assessment and prototype/sample development - for which no statistically significant differences were indicated.

In the preliminary section of the questionnaire, managers had been asked to indicate those key activities which their firms had found to be of particular importance in practice, in ensuring that product innovation initiatives undertaken by their companies were successfully carried through to the point of generating a marketable product. Their responses constitute an interesting corollary note and are summarized in Table 5.15.

Table 5.15 Modal characterization of key activities

	the mere inclusion of this activity makes a difference	inclusion not enough of itself - though its proficient execution does make a difference	positive output from this activity makes a difference
initial concept screening		☝	☝
technical assessment			☝
early marketing activities (preliminary market assessment, market research)			☝
business/financial analysis			☝
product (prototype/sample) design and development			☝
product testing			☝
product launch and marketing			☝

An interesting corollary note to Table 5.15 is that: **technical assessment** and **product (prototype/sample) design and development** were the most consistently classified activities across the overall test set.

Incidence was quite high for almost all **principles** also. Analysis of the overall dataset for the overall test group indicated that almost all principles featured at least once for at least one firm (the exceptions being concentration of power and decentralization), though a number of relatively low activity/case-specific incidences were observed.

Subsequent separate analysis of above- and below- average performers revealed that all above- and below- average performer maps exhibited a number of instances of zero-incidence. Principles most consistently omitted across all maps were, obviously: **concentration of power and decentralization** (all above- average firms and all below- average firms). Other principles fairly consistently omitted across all maps were: **risk taking, co-ordination, use of metrics, output based management, incentives, job rotation across projects and command style communications** (all below- average firms, most above average firms).

Two principles were, reportedly, particularly prevalent. These were: **experience** and **quality** and four principles were, reportedly, particularly significant. These were: **quality, the marketplace, resources** and **detail**.

Activities x Principles ...

An outline impression of the *extent* of activity/principle linkages characterizing obtained profiles is presented in Table 5.16 for the overall test group and above- and below- average groups.

Table 5.16 Outline impression of extent of activity/principle linkages observed: number of principles found to characterize each activity in practice

minimum *average (median)* *maximum* *range*	above- average group	overall test set	below- average group
initial concept screening	11 22 32 21	11 27 34 23	20 33 34 14
early marketing activities	6 17 18 12	6 17.5 23 17	14 21 23 9
prototype/ sample design/ development	24 35 42 18	23 27.5 42 19	23 26 29 6
product testing	15 19 30 15	13 18 30 17	13 17 21 8

Table 5.16 indicates that: (i) the greatest number of linkages - on average - was to be found in relation to prototype/sample design/development (in the case of the above- average group only), (ii) the least number of linkages - on average - was to be found in relation to early marketing activities (in the case of the above- average group only) and product testing (in the case of the below- average group only) and (iii) variability across maps, *in general*, was found to be greatest in relation to initial concept screening.

The statistical significance of differences observed across groups was tested using the Mann-Whitney U-Test. Test statistics, when corrected for ties, indicated a statistically significantly ***higher*** number of linkages in the *above*- average group in relation to prototype/sample design and development (p<=.14, directional estimate) and product testing (p<=.25, directional estimate) and in the ***below***- average group, in relation to concept screening (p<=.14, directional estimate) and early marketing activities (p<=.14, directional estimate).

Table 5.17 provides a more detailed breakdown of linkages observed across obtained profiles. Based on modal linkage indicators, it highlights the points of commonality and difference across above- and below average groups.

Table 5.17 Specific activity/principle linkage patterns[8] differentially characterizing overall test group, above-average performer group and below-average performer group, as indicated by group modes

MODAL linkage indicators for Routine Practice Profiles: **BOTH** = indicated for both groups **NEITHER** = indicated for neither group **HIGH** = above- average or 'high' performers only **LOW** = below- average or 'low' performers only	**concept screening**	**early marketing activities**	**prototype/ sample design and development**	**product testing**
new technologies	NEITHER	HIGH	BOTH	NEITHER
the marketplace	BOTH	BOTH	HIGH	NEITHER
customer orientation	BOTH	BOTH	BOTH	LOW
integration of the needs of the market with technological opportunities available to fulfil those needs	BOTH	BOTH	HIGH	HIGH
internal sources of ideas	HIGH	HIGH	BOTH	BOTH
external sources of ideas	HIGH	HIGH	HIGH	HIGH
experience	BOTH	LOW	BOTH	BOTH
capabilities	BOTH	LOW	BOTH	NEITHER
resources	LOW	LOW	BOTH	BOTH
risk taking	NEITHER	NEITHER	NEITHER	NEITHER
accepting financial risk	NEITHER	NEITHER	NEITHER	NEITHER
minimizing financial risk	LOW	LOW	BOTH	HIGH
complexity (e.g. of activity or design)	LOW	NEITHER	LOW	BOTH
clarity of goals	BOTH	NEITHER	LOW	LOW
formalization	NEITHER	NEITHER	NEITHER	NEITHER
control	LOW	NEITHER	NEITHER	BOTH
co-ordination	NEITHER	NEITHER	NEITHER	NEITHER
pre-planning	LOW	NEITHER	HIGH	HIGH
reducing uncertainties	LOW	NEITHER	NEITHER	NEITHER
formal specifications	HIGH	NEITHER	HIGH	NEITHER
detailed/precise specifications	BOTH	NEITHER	HIGH	BOTH
specific screening criteria	NEITHER	NEITHER	NEITHER	BOTH
well defined procedures - documented if possible	NEITHER	NEITHER	HIGH	BOTH
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)	NEITHER	NEITHER	HIGH	NEITHER
use of metrics	NEITHER	NEITHER	NEITHER	NEITHER
output based management	NEITHER	NEITHER	NEITHER	NEITHER
time based management	LOW	NEITHER	NEITHER	NEITHER
incentives	NEITHER	NEITHER	NEITHER	NEITHER
encouragement of ideas	BOTH	HIGH	BOTH	NEITHER
tolerance of mistakes	HIGH	NEITHER	BOTH	NEITHER
time constraints	BOTH	NEITHER	BOTH	HIGH
budgetary constraints	BOTH	NEITHER	BOTH	NEITHER
flexible resourcing	NEITHER	NEITHER	LOW	NEITHER
early prototypes	HIGH	BOTH	BOTH	BOTH
running activities in parallel	NEITHER	NEITHER	HIGH	NEITHER
proficiency	NEITHER	NEITHER	NEITHER	LOW
efficiency	NEITHER	NEITHER	NEITHER	NEITHER
cost-efficiency	LOW	NEITHER	NEITHER	NEITHER
regular performance checking	NEITHER	NEITHER	HIGH	NEITHER
detail	LOW	HIGH	HIGH	LOW
quality	LOW	BOTH	BOTH	BOTH
clarity of roles	NEITHER	NEITHER	NEITHER	NEITHER
a designated project leader or team	NEITHER	NEITHER	HIGH	HIGH
specific responsibilities and authorities clearly assigned to specific individuals	NEITHER	NEITHER	NEITHER	BOTH
rigid team structure	NEITHER	NEITHER	NEITHER	NEITHER
flexible team structure	LOW	NEITHER	BOTH	NEITHER
concentration of power	NEITHER	NEITHER	NEITHER	NEITHER
decentralization	NEITHER	NEITHER	NEITHER	NEITHER
top management commitment, support and involvement	HIGH	HIGH	HIGH	HIGH
leadership quality	NEITHER	NEITHER	HIGH	NEITHER
shared values	NEITHER	NEITHER	BOTH	NEITHER
teamwork	LOW	NEITHER	HIGH	NEITHER
co-operation	LOW	NEITHER	HIGH	BOTH
few opposing factions within the firm	NEITHER	NEITHER	HIGH	NEITHER
interdisciplinary approach	NEITHER	NEITHER	LOW	NEITHER
specialized skills	NEITHER	LOW	NEITHER	LOW
cross-functional teams	NEITHER	NEITHER	NEITHER	NEITHER
job rotation across projects	NEITHER	NEITHER	NEITHER	NEITHER
consultative style communication	LOW	HIGH	HIGH	NEITHER
command style communication	NEITHER	NEITHER	NEITHER	NEITHER
effective communication between marketing and technical personnel	BOTH	LOW	BOTH	LOW
inter-organizational networking	NEITHER	NEITHER	NEITHER	NEITHER
external consultations (direct outsider involvement)	LOW	LOW	NEITHER	NEITHER
participative decision-making	BOTH	BOTH	BOTH	NEITHER

[8] (modal indicators)

Out of a total possible two-hundred and fifty-six linkages, just forty-seven linkages - but one-hundred and thirty-nine non-linkages were found to be common to above- and below- average groups ... corresponding to seventy-three per cent commonality overall. Twelve common links were found in relation to concept screening, six in relation to early marketing activities, seventeen in relation to prototype/sample design and development and twelve in relation to product testing.

Thirty-eight additional linkages were found in the above-average group only and thirty-two additional linkages were found in the below-average group only.

Regarding the distinctiveness of activity/principle combinations observed across practice profiles, **no** principle was found to feature *just once* across all maps. A number of principles were, however, found to feature just once across all above-average group maps or all below-average group maps. Accepting financial risk, flexible resourcing, proficiency, cost-efficiency, clarity of roles, shared values and an interdisciplinary approach were found to be distinctive in above-average group maps but not in below-average group maps, the converse being true of use of formal models and techniques, rigid team structure, few opposing factions within the firm and cross-functional teams. Median incidence Figures for each principle across the overall product realization script suggested some additional within-group evidence of distinctiveness in both above- and below- average groups - see Table 5.18. (Table 5.18 presents breakdowns of the incidence or **standardness** of principles across obtained profiles for above- and below- average groups.)

Table 5.18 Summary breakdown of the incidence or standardness of principles across obtained practice profiles for above- and below- average product innovation performing firms (median incidence)

Routine Practice Profiles *median incidence maximum value in each cell =4, corresponding to the four activities represented*	above average firms	below average firms
new technologies	3	1
the marketplace	3	2
customer orientation	3	3
integration of the needs of the market with technological opportunities available to fulfil those needs	3	2
internal sources of ideas	4	2
external sources of ideas	2	1
experience	3	4
capabilities	2	3
resources	2	3
risk taking	0	0
accepting financial risk	0	0
minimizing financial risk	2	3
complexity (e.g. of activity or design)	1	3
clarity of goals	1	3
formalization	0	1
control	1	1
co-ordination	0	0
pre-planning	2	2
reducing uncertainties	1	2
formal specifications	2	1
detailed/precise specifications	3	2
specific screening criteria	2	1
well defined procedures - documented if possible	2	1
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)	1	0
use of metrics	0	0
output based management	0	0
time based management	0	1
incentives	0	0
encouragement of ideas	3	2
tolerance of mistakes	2	1
time constraints	3	1
budgetary constraints	2	2
flexible resourcing	0	1
early prototypes	3	2
running activities in parallel	1	0
proficiency	0	1
efficiency	0	0
cost-efficiency	0	1
regular performance checking	1	1
detail	2	2
quality	2	4
clarity of roles	0	0
a designated project leader or team	2	0
specific responsibilities and authorities clearly assigned to specific individuals	1	1
rigid team structure	0	0
flexible team structure	1	2
concentration of power	0	0
decentralization	0	0
top management commitment, support and involvement	3	0
leadership quality	1	0
shared values	1	2
teamwork	1	1
co-operation	1	2
few opposing factions within the firm	1	1
interdisciplinary approach	0	1
specialized skills	0	2
cross-functional teams	0	0
job rotation across projects	0	0
consultative style communication	2	1
command style communication	0	0
effective communication between marketing and technical personnel	2	3
inter-organizational networking	0	1
external consultations (direct outsider involvement)	1	1
participative decision-making	2	2

In general, median standardness values appear quite variable throughout Table 5.18. Whilst the minimum value (zero) is certainly not uncommon (it features forty-one times), the maximum value (four) is rare (it features just three times). Hence most of the variability which occurs across both groups and principles, does so in the range: one through three.

The statistical significance of differences observed across above- average and below- average groups was tested using Chi-Square likelihood ratios. Test statistics, were found to be particularly significant in the case of: **new technologies** (more prevalent across the four product realization tasks as performed by the *below*- average group - $p<=.10$), **time based management (**more prevalent across the four product realization tasks as performed by the *below*- average group - $p<=.016$), **clarity of goals** (more prevalent across the four product realization tasks as performed by the *below*- average group - $p<=.05$), **tolerance of mistakes** (more prevalent across the four product realization tasks as performed by the *above*- average group - $p<=.05$), **top management commitment, support and involvement** (more prevalent across the four product realization tasks as performed by the *above*- average group - $p <=.05$), **flexible resourcing** (more prevalent across the four product realization tasks as performed by the *below*- average group - $p<=.10$), **proficiency** (more prevalent across the four product realization tasks as performed by the *below*- average group- $p<=.10$),

shared values (more prevalent across the four product realization tasks as performed by the *below*- average group - p<=.06), **specialized skills** (more prevalent across the four product realization tasks as performed by the *below*- average group - p<=.10) **interdisciplinary approach** (more prevalent across the four product realization tasks as performed by the *below*- average group, p<=.05) and **consultative style communication** (more prevalent across the four product realization tasks as performed by the *above*- average group - p<=.05).

Figure 5.15 and Tables 5.19 and 5.20 summarize general[9] practice map centrality observed across above- and below- average performing groups ...

Firstly, Figure 5.15 (which is - and is intended to be used simply as - a *very rough advance sketch* of profiles suggested by the data) indicates quite clearly that the routine practice profiles of above- and below-average firms differ considerably in their respective points of emphasis.

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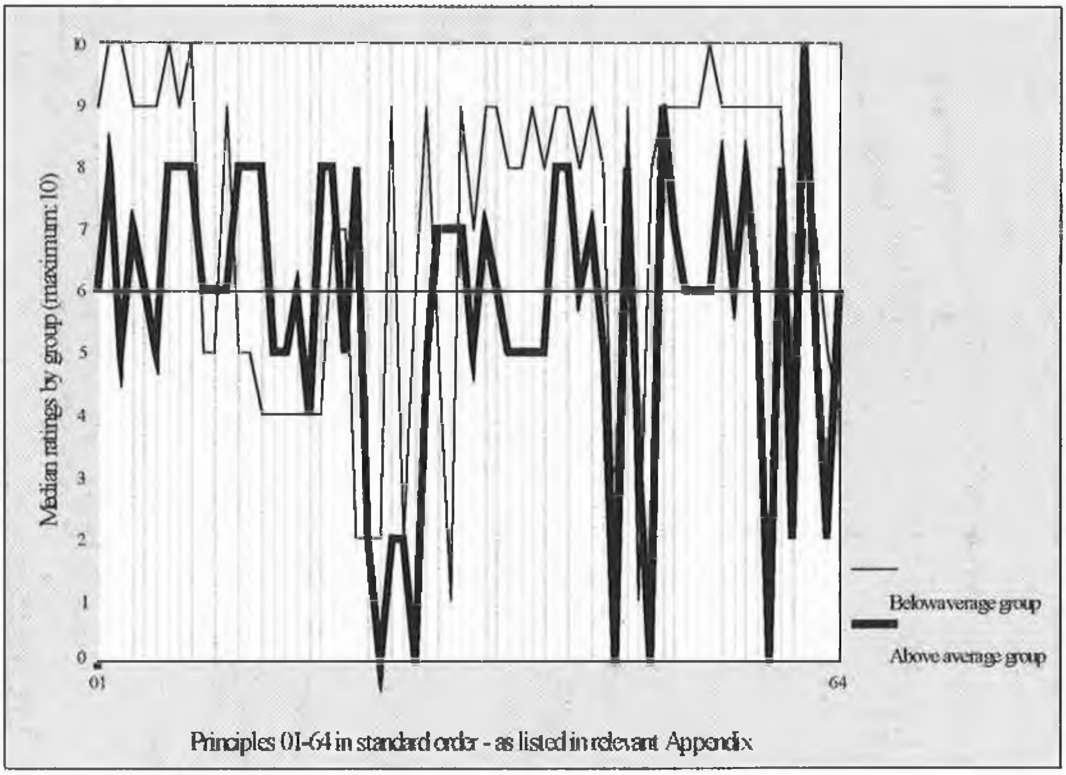
[9] In reviewing these summaries, it is important to bear in mind that *practice* centrality was measured in a *general* way over the *overall* product realization process and not in relation to individual activities as was the case for *cognitive* centrality.

Figure 5.15 Practice Map Centrality: Summary of median significance ratings observed for each principle over all four product realization activities for above- and below- average performers



Note: the Appendix referred to in Figure 5.13 is Appendix C.

Table 5.19 presents profiles outlined in Figure 5.15, in a more accessible form ...

Table 5.19 Overall practice map centrality: above- and below-average group breakdowns of median relevance ratings for each principle over the full product realization process

MEDIAN *strengths of principle/activity linkages observed across Practice Maps*	over all four activities	
AA = above- average performers BA = below- average performers	AA	BA
new technologies	6	9
the marketplace	8	10
customer orientation	5	10
integration of the needs of the market with technological opportunities available to fulfil those needs	7	9
internal sources of ideas	6	9
external sources of ideas	5	9
experience	8	10
capabilities	8	9
resources	8	10
risk taking	6	5
accepting financial risk	6	5
minimizing financial risk	6	9
complexity (e.g. of activity or design)	8	5
clarity of goals	8	5
formalization	8	4
control	5	4
co-ordination	5	4
pre-planning	6	4
reducing uncertainties	4	4
formal specifications	8	4
detailed/precise specifications	8	7
specific screening criteria	5	7
well defined procedures - documented if possible	8	2
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)	2	2
use of metrics	0	2
output based management	2	9
time based management	2	2
incentives	0	6
encouragement of ideas	5	9
tolerance of mistakes	7	5
time constraints	7	1
budgetary constraints	7	9
flexible resourcing	5	7
early prototypes	7	9
running activities in parallel	6	9
proficiency	5	8
efficiency	5	8
cost-efficiency	5	9
regular performance checking	5	8
detail	8	9
quality	8	9
clarity of roles	6	8
a designated project leader or team	7	9
specific responsibilities and authorities clearly assigned to specific individuals	5	8
rigid team structure	0	1
flexible team structure	8	9
concentration of power	3	1
decentralization	0	8
top management commitment, support and involvement	9	9
leadership quality	7	9
shared values	6	9
teamwork	6	9
co-operation	6	10
few opposing factions within the firm	8	9
interdisciplinary approach	6	9
specialized skills	8	9
cross-functional teams	6	9
job rotation across projects	0	9
consultative style communication	8	9
command style communication	2	4
effective communication between marketing and technical personnel	10	7
inter-organizational networking	5	7
external consultations (direct outsider involvement)	2	5
participative decision-making	6	4

The statistical significance of differences observed across above- and below-average groups was tested using the Mann-Whitney U-Test. Test statistics, corrected for ties as appropriate were found to be particularly statistically significant for: complexity (p<=.16), formal specifications (p<=.14), well defined procedures - documented if possible (p<=.16) and effective communication between marketing and technical personnel (p<=.14), each of which was considered more important by *above-* average performers ... and customer orientation (p<=.03), experience (p<=.02), running tasks in parallel (p<=.02), cost efficiency (p<=.04), detail (p<=.06), flexible team structure (p<=.02) and co-operation (p<=.02), each of which was considered more important by *below-* average performers.

As noted earlier, all activities were considered important to all firms. Four principles were emphasised in particular[10]. These were: **quality, the marketplace, resources** and **detail.**

Table 5.20 indicates points of particularly statistically significantly difference, in activity/principle combinations observed in the practice profiles of above- and below-average performing firms[11], together with the most consistent group showings / no-showings.

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[10] that is: were rated particularly significant

[11] (note that whilst this table corresponds generally to Table 5.9 for cognition, the cognition table is based on *centrality* data and the practice table is based on *standardness* data)

Table 5.20 Points of particularly statistically significant difference in activity/principle combinations observed in the routine practice profiles of above- and below-average performing firms

* indicates test statistic statistically significant at p<=.10, directional estimate ** indicates test statistic statistically significant at p<=.05, directional estimate (based on Fisher's Exact Test test statistic, in all cases) most consistent group x show/no-show index: aa: above- average group x showing aa0: above- average group x no-showing ba: below- average group x showing ba0: below- average group x no-showing	concept screening	early marketing activities	prototype/ sample design and development	product testing
new technologies		* ba0		
customer orientation				* ba
integration of the needs of the market with technological opportunities available to fulfil those needs				* ba0aa
internal sources of ideas	* aa			
external sources of ideas				* ba0aa
capabilities		* ba		
minimizing financial risk	* ba	* ba		* ba0aa
complexity (e.g. of activity or design)			* ba	
clarity of goals			* ba	* ba
pre-planning	* ba			* ba0aa
reducing uncertainties	* ba			
formal specifications	* aa			
detailed/precise specifications			* aa	
well defined procedures - documented if possible			* aa	
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)			* ba0aa	
time based management	** aa0ba			
encouragement of ideas		** ba0aa		
time constraints				* ba0aa
flexible resourcing			* aa0ba	
proficiency				* ba
cost-efficiency	* aa0ba			
detail			* aa	* aa0ba
quality	* ba			
a designated project leader or team			* ba0aa	* ba0aa
top management commitment, support and involvement	* ba0aa		* aa	* ba0aa
leadership quality			* ba0aa	
teamwork	* ba			
co-operation	* ba			
few opposing factions within the firm			* aa	
specialized skills		* aa0ba		* ba
consultative style communication	* ba		** ba0aa	
effective communication between marketing and technical personnel		** aa0ba		

In total, forty-two statistically significant differences were found. Thirteen related to concept screening, twelve each to prototype/sample design and development and product testing and just five to early marketing activities.

An inspection of the various matrix configurations presenting across the overall dataset, produced a number of key final observations - as summarized in Tables 5.21 through 5.23 ...

Firstly, Table 5.21 lists both the activity/principle linkages and non-linkages that most consistently characterize routine practice profiles across all firms participating in the study and the activity/principle linkages and non-linkages that both maximally and most consistently differentiate the routine practice profiles of above- and below- average firms.

Note that whilst the centrality of each of the sixty-four principles to each activity is used to identify these points of closest correspondence and greatest difference in relation to cognitive maps, standardness is used in the case of practice maps - commensurate with the manner in which the practice variable was measured.

Table 5.21 Points of closest correspondence and greatest difference in the routine practice profiles of above- and below- average groups

most consistent activity/principle linkages and non-linkages across all firms	**concept screening:** **linkages** the marketplace, experience and capabilities **non-linkages** use of metrics, incentives, flexible resourcing, efficiency, clarity of roles, concentration of power, decentralization, leadership quality, few opposing factions within the firm, job rotation across projects and command style communication **early marketing activities:** **non-linkages** risk taking, accepting financial risk, formalization, control, co-ordination, well-defined procedures - documented if possible, use of formal models and techniques, use of metrics, running activities in parallel, efficiency, specific responsibilities and authorities clearly assigned to specific individuals, flexible team structure, concentration of power, decentralization, leadership quality, teamwork, co-operation, interdisciplinary approach, cross-functional teams and command style communication **prototype/sample design and development:** **linkages** experience, encouragement of ideas, tolerance of mistakes and quality **non-linkages** co-ordination, use of metrics, time based management, incentives, concentration of power and decentralization **product testing:** **linkages** experience and detailed/precise specifications **non-linkages** risk taking, accepting financial risk, co-ordination, output based management, time based management, incentives, budgetary constraints, cost-efficiency, regular performance checking, rigid team structure, flexible team structure, concentration of power, decentralization, shared values, few opposing factions within the firm, interdisciplinary approach, job rotation across projects and command style communication
linkages which most clearly and consistently distinguish between above- and below- average performing firms	**concept screening:** **above-average group linkage, below-average group non-linkage** internal sources of ideas, formal specifications, top management commitment, support and involvement **below-average group linkage, above-average group non-linkage** time based management, minimizing financial risk, pre-planning, reducing uncertainties, cost-efficiency, quality, teamwork, co-operation, consultative style communication **early marketing activities:** **above-average group linkage, below-average group non-linkage** encouragement of ideas and new technologies **below-average group linkage, above-average group non-linkage** effective communication between marketing and technical personnel, capabilities, minimizing financial risk and specialized skills **prototype/sample design and development:** **above-average group linkage, below-average group non-linkage** consultative style communication, detailed/precise specifications, well-defined procedures - documented if possible, use of formal models and techniques, detail, a designated project leader or team, top management commitment, support and involvement, leadership quality and few opposing factions within the firm **below-average group linkage, above-average group non-linkage** complexity, clarity of goals and flexible resourcing **product testing:** **above-average group linkage, below-average group non-linkage** integration of the needs of the market with technological opportunities available to fulfil those needs, external sources of ideas, minimizing financial risk, pre-planning, time constraints, a designated project leader or team and top management commitment, support and involvement **below-average group linkage, above-average group non-linkage** customer orientation, clarity of goals, proficiency, detail and specialized skills

A total of sixty-four points of extreme consistency and forty-two points of extreme *in*-consistency were identified.

It was interesting to find that most points of extreme consistency related to *non*-linkages. Indeed, just nine extremely consistent linkages featured.

Twenty-one of the points of extreme *in*-consistency related to linkages which were common throughout the *above*- average group but uncommon in the below-average group - the converse being true of the rest.

Table 5.22 provides a listing of matrix linkages unique to and common to all above-average group profiles.

In total, just nine combinations unique to and common to all above-average group maps were identified. Two of these were identified in relation to concept screening, just one in relation to early marketing activities and six in relation to prototype/sample design and development. None were isolated for product testing.

Table 5.22 Combinations *unique to* and *common to* the routine practice profiles of *all* above- average performing firms

	concept screening	early marketing activities	prototype/ sample design and development	product testing
internal sources of ideas	✓			
formal specifications	✓			
detailed/precise specifications			✓	
well defined procedures - documented if possible			✓	
encouragement of ideas		✓		
detail			✓	
top management commitment, support and involvement			✓	
few opposing factions within the firm			✓	
consultative style communication			✓	

Finally, overall indications regarding the extent to which practitioners' routine practice profiles correspond with the recommendations of the relevant international innovation literature are generally quite good - though not complete.

Table 5.23 provides a rough indication of the main areas of correspondence (based on principles presenting at least two out of a maximum possible: four times (corresponding to the four activities represented)[12], on average (median estimates) overall) for above- and below- average groups.

[12] a presentation rate of at least 50% was decided upon as a cut-off point as this represented clearer evidence of routine implementation than a single occurrence whilst allowing for constraints of budget/time restricted development conditions

Table 5.23 A rough indication of the principal areas of correspondence of routine practice profile map characterizations and the recommendations of the international innovation literature

Points of correspondence of routine product realization practice and the recommendations of the international innovation literature	principles presenting at least two out of four times on average overall	
AA = above- average performers **BA = below- average performers**	**AA**	**BA**
new technologies	*	
the marketplace	*	*
customer orientation	*	*
integration of the needs of the market with technological opportunities available to fulfil those needs	*	*
internal sources of ideas	*	*
external sources of ideas	*	
experience	*	*
capabilities	*	*
resources	*	*
risk taking		
accepting financial risk		
minimizing financial risk	*	*
complexity (e.g. of activity or design)		*
clarity of goals		*
formalization		
control		
co-ordination		
pre-planning	*	*
reducing uncertainties		*
formal specifications	*	
detailed/precise specifications	*	*
specific screening criteria	*	
well defined procedures - documented if possible	*	
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)		
use of metrics		
output based management		
time based management		
incentives		
encouragement of ideas	*	*
tolerance of mistakes	*	
time constraints	*	
budgetary constraints	*	*
flexible resourcing		
early prototypes	*	*
running activities in parallel		
proficiency		
efficiency		
cost-efficiency		
regular performance checking		
detail	*	*
quality	*	*
clarity of roles		
a designated project leader or team	*	
specific responsibilities and authorities clearly assigned to specific individuals		
rigid team structure		
flexible team structure		*
concentration of power		
decentralization		
top management commitment, support and involvement	*	
leadership quality		
shared values		*
teamwork		
co-operation		*
few opposing factions within the firm		
interdisciplinary approach		
specialized skills		*
cross-functional teams		
job rotation across projects		
consultative style communication	*	
command style communication		
effective communication between marketing and technical personnel	*	*
inter-organizational networking		
external consultations (direct outsider involvement)		
participative decision-making	*	*

A less-than-fifty-per-cent correspondence level was *estimated* for both above-average and below-average profiles:- thirty-seven per cent in the case of the *below*-average group, leaving a shortfall of sixty-three per cent and forty-two per cent in the case of the *above*-average group, leaving a shortfall of fifty-eight per cent.

It was interesting to find that correspondence was *estimated* to be relatively *poor* (but again, note that this was just *on average*) across *both groups* in relation to:

risk taking, accepting financial risk, formalization, control, co-ordination, use of formal models and techniques, use of metrics, output based management, time based management, incentives, flexible resourcing, running activities in parallel, proficiency, efficiency, cost-efficiency, regular performance checking, clarity of roles, specific responsibilities and authorities clearly assigned to specific individuals, rigid team structure, concentration of power, decentralization, leadership quality, teamwork, few opposing factions within the firm, interdisciplinary approach, cross-functional teams, job rotation across projects, command style communication, inter-organizational networking and external consultations (direct outsider involvement).

5.4 KEY INTER-COMPONENT / INTER-GROUP / MULTI-VARIATE / INFERENTIAL ANALYSES

5.4.1 Examining the relationship between managerial cognition and company performance

An analysis of the relationship between managerial cognition and company performance, yielded the following results...

The relationship between map size, completeness or complexity (the total number of cognitive map elements overall / total number of linkages overall) and percentage of projects brought to a successful conclusion was assessed using Spearman's test of association. It was found to be both positive and quite statistically significant (rho= .7247, significant at p<=.052 - directional testing).

The number of principles characterizing individual product realization activities was found to be positively correlated with the percentage of projects brought to a successful conclusion - and statistically significant as follows (based on Spearman's test of association - directional testing): concept screening: p<=.41, **early marketing activities: p<=.15, prototype/sample design and development: p<=.09, product testing: p<=.004**.

Yet it would seem reasonable to suppose that it is likely to be the nature rather than the number of linkages that is of greater importance.

The relationship between the overall standardness or prevalence of each of the sixty-four product realization principles across product realization scripts and the percentage of projects brought to a successful conclusion was also assessed using Spearman's test of association.

'Rho' co-efficients yielded for each principle are presented in Table 5.24, together with relevant directional probability estimates for co-efficients found to be statistically significant at $p<=.30$.

Statistically significant relationships were indicated for **seventy-eight per cent** of principles, thirty-four per cent of which were significant at $p<=.05$.

The standardness of **pre-planning, few opposing factions within the firm** and an **interdisciplinary approach** were each found to be particularly strongly, positively associated with the percentage of projects successfully completed.

Table 5.24 The relationship between the overall <u>standardness</u> of each of the sixty-four product realization principles across product realization scripts and the percentage of projects brought to a successful conclusion

Cognitive map Standardness x %age projects successfully completed n = 6 throughout neg. = negative correlation	rho (rounded to two decimal points)	p (directional test estimates)
new technologies	.67	.070
the marketplace	.74	.048
customer orientation	.42	.203
integration of the needs of the market with technological opportunities available to fulfil those needs	.74	.048
internal sources of ideas	.61	.098
external sources of ideas	.43	.198
experience	.27	
capabilities	.66	.075
resources	.66	.075
risk taking	.25	
accepting financial risk	.25	
minimizing financial risk	.51	.148
complexity (e.g. of activity or design)	.08 neg.	
clarity of goals	.27	
formalization	.75	.042
control	.76	.039
co-ordination	.60	.105
pre-planning	.85	.017
reducing uncertainties	.79	.031
formal specifications	.77	.036
detailed/precise specifications	.74	.048
specific screening criteria	.41	.212
well defined procedures - documented if possible	.58	.114
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)	.76	.039
use of metrics	.13	
output based management	.62	.096
time based management	.62	.096
incentives	.69	.064
encouragement of ideas	.68	.070
tolerance of mistakes	.68	.070
time constraints	.53	.143
budgetary constraints	.58	.114
flexible resourcing	.58	.114
early prototypes	.58	.114
running activities in parallel	.62	.096
proficiency	.17	
efficiency	.59	.106
cost-efficiency	.73	.049
regular performance checking	.73	.049
detail	.17	
quality	.11 neg.	
clarity of roles	.41	.212
a designated project leader or team	.41	.212
specific responsibilities and authorities clearly assigned to specific individuals	.41	.212
rigid team structure	.55	.128
flexible team structure	.41	.212
concentration of power	.07	
decentralization	.49	.165
top management commitment, support and involvement	.83	.020
leadership quality	.73	.049
shared values	.59	.106
teamwork	.59	.106
co-operation	.63	.090
few opposing factions within the firm	.86	.014
interdisciplinary approach	.85	.016
specialized skills	.02 neg.	
cross-functional teams	.41	.212
job rotation across projects	.75	.042
consultative style communication	.19	
command style communication	.31	.273
effective communication between marketing and technical personnel	.02	
inter-organizational networking	.78	.034
external consultations (direct outsider involvement)	.58	.114
participative decision-making	.11 neg.	

The relationship between the centrality or relevance rating (perceived importance) of each of the sixty-four product realization principles and percentage of projects brought to a successful conclusion was also assessed using Spearman's test of association.

'Rho' co-efficients yielded for each principle are presented in Table 5.25, together with relevant directional probability estimates for co-efficients found to be statistically significant at $p<=.30$.

Statistically significant relationships were indicated for **sixty-seven per cent** of principles - twenty-three per cent of which were statistically significant at $p<=.05$.

The centrality of **regular performance checking, top management commitment, support and involvement, pre-planning** and **leadership quality** were found to be particularly strongly, positively associated with the percentage of projects successfully completed.

Table 5.25 The relationship between the <u>centrality</u> or relevance rating (perceived importance) of each of the sixty-four product realization principles and percentage of projects brought to a successful conclusion

Cognitive map Centrality x %age projects completed n = 6 throughout neg. = negative	rho (rounded to two decimal points)	p (directional test estimates)
new technologies	.17	
the marketplace	.69	.064
customer orientation	.25 neg.	
integration of the needs of the market with technological opportunities available to fulfil those needs	.61	.099
internal sources of ideas	.46	.177
external sources of ideas	.44	.191
experience	.13	
capabilities	.32	.269
resources	.26	
risk taking	.31	.269
accepting financial risk	.03	
minimizing financial risk	.46	.177
complexity (e.g. of activity or design)	.65 neg.	.082
clarity of goals	.29 neg.	.286
formalization	.35	.250
control	.53	.140
co-ordination	.35	.250
pre-planning	.84	.018
reducing uncertainties	.46	.177
formal specifications	.26	
detailed/precise specifications	.06	
specific screening criteria	.12	
well defined procedures - documented if possible	.78	.033
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)	.65	.082
use of metrics	.12 neg.	
output based management	.09 neg.	
time based management	.06 neg.	
incentives	.63	.089
encouragement of ideas	.43	.194
tolerance of mistakes	.52	.144
time constraints	.38	.231
budgetary constraints	.23	
flexible resourcing	.32	.269
early prototypes	.38	.231
running activities in parallel	.52	.144
proficiency	.41	.212
efficiency	.75	.042
cost-efficiency	.81	.025
regular performance checking	.93	.004
detail	.06	
quality	.60 neg.	.103
clarity of roles	.21	
a designated project leader or team	.38	.231
specific responsibilities and authorities clearly assigned to specific individuals	.43	.200
rigid team structure	.21	
flexible team structure	.00	
concentration of power	.24 neg.	
decentralization	.18	
top management commitment, support and involvement	.90	.007
leadership quality	.84	.018
shared values	.81	.026
teamwork	.52	.144
co-operation	.78	.033
few opposing factions within the firm	.38	.231
interdisciplinary approach	.52	.144
specialized skills	.08 neg.	
cross-functional teams	.46	.177
job rotation across projects	.71	.058
consultative style communication	.34 neg.	.256
command style communication	.34	.256
effective communication between marketing and technical personnel	.23 neg.	
inter-organizational networking	.75	.042
external consultations (direct outsider involvement)	.52	.144
participative decision-making	.00	

It is interesting to note that within the above average group, higher completion rates for product innovation initiatives were associated in a particularly strong way (positively and, based on the application of Spearman's test of association, statistically, significantly) with managers' emphasis of: minimizing financial risk, formalization, control, co-ordination, pre-planning, time-based management, proficiency, efficiency, cost-efficiency, regular performance checking, detail, shared values, co-operation, interdisciplinary approach and inter-organizational networking, and the *de*-emphasis of: risk taking, accepting financial risk, complexity and few opposing factions within the firm.

Within the below average group, higher completion rates were also associated (positively and, again, based on the application of Spearman's test of association, statistically, significantly) with higher centrality in cognitive maps of: minimizing financial risk, formalization, pre-planning, cost-efficiency, regular performance checking and co-operation - but also with reducing uncertainties, detailed/precise specifications, well defined procedures - documented if possible, time constraints, budgetary constraints, flexible resourcing, early prototypes, running tasks in parallel, few opposing factions within the firm and external consultations (direct outsider involvement).

5.4.2 Examining the degree of correspondence between managers' cognitive maps and companies' practice profiles

An examination of the degree of correspondence between managers' cognitive maps and companies' practice profiles, yielded the following results ...

As stated elsewhere, none of the four generic activities were omitted from any cognitive and practice maps. Thus, with regard to activities deemed relevant to the product realization process, there was one-to-one correspondence between theory and practice. This was not surprising, however, given that they were so broadly defined.

With regard to the more specifically detailed product realization principles, the correspondence between theory and practice was less 'clear-cut', however.

In general[1], substantial correspondence was observed, the most notable points of correspondence being[2] in regard to the perceived relevance and reported consideration/incorporation in practice of: **new technologies**

[1] (that is: in relation to overall product realization maps - as opposed to individual activities and to the full sample set - taken as a whole)
[2] (as suggested by extremely statistically significant Spearman rho co-efficients)

(p<=.004), **customer orientation** (p<=.038), capabilities (p<=.048 - negative correlation), **minimizing financial risk** (p<=.004), **specific screening criteria** (p<=.004), **well defined procedures - documented if possible** (p<=.012), **use of metrics** (p<=.017), **incentives** (p<=.083), **tolerance of mistakes** (p<=.064), **time constraints** (p<=.009), **budgetary constraints** (p<=.087), **proficiency** (p<=.002), **efficiency** (p<=.055), **decentralization** (p<=.003), **specialized skills** (p<=.048) and **inter-organizational networking** (p<=.087) ... all based on directional probability estimates.

Of greater interest, however, is perhaps the fact that the actual *et of points of closest correspondence differed* to some extent across above- and below- average performing groups - see Table 5.26.

Table 5.26 The variability of points of closest correspondence between cognition and practice across above- and below- average performers

POINTS OF GREATEST CORRESPONDENCE BETWEEN COGNITION AND PRACTICE *A: above- average performers B: below- average performers*	*A*	*B*
new technologies	*	*
the marketplace	*	*
customer orientation		*
integration of the needs of the market with technological opportunities available to fulfil those needs		
internal sources of ideas		
external sources of ideas		*
experience		
capabilities		* *' rho
resources		
risk taking	*	*
accepting financial risk		*
minimizing financial risk	*	
complexity (e.g. of activity or design)	*	
clarity of goals		
formalization		
control		*
co-ordination		
pre-planning		
reducing uncertainties	*	
formal specifications		
detailed/precise specifications		
specific screening criteria		*
well defined procedures - documented if possible		
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)		*
use of metrics		
output based management		
time based management		
incentives	*	*
encouragement of ideas	*	
tolerance of mistakes	*	*
time constraints	*	
budgetary constraints	*	
flexible resourcing		
early prototypes		
running activities in parallel		
proficiency	*	*
efficiency	*	*
cost-efficiency	*	
regular performance checking	*	
detail		*
quality		
clarity of roles		
a designated project leader or team		
specific responsibilities and authorities clearly assigned to specific individuals		*
rigid team structure		
flexible team structure		
concentration of power		
decentralization		*
top management commitment, support and involvement		
leadership quality		
shared values		
teamwork		
co-operation		
few opposing factions within the firm	*	
interdisciplinary approach		
specialized skills		*
cross-functional teams		
job rotation across projects		
consultative style communication		*
command style communication		
effective communication between marketing and technical personnel		
inter-organizational networking		*
external consultations (direct outsider involvement)		
participative decision-making	*	

Percentage correspondence indices, based on cognitive map relevance ratings of five or more out of ten and practice profile occurrences of at least one, are presented for each of the four product realization activities, in Tables 5.27 through 5.30. Throughout these Tables, shading is used to draw attention to points of *greater-than-fifty-per-cent* correspondence. **Eighty-four** per cent of Table 5.27, **twenty-seven** per cent of Table 5.28, **sixty-nine** per cent of Table 5.29 and **eighty-eight** per cent of Table 5.30 are highlighted in this way, indicating an equivalent percentage of general, overall cognition/practice correspondence for concept screening, early marketing activities, prototype/sample design and development and product testing, respectively. These figures are, certainly, of themselves, quite high ... suggesting an overall correspondence estimate of almost seventy per cent on average (mean) ... *however* ... in reviewing Tables 5.27 through 5.30, it should be noted that whilst attention is drawn to the points of ***closest*** correspondence between cognition and practice, *several un-highlighted points of correspondence have also been found to be statistically significant*. For example:

- in correlating *raw data* for **concept screening**, using Spearman's test of association, the test statistic yielded for ‘specific screening criteria’ (rho=.66) was found to be statistically significant at p<=.075 (directional testing) notwithstanding its not very high ‘predominant correspondence pattern’ index (50%); similarly, ‘specialized skills’ was found to be significant at p<=.13 (directional testing) and ‘top management commitment, support and involvement' was found to be significant, though somewhat less so, at p<=.20 (also, directional testing).

- in correlating *raw data* for **early marketing activities**, using Spearman's test of association, the test statistic yielded for 'flexible resourcing' (rho=.66) was found to be statistically significant at p<=.075 (directional testing) notwithstanding its not very high 'predominant correspondence pattern' index (50%) and 'formal specifications' was found to be significant at p<=.20 (directional testing).

- in correlating *raw data* for **prototype/sample design and development**, using Spearman's test of association, the test statistic yielded for 'specialized skills' (rho=.85) was found to be statistically significant at p<=.015 (directional testing) notwithstanding its not very high 'predominant correspondence pattern' index (50%) and 'risk taking' was found to be significant at p<=.075 (directional testing).

- in correlating *raw data* for **product testing**, using Spearman's test of association, the test statistic yielded for 'detail' (rho=.85) was found to be statistically significant at p<=.015 (directional testing) notwithstanding its not very high 'predominant correspondence pattern' index (50%) and 'running tasks in parallel' was found to be significant at p<=.058 (directional testing).

Table 5.27 Degree of correspondence observed between managers' cognitive maps and companies' practice profiles in Concept Screening

Concept Screening	% Degree of Correspondence
new technologies	50
the marketplace	83.3
customer orientation	100
integration of the needs of the market with technological opportunities available to fulfil those needs	83.3
internal sources of ideas	83.3
external sources of ideas	66.7
experience	100
capabilities	100
resources	66.7
risk taking	66.7
accepting financial risk	66.7
minimizing financial risk	83.3
complexity (e.g. of activity or design)	50
clarity of goals	83.3
formalization	83.3
control	100
co-ordination	66.7
pre-planning	100
reducing uncertainties	100
formal specifications	66.7
detailed/precise specifications	83.3
specific screening criteria	50
well defined procedures - documented if possible	66.7
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)	83.3
use of metrics	83.3
output based management	83.3
time based management	100
incentives	66.7
encouragement of ideas	83.3
tolerance of mistakes	83.3
time constraints	66.7
budgetary constraints	83.3
flexible resourcing	50
early prototypes	100
running activities in parallel	66.7
proficiency	66.7
efficiency	50
cost-efficiency	83.3
regular performance checking	83.3
detail	66.7
quality	100
clarity of roles	66.7
a designated project leader or team	66.7
specific responsibilities and authorities clearly assigned to specific individuals	50
rigid team structure	83.3
flexible team structure	83.3
concentration of power	66.7
decentralization	83.3
top management commitment, support and involvement	50
leadership quality	50
shared values	66.7
teamwork	83.3
co-operation	66.7
few opposing factions within the firm	50
interdisciplinary approach	66.7
specialized skills	50
cross-functional teams	66.7
job rotation across projects	83.3
consultative style communication	66.7
command style communication	100
effective communication between marketing and technical personnel	100
inter-organizational networking	83.3
external consultations (direct outsider involvement)	83.3
participative decision-making	83.3

Table 5.28 **Degree of correspondence observed between managers' cognitive maps and companies' practice profiles in Early Marketing Activities**

Early Marketing Activities	% Degree of Correspondence
new technologies	50
the marketplace	66.7
customer orientation	100
integration of the needs of the market with technological opportunities available to fulfil those needs	83.3
internal sources of ideas	50
external sources of ideas	66.7
experience	50
capabilities	50
resources	33.3
risk taking	33.3
accepting financial risk	50
minimizing financial risk	66.7
complexity (e.g. of activity or design)	66.7
clarity of goals	33.3
formalization	16.7
control	16.7
co-ordination	16.7
pre-planning	33.3
reducing uncertainties	66.7
formal specifications	50
detailed/precise specifications	33.3
specific screening criteria	33.3
well defined procedures - documented if possible	16.7
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)	33.3
use of metrics	50
output based management	33.3
time based management	33.3
incentives	66.7
encouragement of ideas	83.3
tolerance of mistakes	66.7
time constraints	33.3
budgetary constraints	50
flexible resourcing	50
early prototypes	83.3
running activities in parallel	33.3
proficiency	16.7
efficiency	33.3
cost-efficiency	50
regular performance checking	66.7
detail	66.7
quality	83.3
clarity of roles	50
a designated project leader or team	33.3
specific responsibilities and authorities clearly assigned to specific individuals	16.7
rigid team structure	33.3
flexible team structure	16.7
concentration of power	33.3
decentralization	50
top management commitment, support and involvement	83.3
leadership quality	33.3
shared values	33.3
teamwork	16.7
co-operation	16.7
few opposing factions within the firm	50
interdisciplinary approach	50
specialized skills	50
cross-functional teams	33.3
job rotation across projects	83.3
consultative style communication	66.7
command style communication	50
effective communication between marketing and technical personnel	50
inter-organizational networking	33.3
external consultations (direct outsider involvement)	33.3
participative decision-making	33.3

Table 5.29 Degree of correspondence observed between managers' cognitive maps and companies' practice profiles in Prototype/Sample Design and Development

Prototype/Sample Design and Development	% Degree of Correspondence
new technologies	83.3
the marketplace	83.3
customer orientation	83.3
integration of the needs of the market with technological opportunities available to fulfil those needs	83.3
internal sources of ideas	100
external sources of ideas	33.3
experience	100
capabilities	83.3
resources	83.3
risk taking	50
accepting financial risk	83.3
minimizing financial risk	100
complexity (e.g. of activity or design)	83.3
clarity of goals	66.7
formalization	50
control	66.7
co-ordination	16.7
pre-planning	66.7
reducing uncertainties	66.7
formal specifications	66.7
detailed/precise specifications	83.3
specific screening criteria	50
well defined procedures - documented if possible	83.3
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)	66.7
use of metrics	83.3
output based management	50
time based management	33.3
incentives	83.3
encouragement of ideas	100
tolerance of mistakes	100
time constraints	83.3
budgetary constraints	83.3
flexible resourcing	33.3
early prototypes	83.3
running activities in parallel	66.7
proficiency	33.3
efficiency	33.3
cost-efficiency	50
regular performance checking	50
detail	66.7
quality	100
clarity of roles	33.3
a designated project leader or team	50
specific responsibilities and authorities clearly assigned to specific individuals	33.3
rigid team structure	66.7
flexible team structure	83.3
concentration of power	50
decentralization	66.7
top management commitment, support and involvement	83.3
leadership quality	50
shared values	83.3
teamwork	66.7
co-operation	50
few opposing factions within the firm	83.3
interdisciplinary approach	66.7
specialized skills	50
cross-functional teams	33.3
job rotation across projects	83.3
consultative style communication	66.7
command style communication	83.3
effective communication between marketing and technical personnel	83.3
inter-organizational networking	83.3
external consultations (direct outsider involvement)	83.3
participative decision-making	83.3

Table 5.30 Degree of correspondence observed between managers' cognitive maps and companies' practice profiles in Product Testing

Product Testing	% Degree of Correspondence
new technologies	100
the marketplace	100
customer orientation	100
integration of the needs of the market with technological opportunities available to fulfil those needs	83.3
internal sources of ideas	83.3
external sources of ideas	83.3
experience	100
capabilities	66.7
resources	100
risk taking	83.3
accepting financial risk	83.3
minimizing financial risk	100
complexity (e.g. of activity or design)	83.3
clarity of goals	66.7
formalization	100
control	66.7
co-ordination	83.3
pre-planning	100
reducing uncertainties	83.3
formal specifications	66.7
detailed/precise specifications	100
specific screening criteria	100
well defined procedures - documented if possible	83.3
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)	66.7
use of metrics	100
output based management	100
time based management	100
incentives	83.3
encouragement of ideas	100
tolerance of mistakes	100
time constraints	66.7
budgetary constraints	33.3
flexible resourcing	50
early prototypes	83.3
running activities in parallel	50
proficiency	83.3
efficiency	83.3
cost-efficiency	66.7
regular performance checking	66.7
detail	50
quality	66.7
clarity of roles	50
a designated project leader or team	66.7
specific responsibilities and authorities clearly assigned to specific individuals	83.3
rigid team structure	50
flexible team structure	66.7
concentration of power	66.7
decentralization	100
top management commitment, support and involvement	83.3
leadership quality	66.7
shared values	66.7
teamwork	66.7
co-operation	66.7
few opposing factions within the firm	83.3
interdisciplinary approach	66.7
specialized skills	66.7
cross-functional teams	50
job rotation across projects	83.3
consultative style communication	83.3
command style communication	66.7
effective communication between marketing and technical personnel	66.7
inter-organizational networking	83.3
external consultations (direct outsider involvement)	66.7
participative decision-making	33.3

5.4.3 Assessing the relationship between organizational practice and performance

An assessment of the relationship between organizational practice and performance, yielded the following results...

Firstly, process completeness and proficiency were considered in relation to rate of realization ...

The relationship between map size or complexity (the total number of practice profile map elements overall / total number of linkages overall) and percentage of projects brought to a successful conclusion was assessed using Spearman's test of association. It was found to be positive and reasonably statistically significant (rho= .5218, significant at p<=.144 - directional testing).

A significantly reduced routine product realization process *vis-à-vis* the full fifteen-activity model was indicated for just one firm and whilst this was a below-average product innovation performing firm, all four generic key activities of the simplified four-task model were incorporated by all firms and the product realization record this one exceptional firm was certainly in no way inordinately lower than the rest.

An investigation of the relationship between the estimated proficiency with which the various activities comprising the fifteen-task model are completed and the percentage of projects brought to a successful conclusion (using Spearman's non-parametric test of correlation), yielded no statistically significant result (at p<=.05, directional testing) with the exception of a *negative* (!) correlation in the case of **prototype/sample development**. Proficiency in **customer field testing** and proficient **pre-commercialization business analysis** were the next most significant correlates (again, negative), at p<=.066 and .286, respectively. These findings are probably best considered in the broader context of the findings of the preliminary data analysis which indicated the possibility of a not very discerning, over-estimation of proficiency of task execution, by below average performers.

A supplementary analysis of the relationship between the estimated proficiency with which the various activities comprising the fifteen-stage model are completed and total number of initiatives, yielded statistically significant results as follows (based on Spearman's correlation co-efficients and probability directional estimates): **formalized idea generation** (p<=.15, positive correlation), **initial concept screening** (p<=.066, positive correlation), **technical assessment** (p<=.148, positive correlation), **prototype/sample development** (p<=.203, positive correlation), **in-house product testing** (p<=.075, positive correlation) and production start-up (p<=.031, negative correlation).

Table 5.31 provides a summary of the statistically significant links observed between poor proficiency of execution of individual product realization activities and problems associated with the ultimate abandonment/killing of product innovation initiatives.

Table 5.31 Cross-tabulation of poor proficiency of execution estimates for individual product realization activities and problems associated with the ultimate abandonment/killing of product innovation initiatives - a summary of statistically significant links observed

Values in Table 5.31 indicate the probability estimates for statistically significant associations, based on Phi / Cramer's V test statistics	**cost problems**	**project was taking too long**	**problems with core technology**	**change in marketplace**	**project team doubtful of project outcome**	**other important projects competing for same resources**	**senior management no longer wanted to stay with it**
formalized idea generation	***.05***	*.27*	*.27*	*.22*			
initial concept screening	***.05***	*.27*	***.05***	*.22*	***.05***	*.27*	
preliminary market assessment	***.05***		*.15*			***.05***	
technical assessment	***.05***	*.27*	*.27*	*.22*			
detailed market research	***.05***		*.15*			***.05***	
business/financial analysis	*.11*	*.11*	*.11*	*.11*	*.11*		
prototype/sample development		***.05***		*.08*	*.12*		
in-house product testing	***.05***		*.12*	*.27*			
customer field testing			*.11*	*.26*		*.29*	*.11*
trial sell							
trial production / test of facilities	***.05***		*.15*			***.05***	
pre-commercialization business analysis	*.19*	*.19*	*.19*	*.19*	*.19*	*.19*	
production start-up		*.27*	*.27*		***.05***	***.05***	
formal launch planning	***.05***		*.15*			***.05***	
formal launch & marketing	*.11*		*.11*		*.11*	*.11*	

In total, **fifty-five** points of statistically significant association were found, seventeen of which were statistically significant at $p<=.05$. The broadest *associative* impact of poor proficiency was observed in relation to **initial concept screening** and **pre-commercialization business analysis** and, to a slightly lesser extent, business/financial analysis - whilst no statistically significant impact was observed in relation to trial sell. Premature project termination due to **cost problems** was found to be statistically significantly associated with poor proficiency in almost all activities, the same being true of **problems with core technology**. The problem of projects taking too long was most strongly associated with poor proficiency in relation to prototype/sample development. Perhaps, not surprisingly, most points of association of project abandonment due to the problem of other important projects competing for the same resources were the same as those for project abandonment due to cost problems. It would be interesting to 'unpack' the six/one project team to senior management proficiency associated project veto ratio ... particularly in relation to earlier observations, regarding the probable over-estimation of proficiency of task execution by managers of below-average firms.

The number of principles characterizing *individual* product realization activities was found to be *positively* associated with the percentage of projects brought to a successful conclusion in the case of **prototype/sample design and development** (rho=.9856, significant at $p<=.000$, directional testing) and **product testing** (rho=.7537, significant at p<=.042, directional testing) - but somewhat negatively (though *not quite so* statistically, significantly) correlated in the case of concept screening (at p<=.25, directional testing) and early marketing activities (p<=.15, directional testing) .

The relationship between the standardness of individual principles in practice across all four product realization activities studied and the percentage of product innovation initiatives brought to a successful conclusion was found to be most statistically significant in the cases of: **a designated project leader or team** (p<=.003), **the marketplace** (p<=.015), **running activities in parallel** (p<=.015), **internal sources of ideas** (p<=.016), **leadership quality** (p<=.015), **integration of the needs of the market with technological opportunities available to fulfil those needs** (p<=.031), **regular performance checking** (p<=.03), **encouragement of ideas** (p<=.12), **minimizing financial risk** (p<=.13), **external sources of ideas** (p<=.073), **use of formal models and techniques** (p<=.06), **efficiency** (p<=.075), **top management commitment, support and involvement** (p<=.06), **tolerance of mistakes** (p<=.075), **few opposing factions within the firm** (p<=.065) ... all positive associations, directional probability estimates based on Spearman's rho test statistics. Statistically significant *negative* correlations were observed in relation to: quality (p<=.018), complexity (p<=.13), detail (p<=.15), use of metrics (p<=.075), output based management (p<=.075), time based management (p<=.06), flexible team structure (p<=.15), co-ordination (p<=.075), effective communication between marketing and technical personnel (p<=.055), participative decision-making (p<=.165) - all directional probability estimates, based on Spearman's rho test statistics.

A second supplementary analysis (again, using Spearman's test and p<=.05, non-directional testing) of the relationship between the standardness of principles and total number of initiatives yielded the following statistically significant results:

- *positively* correlated: **specific screening criteria** (p<=.003), **time constraints** (p<=.04), **consultative style communications** (p<=.05), **rigid team structure** (p<=.065), **cross-functional teams** (p<=.065), **efficiency** (p<=.075), **top management commitment, support and involvement** (p<.12), **early prototypes** (p<=.135), and **inter-organizational networking** (p<=14);

- *negatively* correlated: capabilities (p<=.013), clarity of goals (p<=.019), formalization (p<=.06) and inter-disciplinary approach (p<=.018).

A degree of association analysis (using Spearman's test and directional estimation) of managers' ratings of the significance of the contribution made by individual principles in practice, in ensuring that product innovation projects initiated by their companies do actually result in the generation of a new or improved marketable product and the percentage of product innovation initiatives brought to a successful conclusion by their companies, revealed a particularly statistically significant correlation for fifteen of the sixty-four principles examined, specifically:

- **risk taking** (p<=.087), **accepting financial risk** (p<=.096), **complexity** (p<=.030), **pre-planning** (p<=.074), **well defined procedures - documented if possible** (p<=.030), **reducing uncertainties** (p<=.19), **concentration of power** (p<=.11), and **external consultations (direct outsider involvement)** (p<=.18) - *all positively associated*;

- experience (p<=.026), resources (p<=.002), running activities in parallel (p<=.070), co-operation (p<=.091), customer orientation (p<=.018), output based management (p<=.16) and specialized skills (p<=.16) - *negative* correlations in each case, directional probability estimates based, again, on Spearman's test statistics - *all negatively associated*.

It was interesting to find a number of very definite, very specific and quite statistically significant associations between incorporation of individual principles of product realization practice recommended by the international innovation literature into routine practice and the lesser likelihood of some specific problem causing the abandonment/killing of product innovation project undertakings.

Table 5.32 provides a summary of the *negative* associations found between principles recommended by the international innovation literature which have been incorporated into routine practice *and* the main problems associated with the ultimate abandonment/killing of product innovation initiatives, found to be statistically significant at p<=.05.

Table 5.32 A summary of statistically significant *points of offset* of product realization principles recommended by the international innovation literature which have been adopted in routine practice *and* the main problems associated with the ultimate abandonment/killing of product innovation initiatives

The code: 'SS' indicates a strong statistically significant Phi / Cramer's V co-efficient at p <= .05 IR: inverse relationship	cost problems	project was taking too long	problems with core technology	change in marketplace	project team doubtful of project outcome	other important projects competing for same resources	senior management no longer wanted to stay with it
customer orientation					SS IR		
integration of the needs of the market with technological opportunities available to fulfil those needs							SS IR
clarity of goals						SS IR	
control							SS IR
detailed/precise specifications					SS IR		
specific screening criteria	SS IR						
tolerance of mistakes						SS IR	
budgetary constraints					SS IR		SS IR
flexible resourcing	SS IR						
regular performance checking		SS IR					
a designated project leader or team				SS IR			
shared values			SS IR				
few opposing factions within the firm							SS IR
interdisciplinary approach						SS IR	
consultative style communication					SS IR		
participative decision-making			SS IR				

A total of seventeen points of offset were found at $p<=.05$. Some appeared to be very simple and straightforward (for example: the negative association between regular performance checking and projects taking too long) whilst others appeared to be potentially, considerably more complex (for example: the negative association between few opposing factions within the firm and senior management no longer wanting to stay with the project).

5.5 CONTINGENCIES/CONTROLS AND OTHER POINTS OF INTEREST[3]

5.5.1 Company variables

A check of **age of firm** and **industry/product-type** data confirmed sampling strategy control of these variables across above- and below- average performer groups.

Some variability in **product lifecycles** data was observed. This prompted an investigation of likely/possible co-variates. The most notable finding was in relation to the variable: *total number of product innovation initiatives* - as shown in Figure 5.16. The r-squared value for the scatterplot's linear regression line, through the origin is 0.6793 (total fit).

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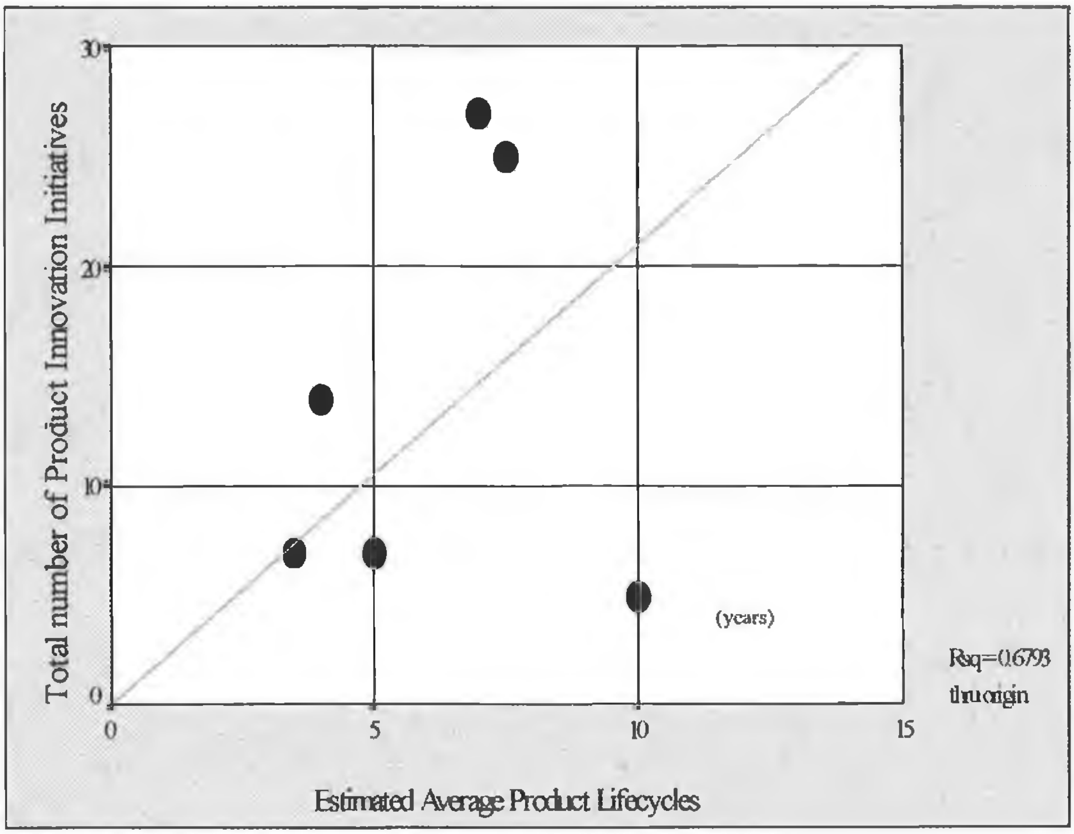
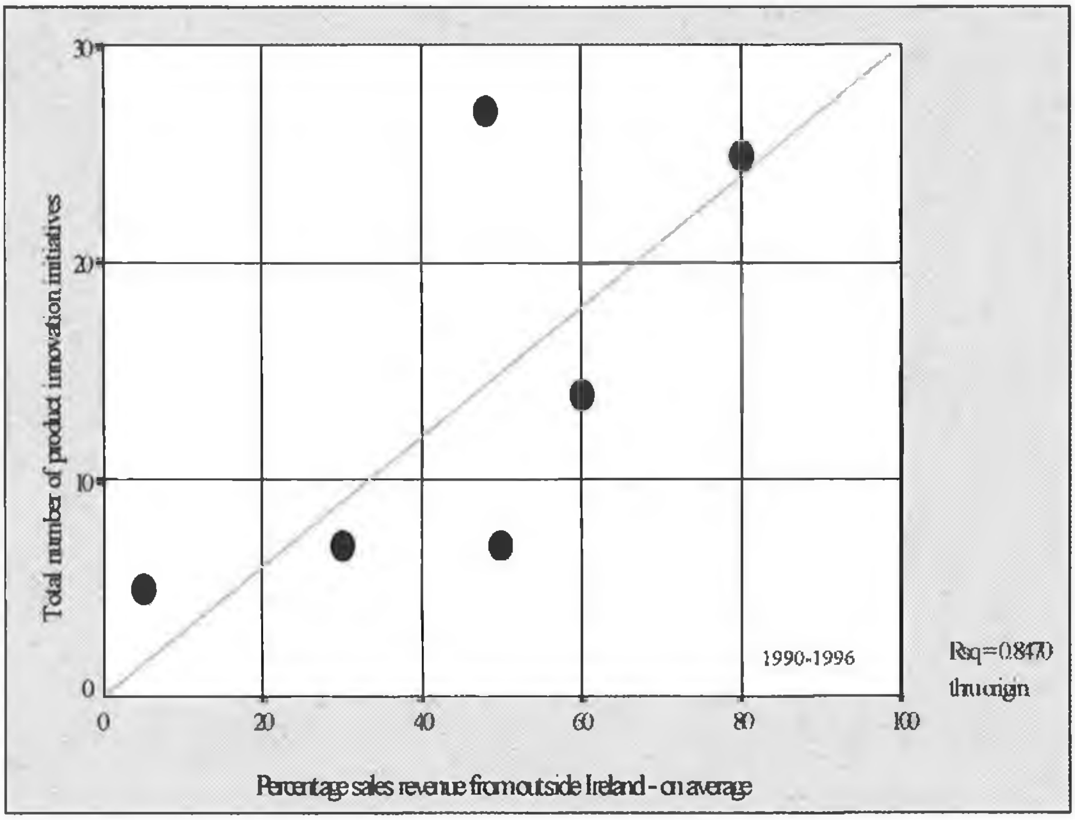
[3] *cf.* Table 4.1

Figure 5.16 The association observed between total number of product innovation initiatives and estimated average product lifecycles



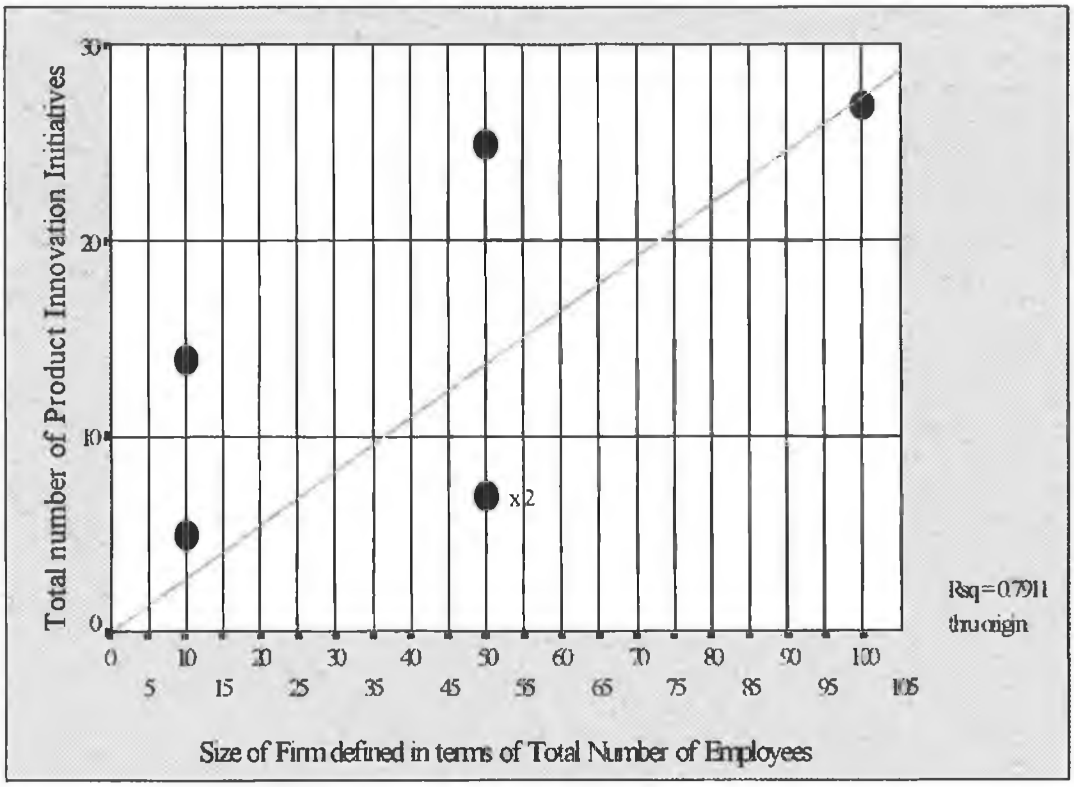
Again, some variability was observed in data obtained on **markets as competitive influence**. An investigation of likely/possible co-variates again showed the most notable finding to be in relation to the variable: *total number of product innovation initiatives* - see Figure 5.17. The r-squared value for the scatterplot's linear regression line, through the origin is 0.8470 (total fit).

Figure 5.17 The association observed between total number of product innovation initiatives and average percentage sales outside Ireland 1990-1996



An investigation of the likely/possible co-variates of **size of firm** data also yielded significant results in relation to *total number of product innovation initiatives* - see Figure 5.18. The r-squared value for the scatterplot's linear regression line, through the origin is 0.7911 (total fit).

Figure 5.18 The association observed between total number of product innovation initiatives and firm size



A check of **Q-Mark and ISO9000** data confirmed an acceptable level[4] of incidental equivalence control of these variables across above- and below-average performer groups, that is: there was practically equivalent representation of Q-Mark-ed and ISO9000 certified firms in both groups. In any case, an investigation of the possible effects of Q-Mark/ISO9000 certification on relevant variables (in particular: the number of principles characterizing routine product

[4] such that further investigation of possible confounding effects could be deemed unnecessary

realization practice profiles) revealed - perhaps, surprisingly - no statistically significant effects (based on Mann-Whitney U-Test test statistics).

An investigation of the co-variates of the, not surprisingly variable, **extent and nature of external linkages (universities, multi-national companies and government agencies)** data, yielded interesting results in relation to both *total number of initiatives* and *percentage of projects brought to successful completion* - as shown in Figures 19 and 20, the former seemingly making the general case for external linkages, the latter seemingly making the case for selectivity in external linkages!

Figure 5.19 The association observed between total number of product innovation initiatives and extent of external linkages

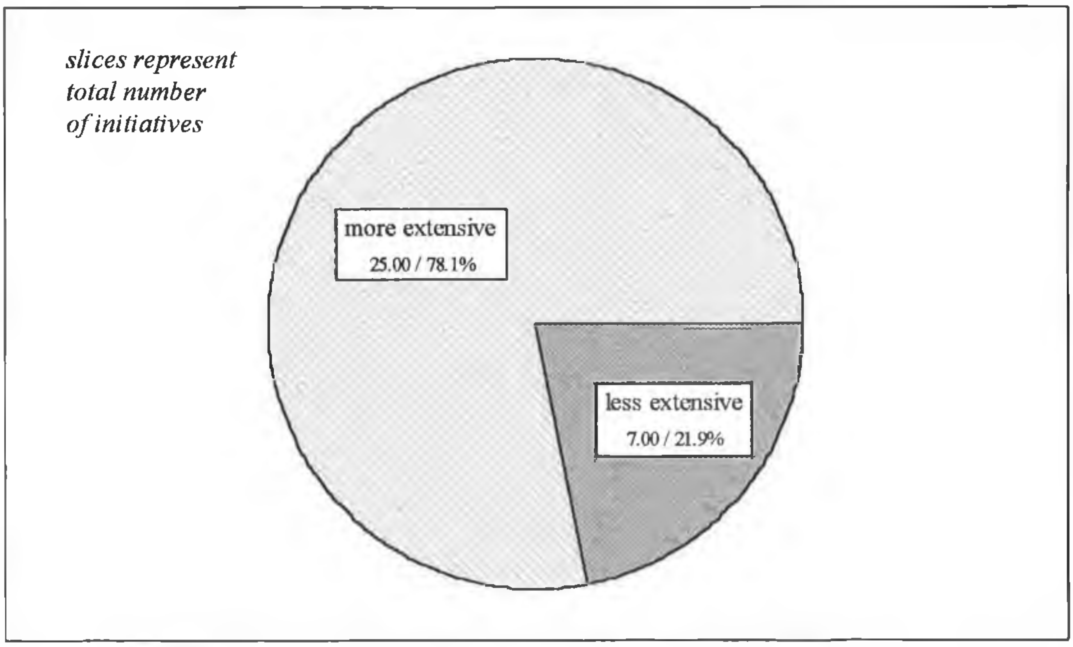
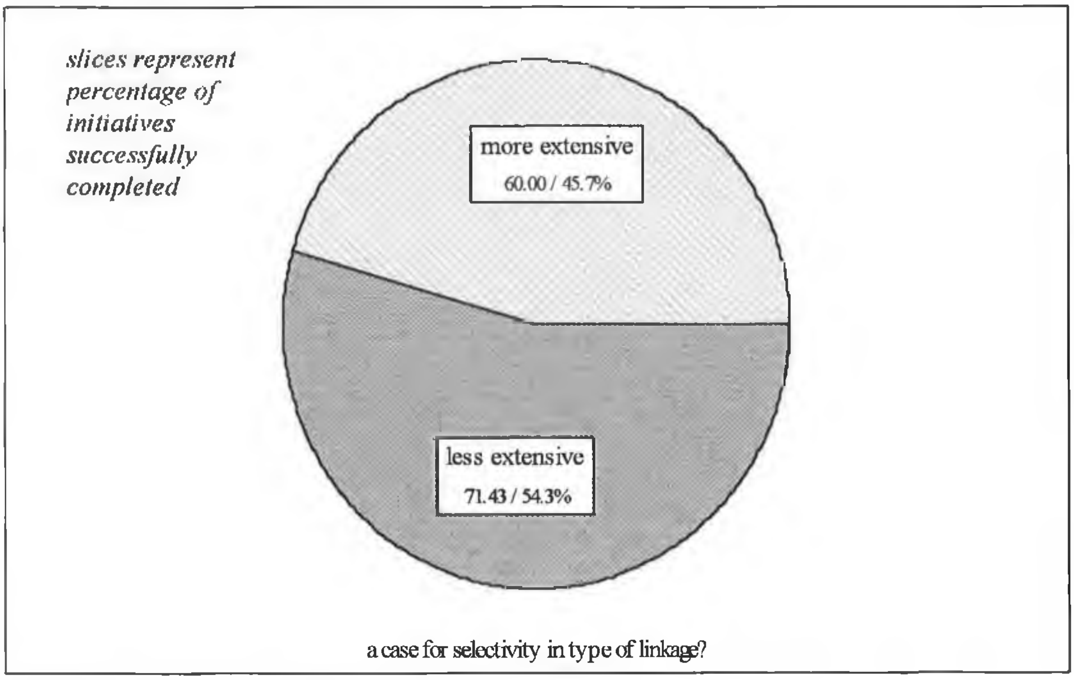


Figure 5.20 The association observed between percentage of product innovation initiatives successfully completed and extent of external linkages



Both **annual** and **current product innovation budgets** were found to differ statistically significantly across above- and below- average groups at p <=.20 (both based on a Mann-Whitney U-Test and directional estimation:- U=2.5 with above-average group > below- average group in each case).

Thus, it seemed appropriate to investigate likely/possible co-variates of these potentially confounding variables ...

The most marked results of this investigation were found in relation to:

(i) annual product innovation budget and percentage of product innovation initiatives successfully completed - in relation to which the r-squared value for the scatterplot's linear regression line, through the origin, was found to be 0.6803 (total fit) ... the complementary r-squared value for *current* product innovation budget was 0.5943;

(ii) annual product innovation budget and routine product realization practice process completeness (or the *total number of elements characterizing company product realization practice profiles*) - in relation to which the r-squared value for the scatterplot's linear regression line, through the origin was found to be 0.6615 (total fit) ... the complementary r-squared value for *current* product innovation budget was 0.5730;

(iii) annual product innovation budget and *proportion of total sales accounted for by new/improved products* - in relation to which the r-squared value for the scatterplot's linear regression line, through the origin was found to be 0.6471 (total fit) ... the complementary r-squared value for *current* product innovation budget was 0.5431.

See Figures 21 through 23.

Figure 5.21 The association observed between percentage of product innovation initiatives successfully completed and estimated annual product innovation budget

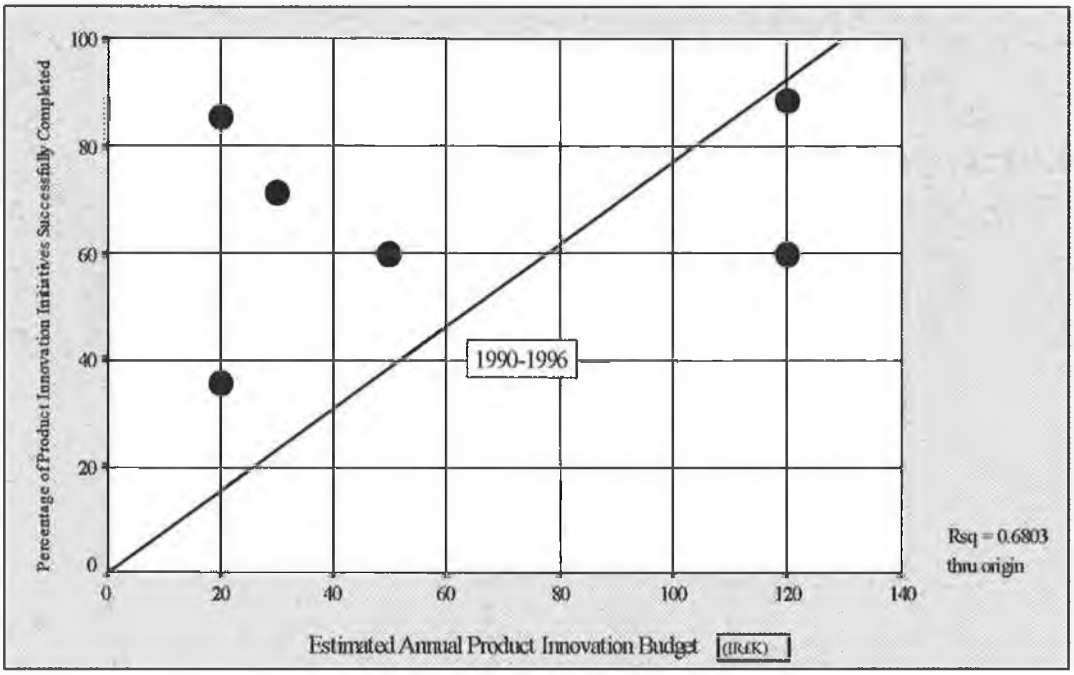


Figure 5.22 The association observed between total number of elements characterizing practice map profiles and estimated average annual product innovation budget

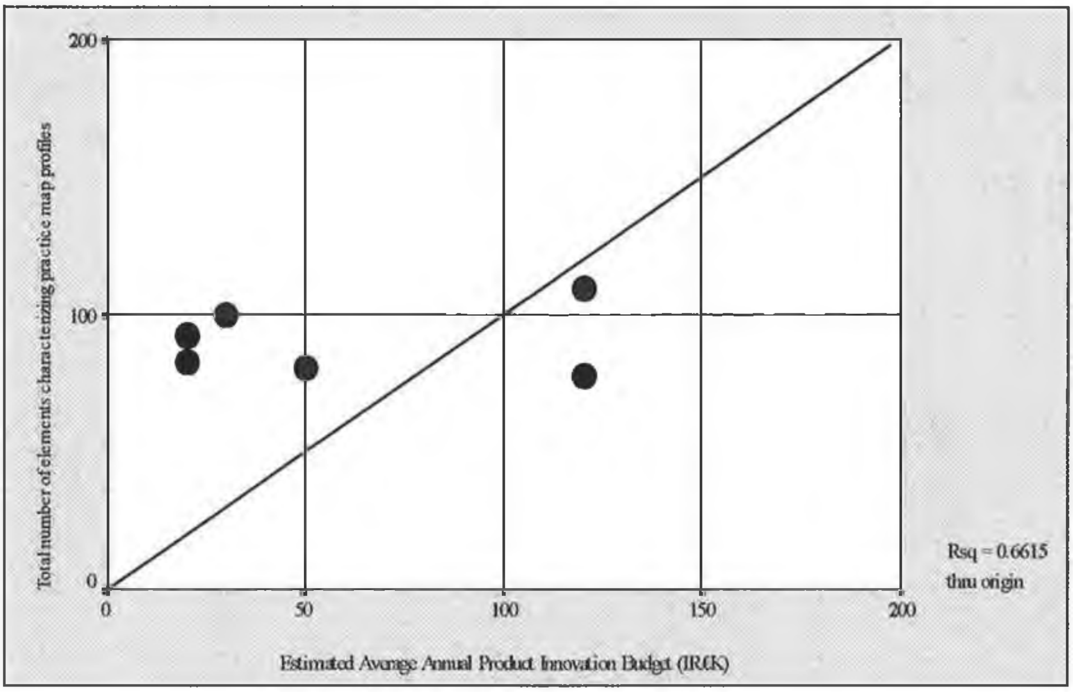
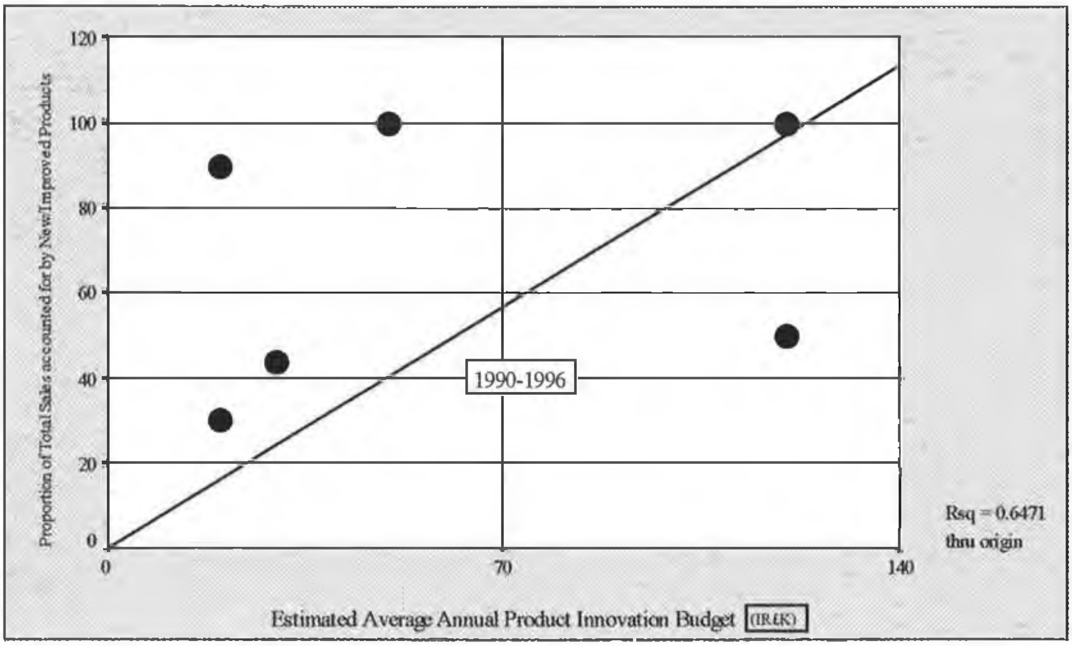
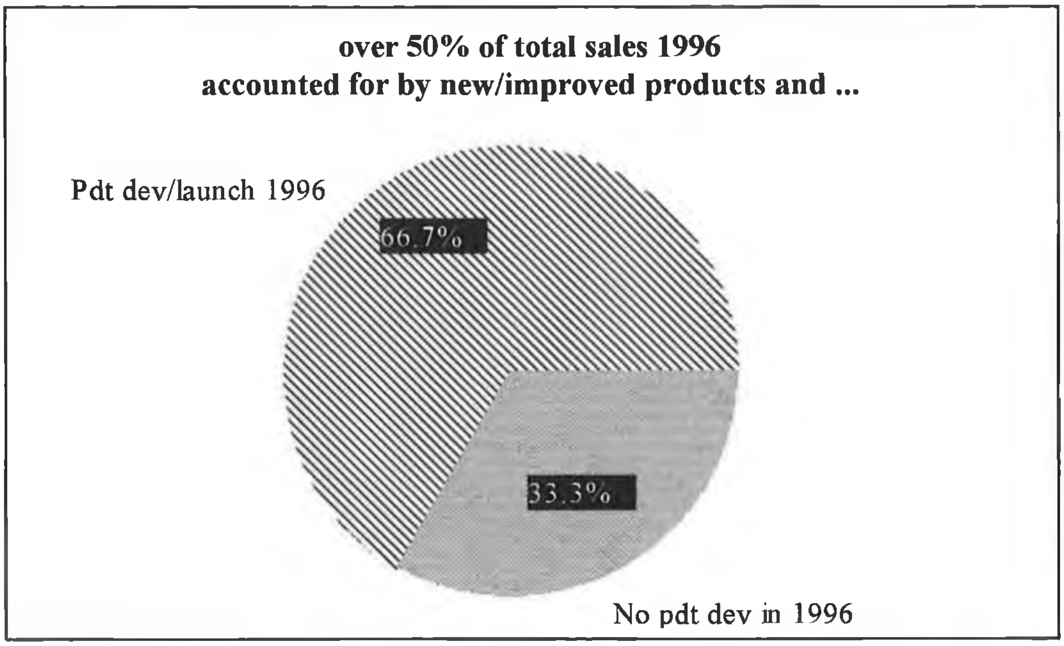


Figure 5.23 The association observed between proportion of total sales accounted for by new/improved products and estimated average annual product innovation budget



Regarding **distribution of sales across various product categories**, an investigation of the possible co-variance of recent *cumulative* sales volumes for *innovated* (as opposed to unchanged) products and current levels of product innovation activity (development/launch of new or improved products) seemed appropriate. The finding: of those companies for which new/improved products accounted for *over fifty per cent* of total sales in 1996, ***66.7%*** *were found to be currently engaged in product innovation activity* - but ... it should be noted that raw data indicated this figure is substantially *de*-flated by one exceptional below-average case ... see Figure 5.24.

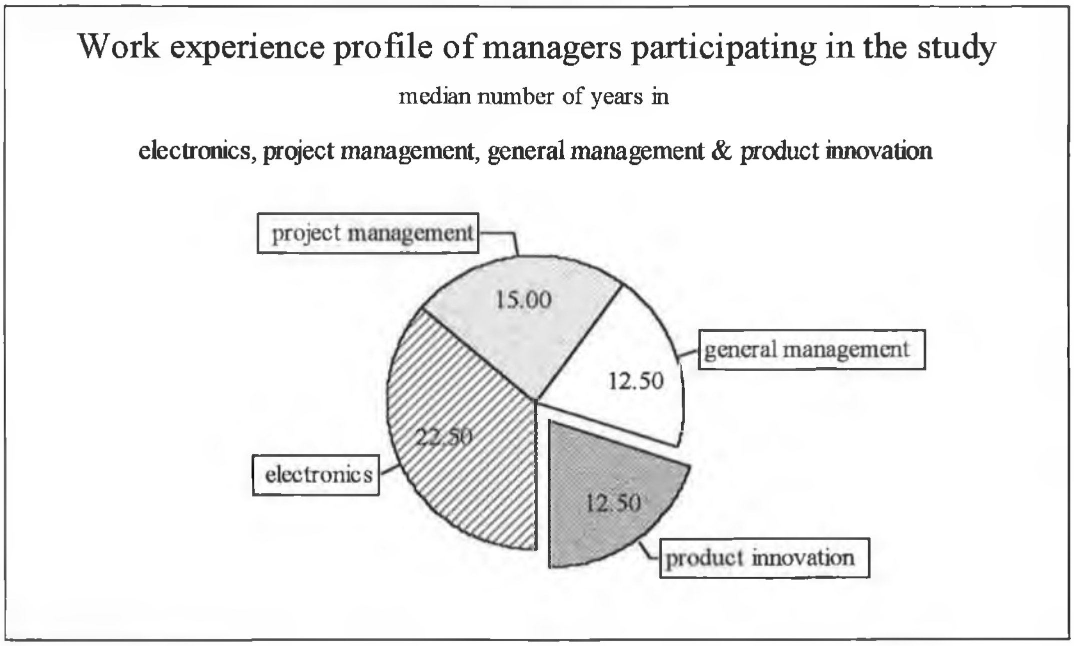
Figure 5.24 Companies for which over 50% of total sales (1996) was accounted for by new/improved products: percentage currently (not) engaged in product innovation activity



5.5.2 Personal variables

A review of the work experience profiles of managers participating in the study, confirmed the sample's credentials as a useful response group for the study (see Figure 5.25).

Figure 5.25 Summarial work experience profile of the overall sample set



It was interesting to find a generally higher representation of greater number of years work experience in the above-average group *across all four areas of experience* ... but it was, perhaps, more interesting to find that for the **product innovation** experience category, managers of below- average performing firms ranged from *eight* to fifteen years whilst managers of above- average firms ranged from *seven* to thirty (minima values, in particular, suggesting that product innovation experience was not a cause for concern as a potentially confounding variable).

A check of **position/role in company** data confirmed the effectiveness of design control of this variable across the overall test set (that is: the questionnaires had reached the individuals in each company, for whom they had been intended, to wit: those individuals identified in the pre-mailing 'phone 'round as having greatest authority/responsibility for and familiarity with product innovation within the company).

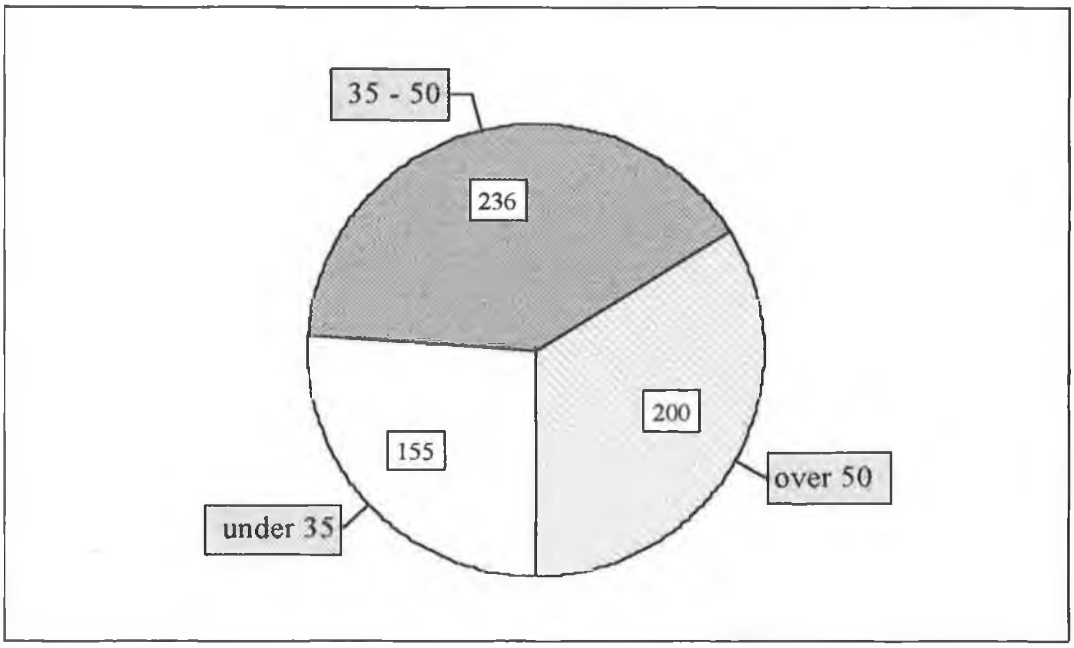
An almost normal distribution was observed in **age** data across the overall test group - with twenty-six per cent in the under-thirty-five group, forty per cent in the thirty-five-to-fifty group and thirty-four per cent in the over-fifty group.

Closer inspection of the data revealed predominant representation by over-fifties in the above-average sub-set and under thirty-fives in the below-average group.

Subsequent examination of likely/possible co-variates yielded most interesting results in relation to managers' cognitive map complexity (the number of elements characterizing cognitive maps). Whilst differences were found to be very marked between the thirty-five-to-fifty and other groups, differences between the remaining groups were not. As the thirty-five-to-fifty group was equally and equivalently, *under*-represented across the study's above- and below- average performing test sets, no further investigation these effects was deemed warranted.

The differences observed are summarized in Figure 5.26.

Figure 5.26 Age profile breakdown of the median number of elements characterizing the cognitive maps of managers participating in the study



A check of **gender** data and **academic/professional education/training** data confirmed incidental equivalence control of these variables across above- and below- average groups (the former in terms of an all-male response set, the latter, in terms of matched data).

An investigation of the possible relationship between cognitive map complexity (total number of elements or linkages) and number of years **work experience in: electronics, project management, general management and product innovation**, yielded the following r-squared values for each respective scatterplot's linear regression line (total fit), through the origin: 0.8764 (see Figure 5.27), 0.8947 (see Figure 5.28), 0.7924 (see Figure 5.29), 0.7821 (see Figure 5.30).

Figure 5.27 The relationship observed between cognitive map complexity (total number of elements or linkages) and number of years work experience in electronics

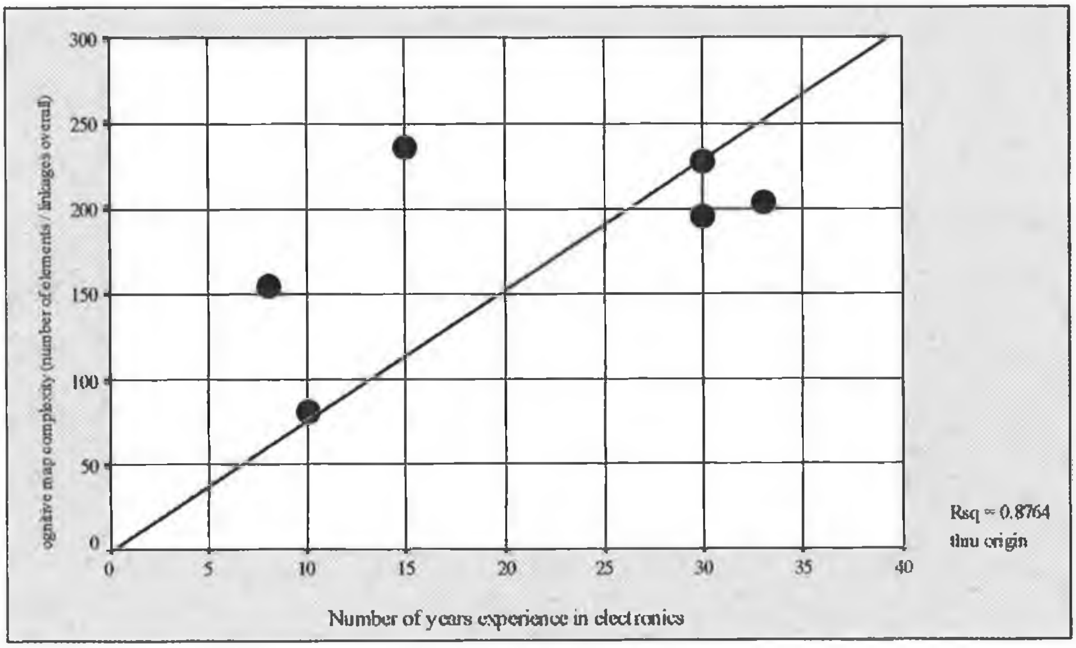


Figure 5.28 The relationship observed between cognitive map complexity (total number of elements or linkages) and number of years work experience in project management

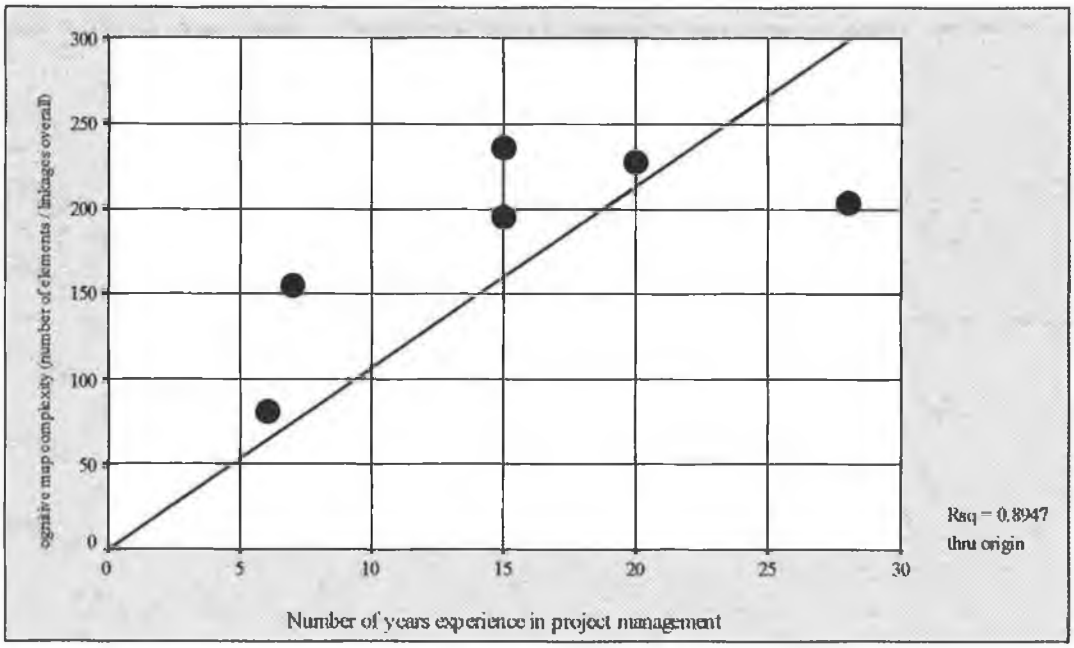


Figure 5.29 The relationship observed between cognitive map complexity (total number of elements or linkages) and number of years work experience in general management

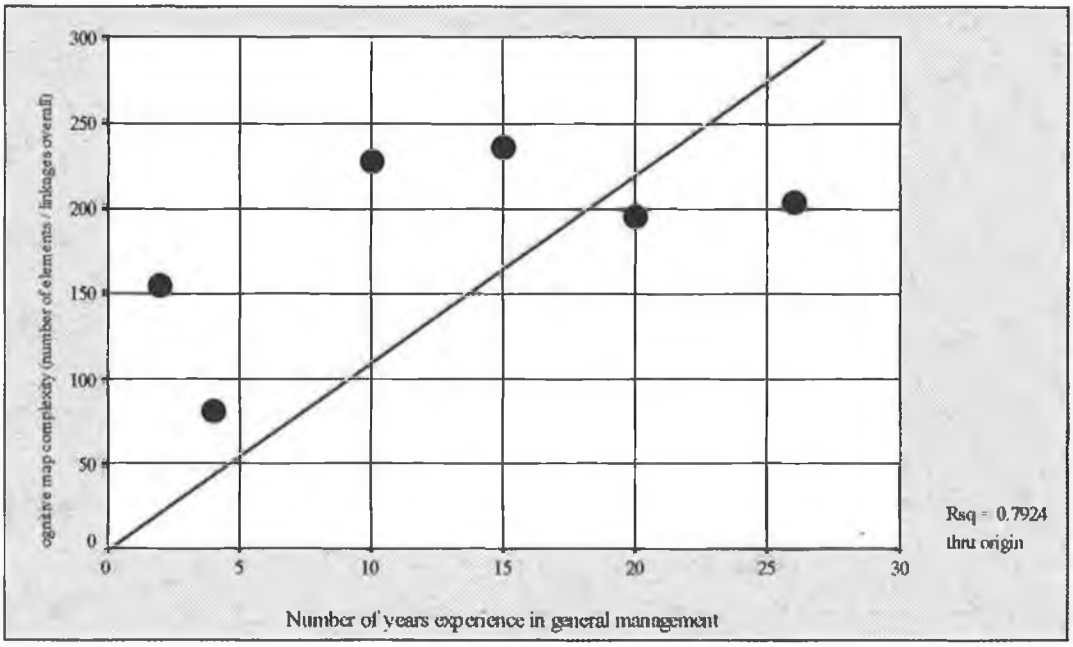
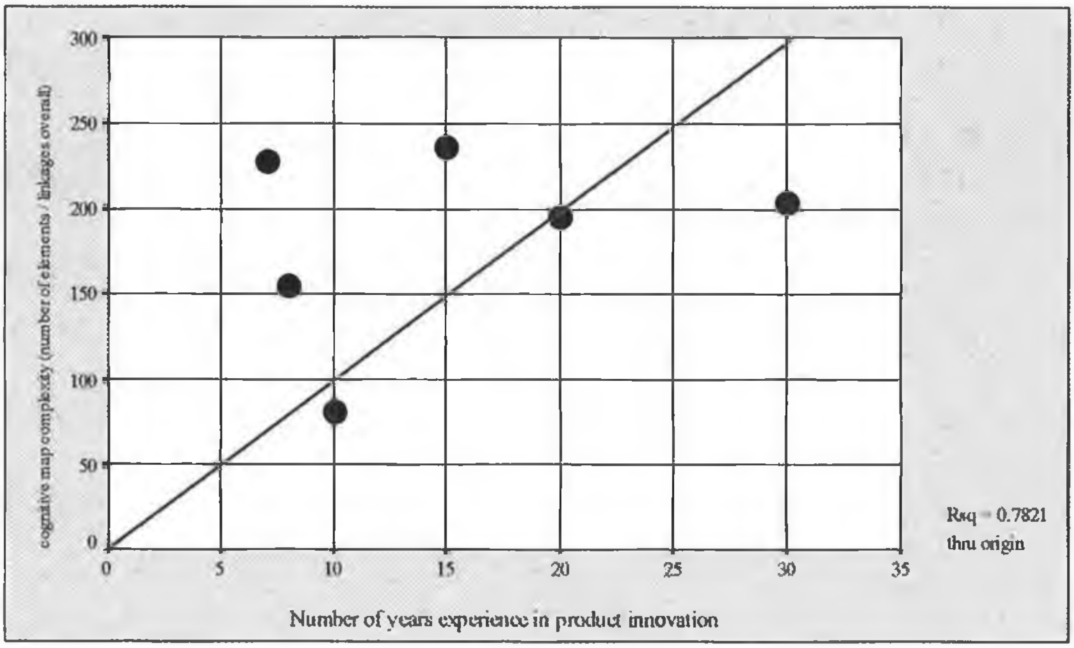


Figure 5.30 The relationship observed between cognitive map complexity (total number of elements or linkages) and number of years work experience in product innovation



5.5.3 Other, more general considerations

Control of the variables: **valid time frame** and **commensurablity of measures** was built into the study's design and test instrument.

A check of **current level of product innovation activity** data confirmed a reasonable level of incidental equivalence control of this variable across above- and below- average groups, that is to say: a level of control which could be deemed adequate in relation to the purposes of the study and appropriate, given the inherent nature of the two groups, that is to say: some degree of currently ongoing product innovation activity was observed in both groups - a slightly higher level of activity being observed in the above average performer group.

Finally, for further confirmation of the validity of sample strata *a propos* meeting stratification objectives, see section 5.3.1's preliminary data analysis for performance data.

5.6 EVALUATING THE FULL COGNITION, PRACTICE AND PERFORMANCE MODEL: SUMMARY OF KEY FINDINGS AND OVERALL CONCLUSIONS

5.6.1 Performance: summary of key findings of preliminary data analysis

Preliminary data analysis for performance data revealed a marked difference in levels of product innovation activity across above-and below-average groups (above-average group > below-average group). Indeed, the above-average group was found to account for 75% of new/improved products launched over the period 1990-1996. Individual case data on numbers of initiatives, completions and pre-mature terminations were found to be enormously variable - both across and within groups. Nevertheless, on average, above-average performers demonstrated statistically, significantly higher rates of initiative and completion than the below average group. An overall realization rate of 65.7% was observed over the full test group. Significantly, figures for citation of unanticipated changes in marketplace as a reason for abandoning/killing product innovation initiatives suggested that relatively poor product realization performance was more likely to be linked to poor proficiency in / inadequate marketing activities rather than the positive filtering power of the product realization process as practised.

5.6.2 Cognition: summary of key findings of preliminary data analysis

Preliminary data analysis for cognitive data showed a marked difference in cognitive map *completeness* across above-and below-average groups (above > below). Even so, summary indicators suggested seventy percent *commonality* in mapping across above- and below- average groups.

All four generic product realization *activities* were included in all maps and most (sixty-four per cent) of the sixty-four *principles* recommended by the international innovation literature featured at least once in all maps.

Four principles were *particularly prevalent*, namely: experience, capabilities, resources and clarity of goals and eleven principles were assigned *particularly high relevance ratings*, namely: clarity of goals, detailed/precise specifications, quality, experience, complexity, formal specifications, specific screening criteria, well-defined procedures - documented if possible, early prototypes, a designated project leader or team, effective communication between marketing and technical personnel.

Statistically significant differences across above- and below- average groups, were observed in the *overall standardness* of thirty of the sixty-four recommended principles and *overall centrality* of twenty-two principles.

Above- and below- average groups differed very statistically significantly in their emphasis/de-emphasis of thirteen principles in relation to concept screening, eight principles in relation to early marketing activities, fifteen principles in relation to prototype/sample design and development and twenty-three principles in relation to product testing ... that's fifty-nine points of significant difference.

Thirty-four activity x principle combinations were isolated as *unique to* and *common to* the cognitive maps of all managers of *above-average* performing firms (interestingly, none were isolated for concept screening).

Correspondence between cognitive map content and the recommendations of the international innovation *literature* was estimated to be greater-than-fifty-per-cent for both above- and below- average groups:- sixty-nine per cent in the case of the above average group, leaving a shortfall of thirty-one per cent and fifty-eight per cent in the case of the below average group, leaving a shortfall of forty-two per cent.

5.6.3 Practice: summary of key findings of preliminary data analysis

Preliminary data analysis for practice data showed just marginal difference in practice map *completeness* across above-and below-average groups (below > above). Summary indicators suggested seventy-three per cent *commonality* in mapping across above- and below- average groups.

All four generic product realization *activities* but not all of the sixty-four *principles* recommended by the international innovation literature were included in all maps. Almost all principles featured at least once for at least one firm, however.

Statistically significant differences across above- and below- average groups, were observed in the *overall standardness* of eleven of the sixty-four principles and *overall centrality* of, again, eleven principles.

Above- and below- average groups differed very statistically significantly in their emphasis/de-emphasis of twelve principles in relation to concept screening - though three principles were emphasised in a very particular way

across all maps, six principles in relation to early marketing activities, twelve principles in relation to prototype/sample design and development - though four principles were emphasised in a very particular way across all maps and twelve principles in relation to product testing - though two principles were emphasised in a very particular way across all maps ... that's sixty-two points of significant difference.

Nine activity x principle combinations were isolated as *unique to* and *common to* the cognitive maps of all managers of above-average performing firms (interestingly, none were isolated in relation to product testing).

Correspondence between practice map content and the recommendations of the international innovation *literature* was estimated to be less-than-fifty-per-cent for both above- and below- average groups:- forty-two per cent in the case of the above average group, leaving a shortfall of fifty-eight per cent and thirty-seven per cent in the case of the below average group, leaving a shortfall of sixty-three per cent.

5.6.4 Cognition and performance: summary of inferential analysis

A statistically significant, positive association was found between cognitive map completeness/complexity and percentage of product innovation projects brought to a successful conclusion.

The number of principles characterizing individual product realization activities was also found to be positively associated with percentage of product innovation projects brought to a successful conclusion and particularly statistically significantly so, in the case of product testing.

The relationship between the standardness (or prevalence) and centrality (or significance rating) of each of the sixty-four principles across the overall product realization script and percentage of product innovation projects brought to a successful conclusion was found to be positive in almost all cases (seventy-eight and sixty-seven per cent, respectively). The standardness of pre-planning, few opposing factions within the firm and an interdisciplinary approach and the centrality of regular performance checking, top management commitment, support and involvement, pre-planning and leadership quality were each found to be particularly strongly associated with the percentage of projects successfully completed.

5.6.5 Cognition and practice: summary of inferential analysis

Conservative correspondence estimates for the overall test group, based on cognitive map relevance ratings of five or more out of ten and practice profile occurrences of at least one, indicated an overall correspondence of almost seventy per cent on average - though the statistical significance of points of correspondence not included, suggest that the real figure is probably higher.

5.6.6 Practice and performance: summary of inferential analysis

The relationship between map size or complexity and percentage of projects brought to a successful conclusion was found to be positive and reasonably statistically significant.

The number of principles characterizing individual product realization activities was also found to be positively associated with percentage of product innovation projects brought to a successful conclusion in the case of prototype/sample design and development and product testing - particularly statistically significantly so, in the case of prototype/sample design and development. The relationship between the standardness (or prevalence) and centrality (or significance rating) of each of the sixty-four principles across the overall product realization script and percentage of product innovation projects brought to a successful conclusion was found to be largely positive. The standardness of: the marketplace, internal sources of ideas, a designated project leader or team, leadership quality and running activities in parallel and the centrality of: risk taking, accepting financial risk, complexity, pre-planning and well defined procedures - documented if possible were each found to be particularly strongly, positively associated with the percentage of projects successfully completed ... and, rather interestingly, seventeen of the sixty-four principles appeared to be particularly useful in offsetting the main problems associated with the move to abandon/kill product innovation initiatives.

5.6.7 Contingencies: summary of findings of controls/contingencies checks

In brief, a positive and statistically significant association was observed between:

- total number of product innovation initiatives **and** product life cycle, size of firm, percentage sales outside Ireland and extent of external linkages
- percentage of projects successfully completed **and** extent of external linkages and annual product innovation budget
- total number of elements characterizing company product realization practice profiles and annual product innovation budget
- proportion of total sales accounted for by new/improved products and annual product innovation budget

- current engagement in product innovation activity and new/improved products accounting for over fifty per cent of recent total sales figures
- cognitive map complexity **and** number of years work experience in electronics, project management, general management and product innovation.

5.6.8 Cognition, practice and performance: summary of inferential analysis

Overall, the findings of Study Two's inferential analyses reveal a reasonable level of association between managerial cognition and product innovation practice and performance **as modelled and operationalized for the study**.

The main part of the analysis, based on the 256-point matrix model of the product realization process and product innovation initiative realization rates, revealed at least a 56.6% level of association between *cognition and performance* overall, a 43.4% level association between *cognition and practice* overall, a 46.9% level of association between *practice and performance* overall and a 33.6% level of association between *cognition, practice and performance* overall - as shown in Table 5.33 together with details of basis of assessment.

For concept screening, sixteen per cent of the sixty-four test points showed a statistically significant link between cognition and performance ***and*** cognition and practice ***and*** practice and performance whilst nineteen per cent of the sixty-four test points showed a link between cognition and performance ***and*** cognition and practice *or* practice and performance. The equivalent figures for early marketing activities were twenty-five per cent and seventy-eight per cent, respectively, for prototype/sample design and development: forty-two per cent and sixty-one per cent respectively and for product testing: fifty-two per cent and sixty-nine per cent, respectively. See Table 5.34 for details and information on basis of assessment.

Table 5.33 Nature and number of statistically significant cognition / practice / performance linkages found in the 256-point activities x principles map matrix

Nature and number of statistically significant cognition / practice / performance activity x principle linkages (positive associations) found in the 256 point matrix based on: • Phi/Cramer's V test statistics significant at p<=.3 for cognition (centrality recoded dichotomously, as follows: 0-4:0 and 5-10:1) by percentage of product innovation projects successfully completed (recoded dichotomously as higher and lower percentages); • Phi/Cramer's V test statistics significant at p<=.4 for practice 'check-offs' by percentage of product innovation projects successfully completed (again, recoded dichotomously as higher and lower percentages); • cognition by practice matches of 50%, 83% or 100%, following Tables 5.27 through 5.30 of the present text	
COGNITION AND PERFORMANCE	**145**
cognition and practice	**111**
practice and performance	**120**
COGNITION AND PRACTICE AND PERFORMANCE	**86**
cognition and performance, cognition and practice but not practice and performance	**111**
cognition and performance, practice and performance but not cognition and practice	**120**
the combination: 'cognition and practice and practice and performance but not cognition and performance' was not checked as the link between cognition and performance is fundamental to the model	*null set*

Table 5.34 Statistically significant cognition, practice and performance linkages found in the test of the full model

C: cognition R: routine practice P: performance *CxP-CxR-RxP: statistically significant evidence of full 3-way link (positive association)* *Any combination of any two of CxP, CxR, RxP: statistically significant evidence of partial (2-way) link (positive association) as indicated*	concept screening	early marketing activities	product design and development	product testing
new technologies		CxP, CxR		CxP-CxR-RxP
the marketplace			CxP-CxR-RxP	CxP-CxR-RxP
customer orientation	CxP-CxR-RxP	CxP-CxR-RxP	CxP-CxR-RxP	
integration of the needs of the market with technological opportunities available to fulfil those needs			CxP-CxR-RxP	CxP-CxR-RxP
internal sources of ideas		CxP-CxR-RxP	CxP-CxR-RxP	
external sources of ideas	CxP-CxR-RxP	CxP-CxR-RxP		CxP-CxR-RxP
experience		CxP-CxR-RxP		
capabilities		CxP, CxR		
resources	CxP-CxR-RxP	CxP, RxP		CxP-CxR-RxP
risk taking		CxP, RxP	CxP-CxR-RxP	CxP-CxR-RxP
accepting financial risk				CxP-CxR-RxP
minimizing financial risk		CxP, CxR	CxP-CxR-RxP	CxP-CxR-RxP
complexity (e.g. of activity or design)	CxP-CxR-RxP			CxP, CxR
clarity of goals	CxP, CxR			
formalization		CxP, RxP	CxP, CxR	
control		CxP, RxP	CxP-CxR-RxP	CxP, CxR
co-ordination		CxP, RxP	CxP, RxP	CxP-CxR-RxP
pre-planning		CxP, RxP	CxP-CxR-RxP	CxP-CxR-RxP
reducing uncertainties				CxP-CxR-RxP
formal specifications		CxP, CxR	CxP-CxR-RxP	
detailed/precise specifications		CxP, RxP	CxP, CxR	
specific screening criteria		CxP, RxP	CxP-CxR-RxP	CxP-CxR-RxP
well defined procedures - documented if possible		CxP, RxP	CxP, CxR	CxP, CxR
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)		CxP, RxP	CxP-CxR-RxP	
use of metrics			CxP-CxR-RxP	
output based management		CxP, RxP		
time based management		CxP, RxP		
incentives	CxP-CxR-RxP		CxP-CxR-RxP	CxP-CxR-RxP
encouragement of ideas	CxP-CxR-RxP	CxP-CxR-RxP		CxP-CxR-RxP
tolerance of mistakes	CxP-CxR-RxP	CxP-CxR-RxP		CxP-CxR-RxP
time constraints		CxP, RxP	CxP, CxR	CxP, CxR
budgetary constraints		CxP-CxR-RxP	CxP, CxR	CxP, RxP
flexible resourcing		CxP-CxR-RxP		CxP, CxR
early prototypes		CxP, CxR	CxP-CxR-RxP	CxP, CxR
running activities in parallel		CxP, RxP	CxP-CxR-RxP	CxP-CxR-RxP
proficiency		CxP, RxP	CxP, RxP	CxP, CxR
efficiency		CxP, RxP	CxP, RxP	CxP-CxR-RxP
cost-efficiency		CxP-CxR-RxP	CxP-CxR-RxP	CxP-CxR-RxP
regular performance checking		CxP-CxR-RxP		CxP-CxR-RxP
detail		CxP-CxR-RxP		CxP-CxR-RxP
quality				CxP-CxR-RxP
clarity of roles		CxP-CxR-RxP	CxP, RxP	CxP-CxR-RxP
a designated project leader or team		CxP, RxP	CxP-CxR-RxP	CxP-CxR-RxP
specific responsibilities and authorities clearly assigned to specific individuals		CxP, RxP		CxP, CxR
rigid team structure		CxP, RxP		
flexible team structure		CxP, RxP	CxP, CxR	CxP-CxR-RxP
concentration of power				CxP-CxR-RxP
decentralization	CxP-CxR-RxP			
top management commitment, support and involvement	CxP, CxR	CxP-CxR-RxP	CxP-CxR-RxP	CxP-CxR-RxP
leadership quality		CxP, RxP	CxP-CxR-RxP	CxP-CxR-RxP
shared values		CxP, RxP	CxP-CxR-RxP	CxP-CxR-RxP
teamwork		CxP, RxP	CxP-CxR-RxP	CxP-CxR-RxP
co-operation		CxP, RxP		CxP, CxR
few opposing factions within the firm		CxP, CxR	CxP-CxR-RxP	CxP-CxR-RxP
interdisciplinary approach		CxP-CxR-RxP	CxP-CxR-RxP	CxP-CxR-RxP
specialized skills		CxP, CxR	CxP, CxR	
cross-functional teams		CxP, RxP	CxP, RxP	CxP-CxR-RxP
job rotation across projects	CxP-CxR-RxP	CxP-CxR-RxP	CxP-CxR-RxP	CxP-CxR-RxP
consultative style communication		CxP-CxR-RxP	CxP-CxR-RxP	
command style communication				
effective communication between marketing and technical personnel				
inter-organizational networking	CxP-CxR-RxP	CxP, RxP	CxP-CxR-RxP	
external consultations (direct outsider involvement)		CxP, RxP	CxP-CxR-RxP	
participative decision-making				CxP, RxP

Statistically significant cognition / practice / performance activity x principle linkages identified are based on:

- Phi/Cramer's V test statistics significant at p<=.3 for cognition (centrality recoded dichotomously, as follows: 0-4:0 and 5-10:1) by percentage of product innovation projects successfully completed (recoded dichotomously as higher and lower percentages);
- Phi/Cramer's V test statistics significant at p<=.4 for practice 'check-offs' by percentage of product innovation projects successfully completed (again, recoded dichotomously as higher and lower percentages);
- cognition by practice matches of 50%, 83% or 100%, following Tables 5.27 through 5.30 of the present text

5.6.9 Final overall conclusions

The main conclusions of Study Two are:

1. The top-down, knowledge-how, script-based approach to examining the role of managerial cognition in product innovation practice and performance, adopted in Study Two, was useful and 'worked well' (subjects were able to respond readily to questions regarding <u>routine</u> practice and a useful dataset was generated).

2. The *a priori* 'ly defined investigative agenda also 'worked fine' (it was found to be valid, reliable and practicable).

3. The 'extended script concept' used to frame the study proved useful (it framed the investigative agenda in such a way as to facilitate its meeting the scope, purpose and required outputs of the study), productive (generated useful data to meet the scope, purpose and required outputs of the study) and readily amenable to analysis.

4. The method of map analysis chosen was found to be appropriate to research purposes, adequate in meeting the requirements of the study and easily completed.

5. The chosen test case and selected sample set were proven satisfactory (showing sufficient evidence of the phenomenon under investigation, sufficient variability of levels of the phenomenon and sufficiently discernible performance clusters in relation to the phenomenon to facilitate the analysis).

6. In general, the model tested generated a considerable number of statistically significant results, (i) supporting the original idea for the study, (ii) confirming definitional reliability and validity of the proposed model and test-of-model and (iii) suggesting (by virtue of the positive results attained) the possibility of further support for the original idea *a propos* variants on its operationalization and testing.

To summarize, the findings of Study Two support the notion (its underlying general hypothesis) that there is, indeed, a substantial link (or, as stated in the general hypothesis: a reasonable level of co-variance) in evidence amongst:
(i) the beliefs and understanding of those manager(s) having greatest authority over, responsibility for (and familiarity with) product innovation within the organization, regarding the manner in which the process of transforming product innovation ideas into marketable products is best managed, (ii) the product realization practices of the firm and (iii) the final product innovation performance of the firm ... as operationalized and tested. It is, however,

important to bear in mind that the level of support is both variable across individual product realization activities and generally greater in relation to the link between managerial cognition and performance (the basic thesis underlying the research) than in relation to managerial cognition, practice and performance (the particular modelled form of the thesis tested). The findings of Study Two and their implications for both the cognitive model of product innovation proposed and the issue of the product innovation performance of Irish industry, are discussed in Chapter Six of the present text.

CHAPTER SIX

Conclusions and Beyond ...

6.1 SUMMARY OF BACKGROUND, IMPETUS, NATURE, FINDINGS AND VERDICT ON THE FINDINGS OF RESEARCH PRESENTED

6.1.1 Background to and impetus for the research, the case for addressing the product innovation performance of Irish industry at an organizational level, for using routine product innovation practice as a focal point for the study and for adopting an overall managerial cognition perspective on the problem, effectively re-casting the work from its initial form: 'an Irish study' as such ... to that of more general research undertaken in an Irish context

The marketing capacity and performance of indigenous Irish industry is weak[1]. This is particularly true with regard to its product innovation performance record[2]. Little is yet known about the reason(s) for the relatively poor product innovation performance of Irish companies. Indeed, we are just now beginning to systematically explore the issue. The findings of a small preliminary study which was carried out in the context of the present research (prompted by the discovery and re-interpretation of an under-exploited finding of an isolated and under-publicized study conducted a decade ago by O'Sullivan and Tomlin

[1] (see Fennell *et al*, 1991 and Clarke, 1995, for example)
[2] (see chapter one of the present text)

(1985) which indicated that over the five-year period 1980-1985, Irish companies had begun to develop a considerable number of innovated and innovative products but had brought just a fraction of these through to final successful launch onto the marketplace) suggested the significance of the manner in which the product innovation process is managed - but, perhaps more importantly, that much of the ineffective management of the product innovation process appears to stem from that which might be termed: 'faulty thinking' about product innovation and an inadequate understanding of the product realization process.

A case was thus made for addressing the product innovation performance of indigenous Irish industry at an organizational level, for using routine organizational product innovation practice as a focal point for the study and for adopting an overall managerial cognition perspective on the problem, the suggested way forward being the further exploration of the nature and effects of managers' beliefs and understanding of how the process of transforming product innovation ideas into marketable products might best be achieved. The pursuit of this latter line of inquiry would, of course, effectively re-cast the work from its initial form: 'an Irish study' as such ... to that of more general research undertaken in an Irish context.

6.1.2 Nature of the research: proposal and test of a script-based model of managerial cognition, the routine product innovation practice of the firm and its product innovation performance, using the indigenous Irish electronics industry as test case

A model of managerial cognition, routine product realization practice and product innovation performance (with special emphasis on realization rates) was proposed and tested. The cognitive component of the model was based on a 'top-down, knowledge-how', modified script concept with four core product realization activities and sixty-four principles of effective product innovation practice recommended by the international innovation literature as an *a priori*'ly defined investigative agenda, a modified Bougon-grid based data elicitation framework and an analytical framework based on the work of Galambos (in Galambos *et al*, 1986) and Langfield-Smith and Wirth (1992). The model was tested using a questionnaire-based study and Irish-owned electronics firms as test case.

6.1.3 Findings of the research and conclusions drawn

In general, the model tested generated a considerable number of statistically significant results, (i) supporting the original idea for the main study, that is to say: supporting the notion (and the study's underlying general hypothesis) that there is a substantial link (or, as stated in the general hypothesis: a reasonable level of co-variance in evidence) amongst: (a) the beliefs and understanding of those manager(s) having greatest authority over, responsibility for (and familiarity with) product innovation within the organization, regarding the manner in which the process of transforming product innovation ideas into marketable products is best managed, (b) the routine product realization practices of the firm and (c) the final product innovation performance of the firm (... all as operationalized and tested, of course), (ii) confirming definitional reliability and validity of the proposed model and test-of-model, (iii) offering very useful, detailed insight into the specific nature of the link between managerial cognition and organizational practice and performance in an accessible form which can readily facilitate the practical appraisal of companies' product innovation capacities, processes and performance, the pinpointing of specific problem areas and the design and adoption of appropriately targeted corrective measures and (iv) suggesting (by virtue of the positive results attained) the possibility of further support for the original idea *a propos* variants on its operationalization and testing.

6.1.4 The verdict on the proposed cognitive perspective on the product innovation performance of Irish industry

The verdict on the proposed cognitive perspective on the product innovation performance of Irish industry based on the present research is as follows ...

A reasonable case for a cognitive perspective on the product innovation performance of Irish industry was made, based on: (i) theoretical argument, (ii) secondary reference data and (iii) the primary empirical data of Study One and Study Two of the present work.

A cognitive perspective on the product innovation performance of Irish companies may thus be taken to be valid.

Overall, the research suggests that managerial cognition may also be considered to be a ***significant*** factor in product innovation practice and performance and that the product innovation performance of Irish-owned firms, could be improved to at least some extent by adjusting managers' beliefs and understanding of the product realization process and how it may best be managed:- at least **one-hundred-and-forty-five** definite points for review were identified for the main study's test case: Irish-owned electronics firms.

6.1.5 A number of caveats

It was interesting to find variable levels of support within the particular cognition x practice x performance model proposed, across the various product realization activities (early marketing activities > product testing > prototype/sample design and development > concept screening (in Tables: 5.33 & 5.34 for example)). This may indicate either the varying significance of the role of managerial cognition in these tasks *or* the potential for greater involvement not currently exploited (which: to be determined by future research).

It was also interesting to find that within individual product realization activities, there was a greater level of support for the basic thesis (that there is a link between managerial cognition and the organization's product innovation performance) than for the form of the thesis tested (the model of managerial cognition, routine organizational ***practice*** and final product innovation performance proposed in Chapter Three and operationally elaborated in Chapter Four). This suggested the potential significance of the direct influence of managerial cognition on organizational performance ((?) and the more plausible alternative possibility) and/or the potential significance of additional factors not stipulated in the model upon which Study Two was based ... again, a matter for further research.

(In considering all of the foregoing, it should be noted that:

1. *the basis of assessment used in generating the summary overall findings presented in tables 5.33 and 5.34 may be subjectively viewed as being more or less appropriate or overly conservative or overly liberal;*
2. *the associative values for outstanding matrix cells, whilst less statistically significant are certainly not all zeros and should not, therefore, be interpreted as supporting the argument for retaining the null hypothesis;*
3. *if matrix cells found to be consistently empty across all cognitive and practice maps represent 'real' null cells for product realization in Irish-owned electronics firms, then, of course, the estimated managerial cognition x practice x performance linkage effect is, indeed, conservative (clearly another issue for further research).)*

6.2 CRITICISMS AND SHORTCOMINGS, RESERVATIONS AND QUALIFICATIONS[3]

In research - as in all of life - it must be borne in mind that: 'The fact that a general impression is more or less universal can not in itself be a guarantee of its validity' (Mahalanobis, in Edwards Deming 1960, p.61) ... and, indeed ... 'One unerring mark of the love of truth is not entertaining any proposition with greater assurance than the proofs it is built upon will warrant' (John Locke, 1690, in Sagan, 1996, pp. 64-65). That which Sagan (1996) refers to as 'The Fine Art of Baloney Detection' (Sagan, 1996, p.189), in his view: 'boils down to ... whether the conclusion *follows* from the premises or starting point and whether that premise is true' (Sagan, 1996, p. 197). There are, of course, other views (complementary/alternative):- that of Collingwood (1959), for example: 'Whether a given proposition is true or false, significant or meaningless, depends upon what questions it was meant to answer' (Collingwood, in Peters, 1959, p.1).

A review of the literature reveals that the following parameters are regularly used to evaluate work ...

[3] *cf.* observations made throughout earlier sections of the present text

1. **intended reference and relevancy** (audience targeting and approach - whether authoritarian or collaborative, timeliness, reference to and (in-)compatibility with other perspectives);
2. **adequacy in satisfying truth criteria:** general design, explicitness of associative, causal and extra-scientific assumptions, types of evidence sought, research methods and sampling techniques employed, association with action and statistics (analytical techniques employed);
3. **cogency or persuasiveness** including actual and potential empirical support;
4. **form and aesthetics:** structure, content, language, degree of formalization, parsimony, degree of elaboration, extent/nature of connectivity with other theories, heuristic value (capability of indicating alternative/additional research), internal consistency (that is: having no logical contradictions), originality and novelty or generative capacity (ability to challenge commonly accepted assumptions and /or to suggest new/alternative ways of looking at phenomena), falsifiability, presentation, certainty, riskiness, political controversiality and final overall interpretability.

Edwards Deming (1960) classifies the various uncertainties and deficiencies of research as follows: (a) built-in deficiencies, missing the point and measuring properties of the material not fully suited to the problem.; (b) blemishes and blunders made in carrying out the field-work, testing, interviewing, coding, computations and other work.

In general, some form of 'reality testing' (see Zaltman *et al*, 1982) is used to determine the degree of 'acceptability' of proposed models of / solutions to a problem. The various forms of reality testing generally employed, may be classified after Zaltman *et al* (*ibid.*) as: tradition, authoritative, consensual, so-called 'magical', rational, empirical and pragmatic ...

'Reality testing' the present work

Tradition tests examine the goodness-of-fit with that which is considered to be 'already known'. Certainly, the present work 'fits both ways' with extant grounded work on product development practice and psychological research on cognition and behaviour (as shown throughout the present text).

Authoritative tests examine the credentials of the proposer ('all knowledge originates in an observer and retains the stamp of the observer's peculiar relation to the experiential base' Holzner and Marx, 1979, p. 93). Well, the proposer's educational background is predominantly **applied psychology**[4]

[4] She holds a 2.1 B.A. (Hons.) in 'double honours' applied psychology - 1987 - and a 2.1 M.A. (Hons.) in applied psychology (specialization: information technology) - 1989 - both from the National University of Ireland, University College, Cork.

(with particular emphasis on experimental psychology and ergonomics - particularly, human-computer interaction) but includes computer studies (including knowledge-based systems), applied statistics, economics and languages ... it features **and a thorough grounding in a broad range of research theories and skills** (philosophy of science, the scientific method, measurement and metrics, problem definition (clarification), research and experimental design, data acquisition, representation, checking and manipulation techniques, statistical analysis (techniques and tooling), computer skills and result write-up and presentation skills (the presentation of research findings in various forms: report, lecture, journal article, book, etc.) both as an independent researcher and part of a research team); her industrial and academic experience is exceedingly broad-based but does include a substantial amount of **cognitive-based work** (for example: B.A. specialization project: the design and development of a knowledge-based system, main B.A. dissertation on the design of user-friendly information retrieval systems (Rooney, 1987) and M.A. thesis on statistical software interface design for the amateur data analyst (Rooney, 1989) - all three projects incorporating work on computer users' mental models of both system and task, task analysis and gulfs of execution between user, system and task, **industrial process evaluation and development** (most notably in relation to a telecommunications multi-national company when re-assigned from work as software designer to ISO9000 certification project co-ordinator - see Rooney, 1991), **product development** (most notably in relation to software design in said company and also in relation to a family craft business and educational course-ware (paper- and software- based - see, for example: Kirakowski and Rooney (1988) and Rooney, 1992)), **a broad range of research work**[5] (problem definition/clarification, research and experimental design, measurement and metrics, data acquisition, representation, checking and manipulation, computer-assisted statistical analysis and result write-up, research presentation (the presentation of research findings in various forms: report, lecture, journal article, book, etc.) both as an independent researcher and part of a research team) in the context of a variety of research settings, teams and projects and a diversity of data sets and required analyses (while working with the Human Factors / Human-Computer Interaction research groups, U.C.C. and Loughborough, U.K. (ESPRIT and other projects), at the Statistics Laboratory, U.C.C. (wide range of small-, medium- and large-scale national and international medical, zoological, agricultural, epidemiological, sport and other research projects ... for example: assessing the role of badgers in the spread of bovine tuberculosis in Ireland for ERAD - see Crowley and Rooney (1992)) and the CEC's DG XII / EUREC Agency's senior committees and associated research groups including those based at the National Micro-Electronics Research Centre, U.C.C. and ISPRA / ISES / Conphoebus, Italy (renewable

[5] (the present not excepted)

energies research, in particular: the technical, economic, environmental impact / public acceptability and commercialization review of wind, biomass, photovoltaics and active and passive solar heating, cooling and daylighting - see Wrixon, Rooney and Palz (1993))).

Consensual tests rely on group evaluation. The case for a managerial cognition perspective on product innovation management made in the context of the present research was 'well received' when presented at the twenty-sixth European Marketing Academy Conference held at the University of Warwick in 1997 (see Rooney, 1997).

So-called 'magical' tests rely on novelty. The present form of the present work: **managerial cognition** and **product realization** is unique - though links with other areas of work are indicated throughout the present text.

Rational tests assess formal structure and logical consistency. Every effort has been made throughout the present text to explicate the origin, evolution and form of the cognitive perspective on product innovation performance presented. Further exploration follows the present sub-section.

Empirical tests rely on systematic experience or observation ... see chapters four and five of the present text.

Pragmatic tests evaluate practical implications or consequences. Again, pragmatic considerations have been suggested throughout the text thusfar and will be further considered in the present chapter.

Fiske and Taylor (1984) identify four key themes in the literature on cognition and behaviour which offer a useful framework within which the *propositions advanced* and tested in the context of the present research concerning the relationship between cognitive scripts and product development practice and performance may be further examined ...

Propositions advanced and tested

Firstly, attention is drawn to the tendency for consistency between cognition and behaviour to be highest when behaviours that are prototypically related to a particular cognition are examined and lowest when behaviours that are less centrally related to the cognitions are examined. The implications for comparing like-framed, albeit 'complete', unqualified cognitive maps with summarial routine practice profiles, are obvious.

Secondly, attention is drawn to the tendency for the explanatory and predictive power of cognitive maps to be greatest in the case where cognitions emerge from personal direct experience rather than mild or passing interest. The credentials of the sample group in this regard are excellent (as shown in chapter five of the present text).

Thirdly, though cognitive scripts have been defined as schematic knowledge structures that specify behaviour or event sequences appropriate for particular activities (see Gioia and Poole, 1984, in Finney and Mitroff, in Sims, *ibid.*), strong situational contingencies - particularly those not previously encountered or accommodated within extant scripts - may draw attention to / away from (particular aspects of) a cognitive script. This may alter perceived script salience with obvious consequences for the (strength of) cognition-behaviour linkages finally observed. The most salient contingencies to be considered in the present context would be: (a) type/scale of product innovation undertaking and (b) time and budgetary considerations. Certainly, old product development predominates across all firms participating in the study and, therefore, maps would probably be more reflective of this than new product development. Regarding time and budgetary constraints, Figure 5.12 would seem to suggest the possibility that this may also be an influence on perceived script element salience, if not overall script enactment *in situ.*

Fourthly, all individual/group difference variables may be interpreted as moderators of the cognition-behaviour relationship. Several such variables were identified *a priori*'ly and either controlled for or measured in the course of the study. They are reported on extensively throughout chapter five of the present text.

'If you can see things that are out of whack, you can also see how things can be in whack' (Dr. Zeuss, in Ansoff, 1987, p 256) ... and ... 'Since all models are wrong the scientist must be alert to what is importantly wrong. It is inappropriate to be concerned about mice when there are tigers abroad.' (George E.P. Box, 1976, in Zaltman et al, 1982 p.163).

The following sections summarize the researcher's *post hoc* reflections on the overall thesis, the model of product innovation proposed and the research instrument and sample sets used in that testing.

On the basis for the overall approach: revisiting the notion of product innovation as 'manageable' process

In chapter one of the present text, it was noted that recent research on competitive strategy emphasises capacities, capabilities, competencies and process, that is: not so much what a company does, but rather how readily, how and how well it does it (see, for example, Prahalad and Hamel, 1990, Stalk 1992, Hammer and Champy, 1993 and Leavy, 1995) - and that innovation generally and, in particular, product development *and its effective 'management'* has already been identified as a key 'core competence' competitive strategy for the nineties by, for example, Prahalad and Hamel, *ibid.*, Wheelright and Clark, 1992 and Brookes, 1992. It was further noted that this does not, necessarily, mean a return to the rational planning and control era, referring, rather, to building up the creative organization (after Gundry, Kickul and Prather, 1994) through the crafting of process[6] (that is: to the awareness of, awareness of the significance of, preparation of and state of preparedness of the elements of process, the sensitivity and complementarity (appropriateness) of process elements' activation and, of course, cognisance of the ultimate effectiveness and performance of the activated process and the relationship between this and the foregoing).

Of course, the very suggestion of the notion of there being a 'best way of doing product development' - albeit a set of recommendations regarding process elements and not a full set piece 'best possible program' - may well, for some, at least, hold at least some of the more negative connotations of historical attempts at 'managing the (product innovation, or, indeed, any)

[6] (again, with apologies to Mintzberg)

process' and 'Tayloresque' aspirations after 'Control in an age of chaos' (Taylor, 1994, p 64) and hence may not hold much appeal (the remaining band of latter day 'postmodernistic nouveau dadaists' being a case in point:- latterday Dada may be essentially defined, after Rand (1992) as a generalized and indiscriminate revolt against anything that seems 'old hat').

The notion may also, of course, be instantly dismissed by those who simply believe that:

> If we make of our lives the heavy burden of having to know where we are going, pre-programming every single step, then ... we have condemned ourselves to a man-made prison (Panikkar, in Wijers, 1996, p.213).[7]

Nevertheless, the search for 'a best way of doing product development' would seem set to continue[8] [9] - albeit despite the fact that: 'Despite the ongoing search for the so-called silver bullet ... there [does not seem to be a] roadmap showing the 'right' way to perform ... product

[7] "Other maps are such shapes, with their islands and capes! But we have our brave Captain to thank" (so the crew would protest) "that he's bought us the best - a perfect and absolute blank!" (Carroll, 1876, in Markoczy and Goldberg, 1995)
[8] (see almost any of the current product innovation literature)
[9] Evidence suggests that product innovations are rarely developed without explicit planning and organizational arrangement (Benson and Chasin, 1976, Johne, 1986) - so this is really, only to be expected.

development' (Calantone, Vickery and Droge, 1995, p.214). Interestingly, though, the present research's consolidation and development of work-to-date does show, clearly, that it may well be not unreasonable to suppose that there are quite a few 'stars to steer ... by' (apologies to John Masefield: *Sea Fever*). The intention underlying the manner in which the firmament is framed for the purposes of the present study (despite the careful expositions of section 1.6, 2.1, 2.2 and 3.7, *et cetera*, of the present text) could well be mis-interpreted, if the foregoing were not to be borne in mind, however.

On adopting a cognitive perspective - indeed: on adopting <u>any particular</u> perspective

On adopting any particular perspective, Eisner (1985) cautions that 'when you provide a window for looking at something, you also ... provide something in the way of a wall' (Eisner, 1985, p. 64-65). Elsewhere, Poggi (1965) puts it more plainly: 'A way of seeing is a way of not seeing!' (Poggi, 1965, p.284). Enough said.

Examples of phenomena correctly observed BUT for which initial explanations furnished have been subsequently replaced by explanations which are the complete opposite of the original, cited by Weinberg and Fraser (1976) include ...

- Observed phenomenon: As a material rots, micro-organisms appear in it in large numbers.

  Initial explanation: Micro-organisms appear as a result of the rotting process.

  Current explanation: Micro-organisms are the cause rather than the result of the rotting process.

- Observed phenomenon: The sun rises in the morning and sets in the evening.

  Initial explanation: The sun revolves around the earth.

  Current explanation: The earth revolves around the sun.

At Tycho Brahe's behest, Johannes Kepler tried, for ***ten years***, to fit the Danish astronomer's observational data to a geo-helio-centric, circular motion model for Mars (see Sagan, 1980) [10] [11]. The data just would not fit. Eventually, Kepler found himself in a position

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[10] An outstanding 'product innovator' of his time, Tycho Brahe 'built wonderful instruments ... before the time of the telescope [pushing] naked eye astronomy about as far as it could go' Gingerich (1994, in KOCE-TV / Coast Community College D.'s Universe: the Infinite Frontier: the origins of modern astronomy) and enabling more accurate data acquisition than ever before possible. cf. the work of ROBERT TEMPLE on the 'ancient' world

[11] The helio-centric model was, of course, Copernican in origin, the *geo*-helio-centric model being Brahe's own variant. The pre-Copernican universe was, however, a geo-centric one ...

> Ptolemy believed that the Earth was at the centre of the universe ... This is the most natural idea in the world. The Earth seems steady, solid, immobile, while we can see the heavenly bodies rising and setting each day. Every culture has leaped to the geocentric hypothesis (Sagan, 1980, p. 51).

For Brahe's system, see Dreyer, 1953.

to consider and try a helio-centric, elliptical model[12]. The rest is history ... not 'ancient history'[13], however ... because this event was one of the milestones which would change the way science 'was done'[14] ... forever. No longer overly concerned with **specific, detailed proofs**, science would, from that time on, busy itself with searching for the **best general explanation** of how things fit together (in the words of Gingerich (*ibid.*): 'the most coherent scheme ... an understanding ... that made sense').

Clearly, one of ***the*** most important things in adopting any particular perspective on anything ... in research - as in life, in general - is a willingness to reposition oneself and ***re-view*** the world - the converse also being true ...

> Shortly after dark, the lookout on the wing of the bridge reported, 'Light, bearing on the starboard bow.' 'Is it steady or moving astern?' the captain called out. Lookout replied, 'Steady, captain,' which meant we were on a dangerous collision course with that ship. The captain then called to the signalman, 'Signal that ship: We are on a collision course, advise you change course 20 degrees.' Back came a signal,

[12] (another variation on the helio-centric model of Copernicus, the notion of *elliptical* orbits being Kepler's own - see Kepler's Commentary on Mars or *Astronomia Nova*)
[13] albeit in the loose sense of the term
[14] (that is: the way in which we perceive / attempt to explain and predict)

> 'Advisable for you to change course 20 degrees.' The captain said, 'Send, I'm a captain, change course 20 degrees.' 'I'm a seaman second class,' came the reply. 'You had better change course 20 degrees.' By that time, the captain was furious. He spat out, 'Send, I'm a battleship. Change course 20 degrees.' Back came the flashing light, 'I'm a lighthouse.' We changed course. (Koch, in Corey, cited by Dayton, 1995, p.290).

Whilst a managerial cognition perspective on the product innovation practices and performance of Irish industry is clearly justified as valid - as shown throughout the present text from section 2.5.3 onwards - the reader is cautioned that it should be viewed as being neither entirely definitive nor entirely exclusive. 'Whoever clings to mind sees not the truth of what's beyond the mind' (Tilopa: *The Song of Mahamudra*[15], adapted from the translation by Garma C. C. Chang, in Kornfield (1993, p.176)).

On managerial cognition and organizational performance

'One key assumption that stands in the way of research in organizational cognition is that individual cognition produces organizational behaviour and, therefore, performance.' (Schneider and Angelmar, 1993, p. 354).

[15] Mahamudra is a teaching and practice, the aim of which is the realization of One Mind.

Schneider and Angelmar's observation that this assumption can, indeed, be challenged ... that 'The causal path linking individual cognition to organizational behaviour is tenuous given the many intermediate steps, and as each connection is subject to many influences' (Schneider and Angelmar, *sic.*) is, of course, quite correct. The issue hardly constitutes that which Meindl *et al* might dub: 'an intractable philosophical problem' (Meindl, Stubbart and Porac, 1994, p. 290), however. Indeed, the matter can be addressed at both a theoretical and empirical level.

In the case of the present research, it must be remembered that the *impetus* for examining <u>managerial</u> cognition and <u>organizational</u> performance came *directly* from early, exploratory, *empirical* work (see, again, chapter two of the present text). Moreover, much extant, cognate organizational research suggested the validity of the proposed research (see, again, chapter three of the present text). The final investigative framework adopted could, perhaps be criticised, however, on the basis of its taking as its focus *associative* rather than definitely *causal* linkages ... though it must be said that a strong - and reasonable - philosophical argument for doing so is presented in chapter four.

On measuring (or mapping) cognition, in general

On measuring cognition in general, it must be remembered that in eliciting cognition, 'What emerges are [just] glimpses from a stream of consciousness presenting a collection of uncertain truths, clouded over by an air of ordinariness' (O'Toole, in O'Kelly, 1995, p. 29 - describing Padraig Murphy's photographic project 'A Sense of Location' - but potentially, equally appropriately used in describing the art/science(/act!) of cognitive mapping). See also section 3.6 of the present text, on the possibility that cognition may be modified or even corrupted by the mere act of its articulation.

On measuring (or mapping) cognition and practice using a 'word-bound', a-priori'ly-defined-investigative-agenda-based, like-framed, ***pre-pared research instrument, in particular***

Firstly, in regard to cognition, it is important to note that whilst ...

> The balance of the evidence appears to be ... that a good deal of our thinking is closely connected with our use of language and is actually carried out in words, ... we use other forms of thinking which are not constrained in this way and are essentially different in character (Fry, 1977, p. 164).

It is important to realize the significance of the role of the words used in that which is usually (and arguably, necessarily?[16]) the 'word-bound' act of cognitive elicitation: 'Words are an aspect of the attempted communication of thought. They are not thought. When we see words described as 'thoughts', we should makes sure we know this distinction' Idries Shah, in Fry (*ibid.*, p. 159).

Cf. Sections 6.5 points 1.(ii-d), 2.(iv) and 3.(i) of the present chapter.

Regarding the issues of 'what' cognition* and 'routine' practice - as elicited in the course of the present study, using an *a priori*'ly defined investigative agenda based like-framed pre-pared research instrument …It may be said that: 'The fact that the elements of a picture are related to one another in a determinate way represents that things are related to one another in the same way' (Wittgenstein, in Elkins, 1996, p.82) …yet … Keesing (1981) asserted that in stressing the manner in which the system fits together and the manner in which elements are functionally interconnected, one is prone to depict 'the system' in a manner that is suggestive of its being in constant and complete, 'timeless equilibrium' (Keesing, 1981, p.353) - something which would, clearly, be inappropriate to **both** cognition and organizational practice.

Regarding, then, the issue of 'how much' cognition and 'how much' practice …

* i.e. Cognitive CONTENT vs PROCESS (& not 'knowledge what')

[16] (an interesting topic for debate and research ... see '*cf.*' cross-references which follow this paragraph)

We have no measure of the full extent of a person's knowledge - though, with time, patience and care, the full extent of an organization's practice (being behavioural and therefore more 'trackable') could probably be measured. In general, though ... how can we know whether we have elicited a sufficient amount, if not all, of a person's knowledge on a matter or obtained a sufficiently complete picture of a company's normal practices? Knowledge engineers and task analysts believe that it ought to be possible to accurately estimate this, using mathematical formalisms. Organizational researchers tend to adopt a more practical approach: 'have we enough information to usefully address a problem? if 'yes', then be satisfied - if 'no', then get some more' (de Chernatony, 1997, personal communication, cited earlier in section 3.6). Thus, where Wittgenstein argued that: 'What constitutes a determinate picture is that its elements are related to one another in a definite way' (Wittgenstein, in Elkins, 1996, p.83), it would seem that, for organizational research, that which constitutes a determinate picture is one in which elements are related to one another in a definite ***and functionally adequate*** way[17]. (The 'accuracy' and completeness of the measured map is, of course, necessarily, largely determined by the research agenda / psychometric approach adopted by the researcher.)

[17] It should be noted that, at a number of points elsewhere in the *Tractatus*, Wittgenstein also asserts that not all pictures are determinate.

For the purposes of the present research, we may content ourselves that all of the pertinent elements of all known charts of the 'known world' of product realization have been explored.

Nevertheless, as noted in chapter three of the present text, we would probably do well to follow the well-founded tradition of cartographers of old and 'flag' the perimeter of this 'combinatorial chart' - however apparently comprehensive - with the cautionary note that though it is certainly extensive, it is based on current knowledge and whilst it is based on all current knowledge, all current knowledge may not ultimately prove to be all 'knowable' knowledge, in sum: ***'beyond here there [may well] be dragons'.***

One such 'dragon' might be moral and ethical considerations in product innovation, for example: the moral and ethical issues pertaining to the realization of electronics products which may ultimately be used as weapons components, though not originally intended for that purpose .. or the moral and ethical issues pertaining to the realization of food products based largely or even just partially on genetically modified or artificial ingredients, the long term effects of which on the food chain - though they may, eventually, be proven non-negative - are not fully understood at the time.

On the use of a quasi-experimental design

A quasi-experimental design was not only ‘the obvious choice’ for the study (given that - as noted in the test specification - *a priori* random assignment of study participants to experimental conditions would be impossible, by definition and purely non-experimental research would be something of a hit-and-miss affair in relation to performance levels represented (necessary representation of the population’s performance range could not be guaranteed)):- it was the only really practicable one for research in the present context, that is: independent, time and budget limited, Ph.D. (as opposed to, say, amply funded, significant other, long-term research), in which the probability of addressing the issue either experimentally or purely non-experimentally would be quite low as it would, if it were to be properly conducted, necessarily, involve:

1. In the experimental case:

- a range of type-specific (for example: minor old product development ... completely new to world product development), real or, at least, extremely ecologically valid and perceived to be real, very closely matched product innovation projects to be developed by very closely, matched development groups under very closely matched circumstances and conditions, one group having the input of a manager having an *a priori*'ly defined (whether inherent or instilled - but certainly largely controlled and certainly estimated and/or checked) set of above-average performing group cognitions, the other group having the input of a manager having an *a priori*'ly defined (again, whether inherent or instilled - but certainly largely controlled and certainly estimated and/or checked) set of below-average performing group cognitions, both managers being matched on the full range of salient characteristics and attributes;

- measuring:
  - cognition *a priori*'ly and *a posteriori*'ly on each project;
  - routine practice 'proper' audit-style (that is: using an independent auditor) instead of self-report style, at regular intervals (consistent across development groups) throughout the course of the development work ...
  - and, of course, project outcome, at the end.

2. In the purely non-experimental case: at the very least, very large numbers of subjects and a great deal of time.

On the form and content of pre-pared research instruments - and their implications[18]

In assessing the present attempt to reduce the product realization process to 'manageable interpretables', it is useful to bear two pertinent borrowings from the world of music in mind ...

- firstly, the observation that: 'Two common errors with regard to rhythm are: (1) making it mechanical, and (2) taking too many liberties' (Cleary, 1971, p. 7);
- secondly, Schoenberg's admonition ...

> Now one word about your intention to analyse these pieces as regards to the basic set of twelve tones. I have to tell you frankly: I could not do this. I consider this question as unimportant. ...instead of the merely mechanical application I can inform you about the compositional and esthetic advantage of it. You will accordingly realize why I call it a 'method', (Schoenberg, in Tamplin, 1991, p.53).

In research - as in all of life - communication is enormously important. It follows, therefore, that for research which utilizes a pre-pared research

[18] *cf.* Chapter three of the present text, on the production of a valid and reliable research instrument and sections 3.5, 6.2 (*On measuring (or mapping) cognition and practice using a 'word-bound', a-priori'ly-defined-investigative-agenda based, pre-pared research instrument, in particular)* and 6.5: points 1. (ii-d), 2. (iv) and 3. (i), of the present chapter.

instrument developed on the basis of an *a priori*'ly defined research agenda, the statement that: 'If something is totally predetermined there is no communication' (Kac, in Vos, 1996, p 227) is also enormously important. Of course, it may be counter-argued that if the pre-pared research instrument is pre-determined through previous communication, there must be at least some, somewhere along the line. Nevertheless, of a print and language-bound pre-set agenda for this type of research, it may, justly, be said that ...

> This proto-semiotic environment is fully replete...The reward, allegedly, comes in transparence, clarity, unequivocality, rapid understanding, stability, vindication, authority. But there is also a loss of potentialities, of a potential understanding of both language and the world in which it is used ... in our never ending attempts to find our way' (Vos, 1996, p 232)

- or, in the case of the present research: subjects' attempts to isolate those elements which define their current way.

The bottom line is ... 'If the specific content of a text is presumed to have meaning in and of itself ... then it becomes important for readers to derive the meaning that the writer intended' (Baron, 1997, p.17) and, of course, as with holopoetry ...

> When the viewer starts to look for words and their links, the texts will transform themselves ... change in...meaning...This viewer-activated choreography is as much a part of the signifying process as the ... verbal...elements themselves (Kac, in Vos, 1996, p. 230).

In the present study the text content is (intended to be) used merely as a 'shorthand' for reminding the reader of a number of parameters of the problem space of interest to the study, however ... and, as this is clearly indicated throughout the research instrument's instruction sets, the use of a pre-set agenda, arguably, poses no real problem for the present research.

Nevertheless, it is worth noting that in presenting a problem space as an *a priori*'ly defined, apparently fixed, two-dimensional matrix, it is important that the medium of presentation ensures that subjects are not just assumed to be allowed but also *actively encouraged* to freely respond. The act of responding to a problem space so defined, is analogous to the 'art' of painting, where it is important, to at least some extent, that ...

> When you go out to paint, [you] try to forget what objects you have in front of you, a tree, a field...Merely think, here is a little square of blue, here an oblong of pink, here a streak of yellow, and paint it just as it looks to you, the exact colour and shape, until it gives your own naive impression of the scene. (Monet, in Adlerblum, 1990, p 21).

In this regard, the research instrument used should present essentially - *though not necessarily obviously* - as a palette set out to facilitate spontaneous response and NOT as a canvas pre-pared for 'painting-by-numbers' (regarding the adequate preparation of the palette's pigments, see again, chapter four of the present text, on concept definition, validity and reliability).

Of course, palette layout is also important ...

> The unimaginatively named Lynx the Lynx owes its identity to the astronomer Hevelius, who in the mid-seventeenth century constructed the figure from 19 dim stars. Though he assembled and promoted the constellation, in the words of astronomical historian Richard Hinckley Allen, Hevelius "acknowledged the insignificance of the components", (Macdonald, 1996, p. 68).

Regarding the present research, the question of whether there is / should be / appears to be, equal treatment of the significance of individual matrix cells *or* whether the impression being given is that the sum of the product realization matrix is greater than its parts *and*, of course whether this matters? Perhaps, this issue should have received greater (and more explicit) attention and consideration in the preparation of the study and the design of the test instrument.

On the quality of self-report routine practice data

Chris Argyris commented, quite some ago, on the discrepancy between what an organization says it does and what it actually does (Argyris, 1964). Yet, much can be done - and, indeed, has been done in the context of the present research - to reduce or even eliminate this source of error. The mere acts of stressing the confidentiality of data and the 'of no vested interest' nature of the research to the subject are but two very simple strategies which have been found to be useful and are regularly employed for this purpose.

On sampling strategy and sample validity

In 1978, Spiro inadvertently made a very interesting observation regarding sampling strategy and sample validity, upon noting that:

'The Hopi may be no less hostile than the Sioux, despite the fact that the latter exhibit much more social aggression, and ... their cultural values concerning aggression are ... different' (Spiro, 1978, p. 358, in Keesing, 1981, p.94).

Translation (or, more correctly: interpretation in the present context): characteristics of cluster samples may be more apparent than real!

In view of this observation, it seems important to highlight the fact that in the present study, a more-or-less one-to-one correspondence was found in relation to hostility and social aggression equivalents:- that is to say: it was, generally, found that: *a priori*'ly defined high performers exhibited higher initiative and completion rates than *a priori*'ly defined poor performers.

Of course, it is important to bear in mind that the Hopi and Sioux are not necessarily representative of 'the whole Indian nation' ... that is to say: Irish-owned electronics firms - whilst a useful test case for the model - may not, necessarily, be representative of the whole of Irish industry.

6.3 THEREFORE, ON CONCLUSIONS DRAWN ...

'*Science is* primarily *an activity of extending perception into new contexts and into new forms, and only secondarily a means of obtaining what may be called reliable knowledge.'* Bohm (in Suppe, 1977, p. 374).

As Nietzsche observes:

> ... science, spurred by its powerful illusion, speeds irresistibly towards its limits where optimism, concealed in the essence of logic, suffers shipwreck. For the periphery of the circle of science has an infinite number of points; and ... there is no testing how this circle could ever be surveyed completely ... (Nietzsche, in Moriarty, 1998, p. Ixx).

Moreover, after lengthy consideration, Paul Feyerabend (1993) concluded that a theory of science that devises standards, rules and structural elements for all scientific activities may well impress outsiders but it is likely to be far too crude an instrument for scientists on the ground facing some concrete problem. Perhaps the same may ultimately be found to be true of innovation management research and/or practice (that which is cognitively oriented /

originating, in particular). Rules and strategies may well be either too complex or too imperfectly known to serve as useful guides. On the other hand Feyerabend's conclusion that there is only one principle than can be defended under all circumstances, namely the principle 'anything goes' seems not to fit the situation either (moreover, it smacks greatly of some of the more terrifying images from Dante Alighieri's *Divina Comedia*[19] and would seem to be most likely to appeal not so much to the 'all embracing / room for everything / big ol' earth muffin - type philosophers' but largely to those 'intellectual neurotics [who] tend to be drawn to philosophy because it contains no definitive answers' (Janov, 1973, p.180 (presumably the same group drawn to postmodernism))[20] ... and, anyhow, the present study ***has*** shown the empirical approach to be capable of generating quite a few directives on the product innovation problem addressed. Unlike the case of the conversation between Eco's characters William and Adso: ' "... I behaved stubbornly, pursuing a semblance of order, when I should have known well that there is [none]." "But in imagining an erroneous order you still found something..." "...useful [but] meaningless" ' (Eco, translated by Weaver, 1984, p.492), the 'something' found here is, clearly, quite meaningful in addition to being useful.

[19] (and, to paraphrase the great Dante's: 'Lasciate ogni speranza voi ch'entrate' (*Divina Comedia, 'Inferno', iii. 9)*, abandon all hope ye who venture into this philosophy!)
[20] but, presumably, less likely to appeal to the mortal whose preference is to 'defend himself from being regarded as an impotent object in the course of the universe', after Prigogine, in Wijers, 1996, p. 78

Nevertheless, 'No single story ever reveals the truth about organizations' (Fiol, 1995b, p 71). Yet, in the immortal words of Agatha Christie's Miss Marple[21]: '*Nil desperandum*'. There are always the Popperian notions that some scientific knowledge may be true but that is always tentative and that scientists should put up risky hypotheses which should 'live dangerously' (see Chalmers, 1994) to fall back on ... and though 'The structure which is common between the proposition and the world is revealed... only if we understand the rules for their use' (Mounce, 1981, in Elkins, 1996, p.80), it must be remembered that: those methods used and data and results generated at any particular point in the history of an area of inquiry should be adjudged to be of value - or not - ***only*** (as Flinders and Mills (1993) observe) in relation to the stage of the scientific process at which they are used and presented, and the purpose for which they are used.

> At an early stage of the scientific process, for instance, we are mainly playing, exploring ideas for the further ideas or explorations they might lead us to. We don't much care whether the results are valid or not, or whether the conclusions are true. What we really care about is that the discussion proceed (Flinders and Mills, 1993, p. 224-5).

[21] (most memorably in the incomparable Margaret Rutherford's magnificent portrayal of said character in Metro-Goldwyn-Mayer (MGM) 's production of *'Murder Ahoy'*!)

Indeed, many researchers make the distinction between the early and later stages of scientific inquiry, asserting that the success of early studies lies not in the data they produce but, rather, in the questions they raise (see, for example, Morris, in Harris and Morris,1984).

Moreover, Flinders and Mills (*ibid.*) go on to observe that it is often seen as an intellectual mistake to dismiss ideas at an early or exploratory stage of work just because it would seem possible that they might not be true and cite Yuval Yonay as having pointed out that researchers frequently accept all sorts of anomalies if the general position containing them opens up new researchable questions, the exploration of which holds the promise of progress.) Thus ...

> Every way of doing research and arriving at results is good enough, good enough for someone situated at some point in the research process (see Becker, 1986). If it weren't good enough for someone, no one would be doing it... though every scientific method has easily observed technical flaws and is based on not very well hidden philosophical fallacies, they are all used routinely, without much fear or worry, within some research community. The results they produce are good enough for the community of scientific peers that uses them. The flaws will be

> recognized and discounted for; the fallacies will be acknowledged and ignored. Everyone knows all about it, knows that everyone else knows all about it, and they have all agreed not to bother each other about it... (Flinders and Mills, *sic.*)

... and so, we may conclude that: 'Flapping your arms can be flying' (Hall, in Robbins, 1976, p.361) and that, in research, the achievement of uncovering even a 'hint of an explanation' (after Greene, 1986) may be taken to be, of itself, indicative of productive and meritorious effort (though - as with all hints of explanation - the one generated in the course of the present research ought not to be viewed as being in any way presumptive of the 'independent and timeless equilibrium' (after Keesing, 1981, *sic.*) of the phenomena depicted such that the present hint might be taken to be valid for all cases and for all time: 'all phenomena are processes, connections, all is in flux' (Matthiessen, 1980, p.66). Moreover, as Smith points out ...

> truth is not to be understood only as propositional, as it is in the dominant Western tradition. Truth is also person-centered, as is recognized in the Chinese tradition, and tied to things, as is clear in the Indian tradition (Smith, in Wijers, 1996, p. 83).

6.4 ... AND SO TO THE QUESTION: CUI BONO?

'Cato, that great and grave philosopher, did commonly demand, when any new project was propounded unto him, *cui bono*, what good will ensue in case the same is effected?' (Fuller, in Evans, 1990, p. 294)

If, as Yap and Souder (1994) suggest, product innovation really must be an explicit element of corporate objectives and strategies today, then the predictability of innovation outcomes is crucial and the present research may be seen to be beneficial in the following ways ...

Montoya-Weiss and Calantone (1994) observe that existing empirical research on product innovation provides evidence that a wide range of antecedent factors can influence the outcomes of product innovation initiatives ... however ...

> A comprehensive review of this literature reveals a wide variety of study designs and methodological approaches. Quantitative comparisons, although cumbersome, provide a look at the persistent exploratory nature of this research. The findings report a wide variation in results that are

> surprisingly non-convergent. Although there is some consistency as to which factors are considered by researchers, the range of factors in the typical set is narrow. One possible avenue for future research would be to include all factors identified in a single study to jointly assess their impact on performance. (Montoya-Weiss and Calantone, 1994 p. 397).

The present study:

1. frames work to date on effective product realization practice, in an even more concrete, detailed yet clear and accessible form than those previous attempts at consolidation presented by van de Ven *et al*, 1989, Calantone *et al*, 1995 and Chiesa *et al*, 1996 (the latter form constituting not dissimilar work which was being undertaken at the same time as the present research but which remained unknown to the present researcher until recent publication of the research) - a form that is accommodating of apparent points of non-convergence (for example: that which is generated by the variable significance of individual factors across *individual* product realization activities) and which may, therefore, be more readily adopted as guide to or framework for product realization

skill acquisition (self / formal familiarization / training), practice (assessment and development) or research (focal framework);

2. usefully assesses (for the first time) the link between the *full set of* factors so-framed and final innovation performance;
3. contributes to advancing the discipline from its previously, persistently exploratory state - not just by helping to consolidate laws as described at '1.' but - in looking beyond laws to possible, underlying, explanatory, if not predictive, theory (and proposing and testing at least one, namely: managerial cognition);
4. contributes to the facilitation of cognitive investigations in organizations, by proposing, developing and demonstrating the effective use of a modified script concept which enables more direct comparison of cognition and practice (thus overcoming a persistent methodological problem for cognitive research in organizations, formally identified by El Sawy and Pauchant, a decade ago (see El Sawy and Pauchant, 1988);
5. contributes to the cumulation of formal knowledge in management studies:- following the description by Haridimos Tsoukas (1994) of four approaches to obtaining formal knowledge in management research (after Pepper's 'World Hypothesis', namely: formism, mechanism, contextualism and organicism), the present work may, for example, be interpreted as presenting a practical bridge between Mintzberg's

contextualistic and Ansoff's mechanistic/formistic approaches to knowledge;

6. contributes to progressing the applicability and application of formal knowledge in management studies, to product innovation, in linking practice and cognition in a very transparent way so as to provide a clear platform from which the symbolic aspects of shaping a more tangibly creatively productive organization might be explored and manipulated.

Regarding the cognitive perspective on product innovation performance proposed and tested, it has been shown that managerial mindsets are a significant factor in product innovation practice and performance ... and thus it would appear to be true that 'Casual creativity is for those who have immaculate technique in their veins ... as a natural reflex' (Spiekermann, 1987, p.40) ... that for effective product innovation performance, companies must, indeed, consider the innovation mind-set of their management, its inspiration and implementation (as Kuczmarski, 1994, suggests) ... that it is likely that a persistent stability of inadequate managerial cognition 'can potentially damage the organization's ability to adapt' (Hill and Levenhagen, 1995, p. 1064) ... and so learning 'new ways of thinking and acting' (Bounds, Adam and Ranny, 1994, p.43) becomes a necessity... (notwithstanding the rather disturbing fact that 'many .. are trained to exclude areas of knowledge, skills and attitudes ... so that the idea of accepting and valuing areas previously excluded is a difficult one and liable to be rejected unless handled carefully', Garratt (1987, p. 46) ... though resistance to change is, however, generally held to be naturally balanced with a fundamental human propensity *and inclination* to assimilate and accommodate[22] (see Piaget, 1954 and Mussen *et al*, 1984), that is: to adapt[23] (see Calori, Johnson and Sarnin, 1994) and there is something of an inevitability, indeed: evolutionary necessity (see Berg, 1993) about the alteration of knowledge structures which are no longer adequate (see Barr, Stimpert and Huff, 1992)) ... and though it may be argued that product development is an activity that is normally carried out under considerable time and budgetary constraints ... where - as Gordon *et al* (1987, in Rooney, 1989) observe, guidance material of any kind (presumably, even that which has been recently cognitively encoded and not yet automatic - see chapter three) may simply be ignored in favour of getting the job done, knowledge structures 'determine what ... will receive attention' (Barr *et al*, *ibid.*, p. 17) 'for and in the doing' ... and so, once again, it is shown that ... 'As an innovation idea moves form its inception through development and implementation, it is [ultimately] people who push, modify, or drop the innovation' (see Van de Ven, 1986 cited by Angle in van de Ven *et al*, 1989 - p. 135).

[22] 'assimilation' may be defined, after Donaldson (1978) as changing the environment to 'fit' the individual, whilst 'accomodation' may be defined, after Ginsburg and Opper (1979) as changing to fit with the environment

[23] (or, in the case of the US Marines: to improvise, adapt and overcome!)

6.5 SUGGESTIONS FOR ADDITIONAL/ALTERNATIVE RESEARCH[24]

The research potential in this area is vast. The following are just some suggestions ...

1. Obviously, the present form of the present study could be re-worked ... For example ...

(i) Operationalization of key variables could be revisited... for instance: operational definition issues relating to the whose, what and how much aspects of cognition explored in chapter three of the present text may each be revisited.

(ii) Measurement techniques used in the present study could be reviewed and revised ... (a) Arguments for the questionnaire-based approach adopted in the present study are strong (see Chapter Three) ... alternative approaches could, of course, be used, however, for example: the knowledge base of the enterprise may be sketched through contract research - after Haour, 1992. (b) Regarding self-report measures, a study by Fiol (1995a) indicates that there may be some significant differences between managers' public and private communications - particularly in

[24] (that is: in addition to those made elsewhere throughout the present text - see, for example: section 6.1.3)

relation to evaluations of their companies' performance. Fiol suggests the adoption and examination of convergence between different forms of communication as a means of increasing approximation to 'the truth'. The potential advantage versus the practicability of adopting this suggestion in the context of time/budget restricted research would also, of course, have to be considered. (c) The research instrument could be more formally tested for validity and reliability - after, for example: Wise (1985). (d) The possibility of developing a 'word free' cognitive elicitation technique could be explored to enable exploration of the notion of / access to that which is, a potentially (and arguably) a more pure pre-linguistic[25] set of psychical entities than that which is / eventually becomes word-bound (see Einstein in Holton, 1967-8, p. 254 and Goodman, 1968 and *cf.* section 6.2 (*On measuring (or mapping) cognition and practice using a 'word-bound', a priori'ly defined investigative agenda based, pre-pared research instrument, in particular)* and section 6.5: points 2.(iv) and 3. (i) of the present chapter).

(iii) Different test cases could be tried. 'Many of our common errors come from assuming that what is known in some cases is also knowledge

[25] (or, simply, 'appropriate' in the sense of 'ecologically valid' *cf.* Section 6.5 point 2. (iv) of the present text)

for the case in hand' (Dewey, 1922, in Bednarz, 1985, p.300)[26]. For example: '*meal* realization'(!) is equally effective for the great white shark and the piranya, yet the procedures, methods and techniques they use, differ significantly in a number of ways ... for instance: sharks employ a 'shake-to-serrate' sawing action whilst piranya employ a 'clean cut circular chomps' approach ... of course, the difference in the underlying (dental) 'technology' of the two is, probably, the most significant determining factor in the difference in approach.

(iv) The actual model proposed in the present study could be reviewed and revised, for example: the issue of immediacy versus mediatory mechanisms of association between cognition and action could be further explored ... The work of authors such as Lord and Kernan (1987) explores the general notion of scripts as determinants of purposeful behaviour in organizations. As noted in section 3.2 of the present text, the nature of the relationship between cognition and action has been the subject of a debate which remains highly polarized. It is interesting that the findings of the present study could be interpreted as providing evidence in support of both immediacy and mediation, though the case for the former would probably flounder insofar as measures reflect individual cognition and organizational performance. Further research

[26] ...to which the corollary: ... *or, indeed, from assuming that that which is known of / works in some cases, holds true for / works in all cases*, may be added

could explore the case for the latter, based on Staw and Sutton (in Murnighan, 1992), for example, who suggest three very specific, significant ways in which the individual may influence an organization, namely: (i) by taking actions that reflect personal convictions whilst claiming that such actions reflect organizational policies and procedures; (ii) by taking actions that influence organizational structures, processes and performance and (iii) through influencing the aggregate thoughts, feelings and behaviours of the individuals/groups which make up the organization[27] .. or, alternatively, Craik (1943) as described in chapter three of the present text, together with Leavy and Walsh (1995) as described in chapter one of the present text. Alternatively the research instrument developed and used in the present study could be adapted to a new organizational cognition based quasi-experimental design in order to test the immediacy perspective.

2. Elaborative basic and applied issues could be pursued ... For example ...

[27] The question of the degree of influence powerful individuals - particularly leaders - have on organizational attributes and outcomes has been a matter of considerable and often heated debate over the last two decades. It now seems, however, that at last, some degree of consensus is emerging. As Mowday and Sutton observe, it is now generally accepted that 'leaders exert at least a modest influence especially when the organization is small and young'. (Mowday and Sutton (1993, in Porter and Rosenzweig, 1993) p.210). Mowday and Sutton go on to identify two key paths through which these powerful individuals influence organizational attributes, processes and outcomes and which, perhaps not surprisingly given the authors, correspond well with the paths of influence identified by Staw and Sutton. They are: (i) by making decisions that affect the organization and (ii) by shaping the thoughts, feelings and actions of people inside and outside the organization.

(i) The significance of ownership (original / eventual, individual / consensual / shared) and relative significance of ownership-versus-composition issues for cognition could be explored. Comparison of the manner in which knowledge is organized for the individual having greatest authority and responsibility for, and familiarity with product innovation within firms and for various organizational groupings involved in product realization activities could be made using the research instrument and analytical framework used in the present study. The questions of the origin (dictation versus consensual development: see sections 3.2 and 3.3 of the present text) of organizational scripts for product realization and the relative importance of composition versus ownership (see section 3.3 of the present text) could then be explored. One possible and interesting starting point for theoretical consideration would be the statement that:

> The idea of an individual, the idea that there is someone to be known, separate from the relationships, is simply an error [...] we create each other, bring each other into being by being part of a matrix in which the other exists' (Bateson, in Wijers, 1996, p.193).

(ii) The process of product realization knowledge structure development and elaboration could be explored and tracked and the specific mechanisms of assimilation and accommodation referred to in section 3.2 of the present text could be isolated and experimentally manipulated in the context of individual/organizational learning research (using Cohen and Sproull, 1995, for example, as guide).

(iii) The artefacts of organized knowledge on product innovation / product realization, could be investigated:- the nature and magnitude of effect of the positive and negative artefacts of knowledge organized in the form of the modified generic script frame used in the present study could be explored, using points raised in chapter three of the present text as guide.

(iv) The role of cognitive phenomena other than knowledge structures, in product realization, could be examined, for example: the role of cognitive style[28] ... 'the mind is an information-processing device that makes and **manipulates** symbolic representations of the world' (Johnson-Laird, 1993, p. xiii - with emphasis added by the researcher to draw attention to the link between cognitive psychology, artificial intelligence and current

[28] (a predominantly visual or enactive as opposed to verbal imaging style, a normally serialistic or normally wholistic processing style, *et cetera, et cetera* (see, for example: Witkin, Dyk, Faterson, Goodenough and Karp, 1962 and Blaylock and Rees, 1984 - both in Schneider and Angelmar, 1993))

research on symbols and symbol manipulation in the organizational context (for example: Leavy, 1996, cited earlier) ... 'The meeting of minds through the overt symbolic communication among individuals is of course the supreme agent of human culture and social convention' (Johnson-Laird, *sic.*):- perhaps it is the meeting of minds through the overt symbolic communication amongst members of the organization effected through the manipulation of elements of managerial scripts for product realization (activation and translation into symbolic communications according to various cognitive styles which constitute routine cognition manipulation dispositionals) that is the supreme agent of effective product realization also?!).

(v) The potential role(s) and possible form(s) of 'cognitive aids' (after Meindl *et al*, 1994; see also Meindl *et al*, 1996) in product innovation, could be explored, for example: the notion of using 'expert scripts' (the scripts of experts in the field of product innovation - which, by definition, should be relatively more elaborated and/or, presumably, more appropriately refined than non-expert scripts (see Gioia, in Sims *et al*, 1986)) in training could be explored (the two-hundred and fifty-six point matrix of Study Two constitutes a consolidated, generic literature-based expert script which could be used, for example, to explore the notion that 'when we teach each other ... from a point of scientific agreement and consensus, it is extraordinarily effective and powerful' (Hawken, in Wijers, 1996, p.199))... or a prototypical knowledge based system (see Hayes-Roth *et al*, 1983 and Harmon and King, 1985) could be developed based on Study Two's two-hundred-and-fifty-six point product realization matrix using, say, the C++-based shell CRYSTAL and then tested as a management tool in the context of a range of real-life or somewhat more controlled but ecologically valid experimental product innovation initiative scenarios.

(vi) On a smaller scale, results of the present study could be further investigated, for example: (a) empty cells in Table 5.34 could be reviewed in the light of opening statements of the present chapter (bearing in mind the re-casting of Herschel's 'holes in the sky' - made possible by latterday infra-red telescopy), (b) the information contained in Table 5.12 and/or Table 5.23 could form the basis for 'follow-on research', for example: the principal areas of correspondence between cognitive maps and the recommendations of the international innovation literature and the principal areas of correspondence between routine practice maps and the recommendations of the international innovation literature differ across above- and below- average performers ... why ... would below-average performers' concentration on those areas of correspondence which are lacking in their group but not in the above-average group best expedite improvement in performance, or should the two groups be treated separately, in which case: are there other areas which should receive priority attention?

3. Fundamental philosophical issues underlying essential methodology could be examined, for example: the polemic stance underlying the *approach* to applied research adopted could be revisited as follows ...

(i) If, as Kac observes: 'Language plays a fundamental role in the constitution of our experiential world [and] to question the structure of language is to investigate how realities are constructed' (Kac, *ibid.*, p 233), then the whole issue could be followed-up/re-addressed at this level[29]. This may be interpreted as 'an alternative to', 'a different slant on' or 'an extension of' the adopted polemic stance (depending on the manner in which observations made in sections 3.5, 6.2 (*On measuring (or mapping) cognition and practice using a 'word-bound', a-priori'ly-defined-investigative-agenda based, pre-pared research instrument, in particular)* and 6.5: point 1. of the present text are interpreted). An investigation of organizations' *product* innovation culture/climate/capacities/behaviour as a correlate/function of the language of innovation used within the organizations could commence with an analysis of, say, for

[29] (see Whorf, 1950 for practical illustration of the potential value of the approach)

example: mission statements and their (presumed) shared (versus understood) meanings[30]. (On the '*pros* and *cons*' of adopting a linguistic approach ... it may be variously argued, for example, that: language is a code for the signification of thoughts (*pro*) / thoughts take shape out of the material body of language (*pro*) / there is no natural bond between the linguistic signifier and the signified (*con*) / language, taken by itself, has no inherent meaning or value (*con*).)

... BUT beware the 'job of work' to be done in attempting to pursue this line of inquiry in the Irish context ... whilst it is generally accepted that 'code-sharing, whether of language or of values, is always incomplete' (Bateson, in Wijers, 1996, p.191), 'The Irish have a passion for verbal nuance... In Ireland, language conceals just as much as it reveals in a never-ending game of hide-and-seek' (Ruane, 1981, p.2). For example: 'The Irish will avoid making general statements. Instead they will tell you a colourful anecdote ... the meaning is conveyed indirectly through the story, with the help of poetic exaggeration' (Ruane, 1981, *sic.*) ... Ruane cites Sean O Faolain's reference to a 'private code' which we need to 'get the hang of' (*sic.*).

[30] again, *cf.* section 6.5: points 1. (iv) and 2. (iv) of the present text

(ii) Alternatively, any factor other than product innovation performance (the product life cycle, for example) could be used as a starting-point or benchmark for research, in which case, routine organizational practice and/or an overall managerial cognition perspective may or may not be indicated.

(iii) There are, of course, in any case, quite a few perspectives other than the present cognitive, other than cognition in general and other than psychological in general, which may be explored individually or, preferably in combination (see Le Shan, 1972), in relation to product innovation (after, for example, Schwenk, 1989, in relation to strategic change). For example ... A phenomenological perspective could be adopted after Husserl (1929 - *cf.* section 3.2 of the present text) - see Moustakas, 1994. Alternative psychological perspectives may include, for example: top team perception of and attitude and approach to obstacles encountered in the course of the product realization process - with the potential for the application or adaptation/extension of The 1998 Stoltz Adversity Quotient Test. (For theoretical issues pertaining to alternative psychological perspectives, see Bem (1997).) Other alternatives may include, for example: *product* innovation as a socio-political process - after Maute and Locander, 1994 ... see earlier section of the present chapter on the adoption of particular perspectives in research:- 'Neither means nor ends are absolute.' (Kaplan, 1964, in Zaltman *et al*, 1982, p. 54)).

6.6 AND SO, FINALLY, TO SOME 'FINAL WORDS'

Given the foregoing, it seems appropriate to conclude with the following ...

> Here is a book in my hands: fixed, solid. Perhaps-hopefully- its author no longer wholly agrees with it. It is, at least partially, her past. The dilemma of the living/verbing writer is real, but much of the problem resides in the way books are perceived. If they are perceived/used/idolized as Sacred Texts (like the bible or the writings of chairman Mao), then of course the idolators are caught on a wheel that turns but does not move (Daly, 1995, p. xxxi).

Reader beware!

'Now this is not the end. It is not even the beginning of the end. But it is, perhaps, the end of the beginning' (Churchill, in Zaltman *et al*, *ibid.*, p.177).

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APPENDICES

APPENDIX A

Data Sheet One

COMPANY DETAILS

- research reference code: ___
- general description of business: ___
- IQA/ISO900 certification? ___

PRODUCT INNOVATION PROJECT DETAILS

	Successful Project	Unsuccessful Project
within 5 years of each other? yes ☐ no ☐		
description	___ ___	___ ___
commercial success?	___	

PRODUCT REALIZATION PROCESS DETAILS

Product Innovation Activities	**whether (y/n)and with what proficiency (prf.) each activity was executed**				
tick those routinely performed	Y/n	prf.	Y/n	prf.	Comments
1. **formalized idea generation**					
2. **initial concept screening**					
3. **preliminary market assessment**					
4. **technical assessment**					
5. **detailed market research**					
6. **business/financial analysis**					
7. **prototype/sample development**					
8. **in-house product testing**					
9. **customer field testing**					
10.**trial sell**					
11.**trial production / test of facilities**					
12.**pre-commercialization business analysis**					
13.**formally planned production startup**					
14.**formal launch planning**					
15.**formal launch and marketing**					

Additional notes

- screening / realization power comments:
- other comments:

Data Sheet Two

1. clarity of requirements (objectives, tasks, responsibilities):

2. the availability/scarcity of time and resources (budget et cetera):

3. quality of communication and information flows:

4. general approach to innovation: planning/trial-and-error and quality of in-process assessment:

5. additional information, if any:

APPENDIX B

The Product Development Practices of Irish Companies

PRODUCT REALIZATION SURVEY © - Revision 3B - January, 1997

Anne-Marie E. Rooney, Dublin City University, Ireland

Introduction, acknowledgement and general instructions.

This questionnaire forms part of an on-going three year investigation into the product development practices of Irish companies, the findings of which will be presented as the researcher's doctoral thesis.

The key concern of the present stage of the study is that part of the product development process which follows idea generation - the so-called 'product realization process' through which ideas for the development of new or improved products are transformed into actual realized marketable products.

The questionnaire is currently being distributed across the country to managers of Irish-owned electronics firms - whose participation in the study is gratefully appreciated.

The questionnaire attempts to capture two aspects of the product realization process in these companies. Firstly, it explores the manner in which managers conceptualize the nature of the process. Secondly, it examines the nature of the process in practice.

The questionnaire is presented in three sections.

The first section requests some general, relevant background information on companies participating in the study. This section is self-explanatory and relatively straightforward.

Sections two and three constitute the main part of the questionnaire. Both sections are structured in terms of the four key generic product realization activities - and a range of factors, subsets of which have been variously shown to characterize each of these activities to varying degrees.

Section two of the questionnaire explores the views of Irish managers on the nature of the product realization process, by asking them to characterize each generic product realization activity in terms of their assessment of the relevance of each factor to each activity.

Section three examines the manner in which product realization activities are characterized in practice, by asking managers to identify those factors which normally characterize the manner in which each product realization activity is routinely performed in their companies.

Detailed instructions are provided at the start of sections two and three. Respondents are asked to contact the researcher at the address/telephone-number provided in the accompanying cover note, at any time, should they require further clarification.

Respondents are requested to ensure that all three sections of the questionnaire are completed where possible and to return completed questionnaires by the date specified in the accompanying cover note.

Finally, respondents are again sincerely thanked for their participation in the study and are assured that all responses will be treated confidentially.

SECTION ONE

COMPANY DETAILS

1 In what year was your company founded? ____________

2 Please indicate your company's principal product area(s) from 1990 to date (tick as appropriate):

- ☐ security systems
- ☐ sensors
- ☐ power supplies
- ☐ transformers
- ☐ industrial control
- ☐ process control
- ☐ electronics for the buildings industry
- ☐ other (please specify) ______________________________

3 Please provide an estimate of (the average) lifecycle of your company's principal product(s):

____

4 On average, what percentage of your sales revenue currently comes from:

- **the Irish market:** _____%
- **outside Ireland:** _____%

(Should total 100%)

5 How many people are presently employed in your company? (tick as appropriate)

full-time or permanent		*part-time or occasional*
☐	fewer than 10 employees	☐
☐	to 49 employees	☐
☐	to 100 employees	☐
☐	over 100 employees	☐

6 Does your company hold or is your company currently pursuing Q-mark or ISO9000 certification? (tick one) yes ☐ no ☐

7 What is the extent (significance/frequency) and nature (for example: consultant, partnership, customer, supplier, business support, technical support) of your company's linkages with Universities, multi-national companies (MNC's) and Government Agencies (for example: Forfas)? (it would be helpful if you would specify the University, MNC or Government Agency)

	extent of linkage (tick as appropriate)		**nature of linkage / name of University, MNC or Government Agency**
	significant / frequent	*insignificant / occasional*	
Universities	☐	☐	______________________
Multi-national Companies	☐	☐	______________________
Government Agencies	☐	☐	______________________

PERSONAL DETAILS

1 **Are you the *owner* of your business?** yes ☐ no ☐

2 **What is your current 'job title'?** ______________________________

3 **Please indicate your age group (tick one):**

☐ under thirty-five years
☐ thirty-five to fifty years
☐ over fifty years

4 **Please indicate whether you are male or female (tick as appropriate):** male ☐ female ☐

5 **Please indicate the academic/professional education/training and qualification you've obtained to date (tick as appropriate):**

☐ secondary school with Group, Intermediate, Junior or Leaving Certificate

☐ 1-3 years College or Technical School with Certificate, Diploma or Bachelor's Degree in electronics or related discipline

it would be helpful if you would specify the
name of the College or Technical School ______________________________

☐ 1-3 years College or Technical School with Certificate, Diploma or Bachelor's Degree ***not*** in electronics or related discipline (please specify area: ____________________)

it would be helpful if you would specify the
name of the College or Technical School ______________________________

☐ Masters Degree or Doctorate in electronics or related discipline

it would be helpful if you would specify the
name of the College or Technical School ______________________________

☐ Masters Degree or Doctorate ***not*** in electronics or related discipline
(please specify area: ____________________)

it would be helpful if you would specify the
name of the College or Technical School ______________________________

☐ Other qualification (please specify: _______________)

6 **How many years work experience *in total*, do you have in *electronics*?** _____ years

7 **How many years work experience *in total*, do you have in *project management*?** _____ years

8 **How many years work experience *in total*, do you have in *general management*?** _____ years

9 **How many years work experience *in total*, do you have in *product innovation*?** _____ years

YOUR VIEWS ON THE PRODUCT DEVELOPMENT PROCESS

1 Please rate the importance of each of the following product development activities using the four-point rating scale shown (circle one rating for each activity):

0 not important
1 not very important
2 fairly important
3 very important

• formalized idea generation	0	1	2	3
• initial concept screening	0	1	2	3
• preliminary market assessment	0	1	2	3
• technical assessment	0	1	2	3
• detailed market research	0	1	2	3
• business/financial analysis	0	1	2	3
• prototype/sample development	0	1	2	3
• in-house product testing	0	1	2	3
• customer field testing	0	1	2	3
• trial sell	0	1	2	3
• trial production / test of facilities	0	1	2	3
• pre-commercialization business analysis	0	1	2	3
• formally planned production startup	0	1	2	3
• formal launch planning	0	1	2	3
• formal launch and marketing	0	1	2	3

2 Is a formalized system of product development management a good or bad idea (tick one)?

☐ good
☐ depends on the company or project
☐ bad

3 Which of the following product development activities would you consider essential and non-essential in conditions of significantly constrained development budget or development timeframe (use the digit '1' to indicate essential activities and the digit '0' to indicate non-essential activities)?

product development activities	*significantly constrained development budget*	*significantly constrained development timeframe*	*significantly constrained development budget and timeframe*
formalized idea generation			
initial concept screening			
preliminary market assessment			
technical assessment			
detailed market research			
business/financial analysis			
prototype/sample development			
in-house product testing			
customer field testing			
trial sell			
trial production / test of facilities			
pre-commercialization business analysis			
formally planned production startup			
formal launch planning			
formal launch			

PRODUCT INNOVATION AND YOUR COMPANY

1 **Please estimate your company's average <u>annual</u> *product* innovation budget for the period 1990 to date.** Average annual budget 1990 to date: IR£________K.

2 **Please estimate the distribution of your company's total sales/export sales for *1996* across the following product categories:**

	% Total Sales	% Export Sales
• Products essentially unchanged from 1993 to 1996		
• Products subject to minor change from 1993 to 1996		
• Products significantly changed from 1993 to 1996		
• Completely new products		
	(Should total 100%)	(Should total 100%)

3 **What is your company's 1997 <u>*product*</u> innovation budget? (Please supply figures for the <u>calendar year</u> 01 January 1997 to 31 December 1997.)** 1997 Budget: IR£________K

4 **Has your company developed or introduced any new/developed products in 1996 - or is it in the process of doing so at present? (tick one)** yes☐ no☐

5 **During the period 1990 to date, how many of each of the following types of product development projects has your company:**

i. ***<u>initiated</u>*** (that is: commenced <u>regardless</u> of whether ultimately completed, abandoned or killed - projects may be ongoing),

ii. ***<u>completed</u>*** (that is: pursued to the point of their generating realized marketable product(s)),

iii. ***<u>abandoned or 'killed'</u>*** (that is: terminated prior to the point of generating realized marketable product(s) - including projects which are no longer ongoing but which *may* be taken up again at a later stage)?

TYPE OF PRODUCT DEVELOPMENT PROJECT	NUMBER INITIATED (that is: regardless of whether completed, abandoned or 'killed')	NUMBER COMPLETED (that is: number which have resulted in the generation of realized marketable product(s))	NUMBER ABANDONED OR 'KILLED'
• **<u>new to the world products:</u>** these are essentially the first of their kind and create an entirely new market			
• **<u>new product lines:</u>** new products that enable a company to enter an established market for the first time			
• **<u>additions to existing product lines:</u>** new products that enhance a company's established product lines			
• **<u>improvements and revisions to existing products:</u>** new products that provide improved performance or greater perceived value and replace existing products in a firm's product line			
• **<u>repositionings:</u>** essentially new applications for existing products which are targeted towards new markets or market segments			
• **<u>cost reductions:</u>** new products that provide similar performance and benefits at a lower cost			
• **<u>other (please specify):</u>** ________ ________ ________	________ ________ ________	________ ________ ________	________ ________ ________

6 What were your reason(s) for abandoning or 'killing' each of the projects which were not completed? (starting with the *most recently* abandoned/killed project, tick reasons as appropriate)

project a - 199☐ abandoned ☐ killed ☐ (tick as appropriate)

- ☐ cost problems
- ☐ project was taking too long
- ☐ problems with core technology
- ☐ unanticipated change in marketplace
- ☐ project team doubtful of project outcome (destined to fail or achieve only marginal success)
- ☐ other important project(s) competing for the same resources
- ☐ senior management no longer wanted to stay with it
- ☐ other reason(s) (please specify: ______________________

project b - 199☐ abandoned ☐ killed ☐ (tick as appropriate)

- ☐ cost problems
- ☐ project was taking too long
- ☐ problems with core technology
- ☐ unanticipated change in marketplace
- ☐ project team doubtful of project outcome (destined to fail or achieve only marginal success)
- ☐ other important project(s) competing for the same resources
- ☐ senior management no longer wanted to stay with it
- ☐ other reason(s) (please specify: ______________________

project c - 199☐ abandoned ☐ killed ☐ (tick as appropriate)

- ☐ cost problems
- ☐ project was taking too long
- ☐ problems with core technology
- ☐ unanticipated change in marketplace
- ☐ project team doubtful of project outcome (destined to fail or achieve only marginal success)
- ☐ other important project(s) competing for the same resources
- ☐ senior management no longer wanted to stay with it
- ☐ other reason(s) (please specify: ______________________

7 **Please estimate the proficiency of your company in carrying out each of the following product development activities (using the four-point rating scale provided, circle one rating for each activity):**

n/a — *not applicable: we don't do this*
1 — *poor*
2 — *not very proficient*
3 — *reasonably proficient*
4 — *very proficient*

• formalized idea generation	n/a	1	2	3	4
• initial concept screening	n/a	1	2	3	4
• preliminary market assessment	n/a	1	2	3	4
• technical assessment	n/a	1	2	3	4
• detailed market research	n/a	1	2	3	4
• business/financial analysis	n/a	1	2	3	4
• prototype/sample development	n/a	1	2	3	4
• in-house product testing	n/a	1	2	3	4
• customer field testing	n/a	1	2	3	4
• trial sell	n/a	1	2	3	4
• trial production / test of facilities	n/a	1	2	3	4
• pre-commercialization business analysis	n/a	1	2	3	4
• formally planned production startup	n/a	1	2	3	4
• formal launch planning	n/a	1	2	3	4
• formal launch and marketing	n/a	1	2	3	4

8 **Please characterize the role played by each of the following product development activities in determining whether product innovation projects initiated by your company do actually eventually result in the generation of a new or improved marketable product (tick as appropriate):**

	The mere inclusion of this activity makes a difference	*Inclusion not enough of itself - though its proficient execution does make a difference*	*Positive output from this activity makes a difference*
• Initial concept screening			
• Technical assessment			
• Early marketing activities *(preliminary market assessment, market research)*			
• Business / financial analysis			
• Prototype / sample design and development			
• Product testing			
• Product launch and marketing			

9 Please rate the significance of the contibution made by each of the following factors in practice, in ensuring that product innovation projects initiated by your company do actually result in the generation of a new or improved marketable product *(using the eleven-point rating scale provided, circle one rating for each factor; use zero to indicate an insignificant contribution and ten to indicate an extremely significant contribution):*

new technologies	0 1 2 3 4 5 6 7 8 9 10
the marketplace	0 1 2 3 4 5 6 7 8 9 10
customer orientation	0 1 2 3 4 5 6 7 8 9 10
integration of the needs of the market with technological opportunities available to fulfill those needs	0 1 2 3 4 5 6 7 8 9 10
internal sources of ideas	0 1 2 3 4 5 6 7 8 9 10
external sources of ideas	0 1 2 3 4 5 6 7 8 9 10
experience	0 1 2 3 4 5 6 7 8 9 10
capabilities	0 1 2 3 4 5 6 7 8 9 10
resources	0 1 2 3 4 5 6 7 8 9 10
risk taking	0 1 2 3 4 5 6 7 8 9 10
accepting financial risk	0 1 2 3 4 5 6 7 8 9 10
minimizing financial risk	0 1 2 3 4 5 6 7 8 9 10
complexity (e.g. of task or design)	0 1 2 3 4 5 6 7 8 9 10
clarity of goals	0 1 2 3 4 5 6 7 8 9 10
formalization	0 1 2 3 4 5 6 7 8 9 10
control	0 1 2 3 4 5 6 7 8 9 10
co-ordination	0 1 2 3 4 5 6 7 8 9 10
pre-planning	0 1 2 3 4 5 6 7 8 9 10
reducing uncertainties	0 1 2 3 4 5 6 7 8 9 10
formal specifications	0 1 2 3 4 5 6 7 8 9 10
detailed/precise specifications	0 1 2 3 4 5 6 7 8 9 10
specific screening criteria	0 1 2 3 4 5 6 7 8 9 10
well defined procedures - documented if possible	0 1 2 3 4 5 6 7 8 9 10
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)	0 1 2 3 4 5 6 7 8 9 10
use of metrics	0 1 2 3 4 5 6 7 8 9 10
output based management	0 1 2 3 4 5 6 7 8 9 10
time based management	0 1 2 3 4 5 6 7 8 9 10
incentives	0 1 2 3 4 5 6 7 8 9 10
encouragement of ideas	0 1 2 3 4 5 6 7 8 9 10
tolerance of mistakes	0 1 2 3 4 5 6 7 8 9 10
time constraints	0 1 2 3 4 5 6 7 8 9 10
budgetary constraints	0 1 2 3 4 5 6 7 8 9 10
flexible resourcing	0 1 2 3 4 5 6 7 8 9 10
early prototypes	0 1 2 3 4 5 6 7 8 9 10
running tasks in parallel	0 1 2 3 4 5 6 7 8 9 10
proficiency	0 1 2 3 4 5 6 7 8 9 10
efficiency	0 1 2 3 4 5 6 7 8 9 10
cost-efficiency	0 1 2 3 4 5 6 7 8 9 10
regular performance checking	0 1 2 3 4 5 6 7 8 9 10
detail	0 1 2 3 4 5 6 7 8 9 10
quality	0 1 2 3 4 5 6 7 8 9 10
clarity of roles	0 1 2 3 4 5 6 7 8 9 10
a designated project leader or team	0 1 2 3 4 5 6 7 8 9 10
specific responsibilities and authorities clearly assigned to specific individuals	0 1 2 3 4 5 6 7 8 9 10
rigid team structure	0 1 2 3 4 5 6 7 8 9 10
flexible team structure	0 1 2 3 4 5 6 7 8 9 10
concentration of power	0 1 2 3 4 5 6 7 8 9 10
decentralization	0 1 2 3 4 5 6 7 8 9 10
top management commitment, support and involvement	0 1 2 3 4 5 6 7 8 9 10
leadership quality	0 1 2 3 4 5 6 7 8 9 10
shared values	0 1 2 3 4 5 6 7 8 9 10
teamwork	0 1 2 3 4 5 6 7 8 9 10
co-operation	0 1 2 3 4 5 6 7 8 9 10
few opposing factions within the firm	0 1 2 3 4 5 6 7 8 9 10
interdisciplinary approach	0 1 2 3 4 5 6 7 8 9 10
specialized skills	0 1 2 3 4 5 6 7 8 9 10
cross-functional teams	0 1 2 3 4 5 6 7 8 9 10
job rotation across projects	0 1 2 3 4 5 6 7 8 9 10
consultative style communication	0 1 2 3 4 5 6 7 8 9 10
command style communication	0 1 2 3 4 5 6 7 8 9 10
effective communication between marketing and technical personnel	0 1 2 3 4 5 6 7 8 9 10
inter-organizational networking	0 1 2 3 4 5 6 7 8 9 10
external consultations (direct outsider involvement)	0 1 2 3 4 5 6 7 8 9 10
participative decision-making	0 1 2 3 4 5 6 7 8 9 10

SECTION TWO

Section Two: introduction and instructions.

Section two of the questionnaire explores the views of Irish managers on the nature of the product realization process.

This section is structured in terms of the four key generic product realization activities and the large set of factors thought to variously characterize the overall process. Each activity is represented on a separate sheet and the full set of factors characterizing the overall product realization process is reproduced on each sheet. An eleven-point rating scale, corresponding to each characterizing factor, is also reproduced on each sheet.

IN ORDER TO COMPLETE SECTION TWO, RESPONDENTS ARE ASKED TO RATE THE RELEVANCE OF EACH FACTOR TO EACH ACTIVITY, USING THE ELEVEN-POINT SCALE PROVIDED - WHERE ZERO REPRESENTS TOTAL IRRELEVANCE AND TEN REPRESENTS GREAT RELEVANCE.

Example:

The first sheet examines the generic activity of 'initial concept screening'.

If a respondent thinks that 'specialized skills', for example, are of great relevance to the generic activity of 'initial concept screening', (s)he should circle the number ten on the scale corresponding to that factor.

Similarly, if (s)he thinks that 'top management commitment, support and involvement' is not very relevant - but not entirely irrelevant, (s)he might circle the number two.

If (s)he thinks that the 'shared values' factor is fairly but not very relevant, (s)he might circle the number five.

SHOULD RESPONDENTS REQUIRE FURTHER CLARIFICATION, THEY SHOULD CONTACT THE RESEARCHER AT THE ADDRESS/TELEPHONE-NUMBER PROVIDED IN THE ACCOMPANYING COVERING NOTE.

Initial concept screening

new technologies 0 1 2 3 4 5 6 7 8 9 10
the marketplace 0 1 2 3 4 5 6 7 8 9 10
customer orientation 0 1 2 3 4 5 6 7 8 9 10
integration of the needs of the market with technological opportunities available to fulfill those needs 0 1 2 3 4 5 6 7 8 9 10

internal sources of ideas 0 1 2 3 4 5 6 7 8 9 10
external sources of ideas 0 1 2 3 4 5 6 7 8 9 10

experience 0 1 2 3 4 5 6 7 8 9 10
capabilities 0 1 2 3 4 5 6 7 8 9 10
resources 0 1 2 3 4 5 6 7 8 9 10

risk taking 0 1 2 3 4 5 6 7 8 9 10
accepting financial risk 0 1 2 3 4 5 6 7 8 9 10
minimizing financial risk 0 1 2 3 4 5 6 7 8 9 10

complexity (e.g. of task or design) 0 1 2 3 4 5 6 7 8 9 10

clarity of goals 0 1 2 3 4 5 6 7 8 9 10
formalization 0 1 2 3 4 5 6 7 8 9 10
control 0 1 2 3 4 5 6 7 8 9 10
co-ordination 0 1 2 3 4 5 6 7 8 9 10
pre-planning 0 1 2 3 4 5 6 7 8 9 10
reducing uncertainties 0 1 2 3 4 5 6 7 8 9 10
formal specifications 0 1 2 3 4 5 6 7 8 9 10
detailed/precise specifications 0 1 2 3 4 5 6 7 8 9 10
specific screening criteria 0 1 2 3 4 5 6 7 8 9 10
well defined procedures - documented if possible 0 1 2 3 4 5 6 7 8 9 10
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models) 0 1 2 3 4 5 6 7 8 9 10
use of metrics 0 1 2 3 4 5 6 7 8 9 10
output based management 0 1 2 3 4 5 6 7 8 9 10
time based management 0 1 2 3 4 5 6 7 8 9 10

incentives 0 1 2 3 4 5 6 7 8 9 10
encouragement of ideas 0 1 2 3 4 5 6 7 8 9 10
tolerance of mistakes 0 1 2 3 4 5 6 7 8 9 10

time constraints 0 1 2 3 4 5 6 7 8 9 10
budgetary constraints 0 1 2 3 4 5 6 7 8 9 10
flexible resourcing 0 1 2 3 4 5 6 7 8 9 10

early prototypes 0 1 2 3 4 5 6 7 8 9 10

running tasks in parallel 0 1 2 3 4 5 6 7 8 9 10

proficiency 0 1 2 3 4 5 6 7 8 9 10
efficiency 0 1 2 3 4 5 6 7 8 9 10
cost-efficiency 0 1 2 3 4 5 6 7 8 9 10
regular performance checking 0 1 2 3 4 5 6 7 8 9 10

detail 0 1 2 3 4 5 6 7 8 9 10
quality 0 1 2 3 4 5 6 7 8 9 10

clarity of roles 0 1 2 3 4 5 6 7 8 9 10
a designated project leader or team 0 1 2 3 4 5 6 7 8 9 10
specific responsibilities and authorities clearly assigned to specific individuals 0 1 2 3 4 5 6 7 8 9 10
rigid team structure 0 1 2 3 4 5 6 7 8 9 10
flexible team structure 0 1 2 3 4 5 6 7 8 9 10
concentration of power 0 1 2 3 4 5 6 7 8 9 10
decentralization 0 1 2 3 4 5 6 7 8 9 10

top management commitment, support and involvement 0 1 2 3 4 5 6 7 8 9 10
leadership quality 0 1 2 3 4 5 6 7 8 9 10
shared values 0 1 2 3 4 5 6 7 8 9 10
teamwork 0 1 2 3 4 5 6 7 8 9 10
co-operation 0 1 2 3 4 5 6 7 8 9 10
few opposing factions within the firm 0 1 2 3 4 5 6 7 8 9 10

interdisciplinary approach 0 1 2 3 4 5 6 7 8 9 10
specialized skills 0 1 2 3 4 5 6 7 8 9 10
cross-functional teams 0 1 2 3 4 5 6 7 8 9 10
job rotation across projects 0 1 2 3 4 5 6 7 8 9 10

consultative style communication 0 1 2 3 4 5 6 7 8 9 10
command style communication 0 1 2 3 4 5 6 7 8 9 10
effective communication between marketing and technical personnel 0 1 2 3 4 5 6 7 8 9 10
inter-organizational networking 0 1 2 3 4 5 6 7 8 9 10
external consultations (direct outsider involvement) 0 1 2 3 4 5 6 7 8 9 10

MC-Sheet 1

participative decision-making 0 1 2 3 4 5 6 7 8 9 10

Early marketing activities *(preliminary market assessment, market research)*

new technologies 0 1 2 3 4 5 6 7 8 9 10
the marketplace 0 1 2 3 4 5 6 7 8 9 10
customer orientation 0 1 2 3 4 5 6 7 8 9 10
integration of the needs of the market with technological opportunities available to fulfill those needs 0 1 2 3 4 5 6 7 8 9 10

internal sources of ideas 0 1 2 3 4 5 6 7 8 9 10
external sources of ideas 0 1 2 3 4 5 6 7 8 9 10

experience 0 1 2 3 4 5 6 7 8 9 10
capabilities 0 1 2 3 4 5 6 7 8 9 10
resources 0 1 2 3 4 5 6 7 8 9 10

risk taking 0 1 2 3 4 5 6 7 8 9 10
accepting financial risk 0 1 2 3 4 5 6 7 8 9 10
minimizing financial risk 0 1 2 3 4 5 6 7 8 9 10

complexity (e.g. of task or design) 0 1 2 3 4 5 6 7 8 9 10

clarity of goals 0 1 2 3 4 5 6 7 8 9 10
formalization 0 1 2 3 4 5 6 7 8 9 10
control 0 1 2 3 4 5 6 7 8 9 10
co-ordination 0 1 2 3 4 5 6 7 8 9 10
pre-planning 0 1 2 3 4 5 6 7 8 9 10
reducing uncertainties 0 1 2 3 4 5 6 7 8 9 10
formal specifications 0 1 2 3 4 5 6 7 8 9 10
detailed/precise specifications 0 1 2 3 4 5 6 7 8 9 10
specific screening criteria 0 1 2 3 4 5 6 7 8 9 10
well defined procedures - documented if possible 0 1 2 3 4 5 6 7 8 9 10
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models) 0 1 2 3 4 5 6 7 8 9 10
use of metrics 0 1 2 3 4 5 6 7 8 9 10
output based management 0 1 2 3 4 5 6 7 8 9 10
time based management 0 1 2 3 4 5 6 7 8 9 10

incentives 0 1 2 3 4 5 6 7 8 9 10
encouragement of ideas 0 1 2 3 4 5 6 7 8 9 10
tolerance of mistakes 0 1 2 3 4 5 6 7 8 9 10

time constraints 0 1 2 3 4 5 6 7 8 9 10
budgetary constraints 0 1 2 3 4 5 6 7 8 9 10
flexible resourcing 0 1 2 3 4 5 6 7 8 9 10

early prototypes 0 1 2 3 4 5 6 7 8 9 10

running tasks in parallel 0 1 2 3 4 5 6 7 8 9 10

proficiency 0 1 2 3 4 5 6 7 8 9 10
efficiency 0 1 2 3 4 5 6 7 8 9 10
cost-efficiency 0 1 2 3 4 5 6 7 8 9 10
regular performance checking 0 1 2 3 4 5 6 7 8 9 10

detail 0 1 2 3 4 5 6 7 8 9 10
quality 0 1 2 3 4 5 6 7 8 9 10

clarity of roles 0 1 2 3 4 5 6 7 8 9 10
a designated project leader or team 0 1 2 3 4 5 6 7 8 9 10
specific responsibilities and authorities clearly assigned to specific individuals 0 1 2 3 4 5 6 7 8 9 10
rigid team structure 0 1 2 3 4 5 6 7 8 9 10
flexible team structure 0 1 2 3 4 5 6 7 8 9 10
concentration of power 0 1 2 3 4 5 6 7 8 9 10
decentralization 0 1 2 3 4 5 6 7 8 9 10

top management commitment, support and involvement 0 1 2 3 4 5 6 7 8 9 10
leadership quality 0 1 2 3 4 5 6 7 8 9 10
shared values 0 1 2 3 4 5 6 7 8 9 10
teamwork 0 1 2 3 4 5 6 7 8 9 10
co-operation 0 1 2 3 4 5 6 7 8 9 10
few opposing factions within the firm 0 1 2 3 4 5 6 7 8 9 10

interdisciplinary approach 0 1 2 3 4 5 6 7 8 9 10
specialized skills 0 1 2 3 4 5 6 7 8 9 10
cross-functional teams 0 1 2 3 4 5 6 7 8 9 10
job rotation across projects 0 1 2 3 4 5 6 7 8 9 10

consultative style communication 0 1 2 3 4 5 6 7 8 9 10
command style communication 0 1 2 3 4 5 6 7 8 9 10
effective communication between marketing and technical personnel 0 1 2 3 4 5 6 7 8 9 10
inter-organizational networking 0 1 2 3 4 5 6 7 8 9 10
external consultations (direct outsider involvement) 0 1 2 3 4 5 6 7 8 9 10

MC-Sheet 2

participative decision-making 0 1 2 3 4 5 6 7 8 9 10

Prototype/sample design and development

new technologies	0 1 2 3 4 5 6 7 8 9 10
the marketplace	0 1 2 3 4 5 6 7 8 9 10
customer orientation	0 1 2 3 4 5 6 7 8 9 10
integration of the needs of the market with technological opportunities available to fulfill those needs	0 1 2 3 4 5 6 7 8 9 10
internal sources of ideas	0 1 2 3 4 5 6 7 8 9 10
external sources of ideas	0 1 2 3 4 5 6 7 8 9 10
experience	0 1 2 3 4 5 6 7 8 9 10
capabilities	0 1 2 3 4 5 6 7 8 9 10
resources	0 1 2 3 4 5 6 7 8 9 10
risk taking	0 1 2 3 4 5 6 7 8 9 10
accepting financial risk	0 1 2 3 4 5 6 7 8 9 10
minimizing financial risk	0 1 2 3 4 5 6 7 8 9 10
complexity (e.g. of task or design)	0 1 2 3 4 5 6 7 8 9 10
clarity of goals	0 1 2 3 4 5 6 7 8 9 10
formalization	0 1 2 3 4 5 6 7 8 9 10
control	0 1 2 3 4 5 6 7 8 9 10
co-ordination	0 1 2 3 4 5 6 7 8 9 10
pre-planning	0 1 2 3 4 5 6 7 8 9 10
reducing uncertainties	0 1 2 3 4 5 6 7 8 9 10
formal specifications	0 1 2 3 4 5 6 7 8 9 10
detailed/precise specifications	0 1 2 3 4 5 6 7 8 9 10
specific screening criteria	0 1 2 3 4 5 6 7 8 9 10
well defined procedures - documented if possible	0 1 2 3 4 5 6 7 8 9 10
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)	0 1 2 3 4 5 6 7 8 9 10
use of metrics	0 1 2 3 4 5 6 7 8 9 10
output based management	0 1 2 3 4 5 6 7 8 9 10
time based management	0 1 2 3 4 5 6 7 8 9 10
incentives	0 1 2 3 4 5 6 7 8 9 10
encouragement of ideas	0 1 2 3 4 5 6 7 8 9 10
tolerance of mistakes	0 1 2 3 4 5 6 7 8 9 10
time constraints	0 1 2 3 4 5 6 7 8 9 10
budgetary constraints	0 1 2 3 4 5 6 7 8 9 10
flexible resourcing	0 1 2 3 4 5 6 7 8 9 10
early prototypes	0 1 2 3 4 5 6 7 8 9 10
running tasks in parallel	0 1 2 3 4 5 6 7 8 9 10
proficiency	0 1 2 3 4 5 6 7 8 9 10
efficiency	0 1 2 3 4 5 6 7 8 9 10
cost-efficiency	0 1 2 3 4 5 6 7 8 9 10
regular performance checking	0 1 2 3 4 5 6 7 8 9 10
detail	0 1 2 3 4 5 6 7 8 9 10
quality	0 1 2 3 4 5 6 7 8 9 10
clarity of roles	0 1 2 3 4 5 6 7 8 9 10
a designated project leader or team	0 1 2 3 4 5 6 7 8 9 10
specific responsibilities and authorities clearly assigned to specific individuals	0 1 2 3 4 5 6 7 8 9 10
rigid team structure	0 1 2 3 4 5 6 7 8 9 10
flexible team structure	0 1 2 3 4 5 6 7 8 9 10
concentration of power	0 1 2 3 4 5 6 7 8 9 10
decentralization	0 1 2 3 4 5 6 7 8 9 10
top management commitment, support and involvement	0 1 2 3 4 5 6 7 8 9 10
leadership quality	0 1 2 3 4 5 6 7 8 9 10
shared values	0 1 2 3 4 5 6 7 8 9 10
teamwork	0 1 2 3 4 5 6 7 8 9 10
co-operation	0 1 2 3 4 5 6 7 8 9 10
few opposing factions within the firm	0 1 2 3 4 5 6 7 8 9 10
interdisciplinary approach	0 1 2 3 4 5 6 7 8 9 10
specialized skills	0 1 2 3 4 5 6 7 8 9 10
cross-functional teams	0 1 2 3 4 5 6 7 8 9 10
job rotation across projects	0 1 2 3 4 5 6 7 8 9 10
consultative style communication	0 1 2 3 4 5 6 7 8 9 10
command style communication	0 1 2 3 4 5 6 7 8 9 10
effective communication between marketing and technical personnel	0 1 2 3 4 5 6 7 8 9 10
inter-organizational networking	0 1 2 3 4 5 6 7 8 9 10
external consultations (direct outsider involvement)	0 1 2 3 4 5 6 7 8 9 10
participative decision-making	0 1 2 3 4 5 6 7 8 9 10

MC-Sheet 3

Product testing

new technologies	0 1 2 3 4 5 6 7 8 9 10
the marketplace	0 1 2 3 4 5 6 7 8 9 10
customer orientation	0 1 2 3 4 5 6 7 8 9 10
integration of the needs of the market with technological opportunities available to fulfill those needs	0 1 2 3 4 5 6 7 8 9 10
internal sources of ideas	0 1 2 3 4 5 6 7 8 9 10
external sources of ideas	0 1 2 3 4 5 6 7 8 9 10
experience	0 1 2 3 4 5 6 7 8 9 10
capabilities	0 1 2 3 4 5 6 7 8 9 10
resources	0 1 2 3 4 5 6 7 8 9 10
risk taking	0 1 2 3 4 5 6 7 8 9 10
accepting financial risk	0 1 2 3 4 5 6 7 8 9 10
minimizing financial risk	0 1 2 3 4 5 6 7 8 9 10
complexity (e.g. of task or design)	0 1 2 3 4 5 6 7 8 9 10
clarity of goals	0 1 2 3 4 5 6 7 8 9 10
formalization	0 1 2 3 4 5 6 7 8 9 10
control	0 1 2 3 4 5 6 7 8 9 10
co-ordination	0 1 2 3 4 5 6 7 8 9 10
pre-planning	0 1 2 3 4 5 6 7 8 9 10
reducing uncertainties	0 1 2 3 4 5 6 7 8 9 10
formal specifications	0 1 2 3 4 5 6 7 8 9 10
detailed precise specifications	0 1 2 3 4 5 6 7 8 9 10
specific screening criteria	0 1 2 3 4 5 6 7 8 9 10
well defined procedures - documented if possible	0 1 2 3 4 5 6 7 8 9 10
use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)	0 1 2 3 4 5 6 7 8 9 10
use of metrics	0 1 2 3 4 5 6 7 8 9 10
output based management	0 1 2 3 4 5 6 7 8 9 10
time based management	0 1 2 3 4 5 6 7 8 9 10
incentives	0 1 2 3 4 5 6 7 8 9 10
encouragement of ideas	0 1 2 3 4 5 6 7 8 9 10
tolerance of mistakes	0 1 2 3 4 5 6 7 8 9 10
time constraints	0 1 2 3 4 5 6 7 8 9 10
budgetary constraints	0 1 2 3 4 5 6 7 8 9 10
flexible resourcing	0 1 2 3 4 5 6 7 8 9 10
early prototypes	0 1 2 3 4 5 6 7 8 9 10
running tasks in parallel	0 1 2 3 4 5 6 7 8 9 10
proficiency	0 1 2 3 4 5 6 7 8 9 10
efficiency	0 1 2 3 4 5 6 7 8 9 10
cost-efficiency	0 1 2 3 4 5 6 7 8 9 10
regular performance checking	0 1 2 3 4 5 6 7 8 9 10
detail	0 1 2 3 4 5 6 7 8 9 10
quality	0 1 2 3 4 5 6 7 8 9 10
clarity of roles	0 1 2 3 4 5 6 7 8 9 10
a designated project leader or team	0 1 2 3 4 5 6 7 8 9 10
specific responsibilities and authorities clearly assigned to specific individuals	0 1 2 3 4 5 6 7 8 9 10
rigid team structure	0 1 2 3 4 5 6 7 8 9 10
flexible team structure	0 1 2 3 4 5 6 7 8 9 10
concentration of power	0 1 2 3 4 5 6 7 8 9 10
decentralization	0 1 2 3 4 5 6 7 8 9 10
top management commitment, support and involvement	0 1 2 3 4 5 6 7 8 9 10
leadership quality	0 1 2 3 4 5 6 7 8 9 10
shared values	0 1 2 3 4 5 6 7 8 9 10
teamwork	0 1 2 3 4 5 6 7 8 9 10
co-operation	0 1 2 3 4 5 6 7 8 9 10
few opposing factions within the firm	0 1 2 3 4 5 6 7 8 9 10
interdisciplinary approach	0 1 2 3 4 5 6 7 8 9 10
specialized skills	0 1 2 3 4 5 6 7 8 9 10
cross-functional teams	0 1 2 3 4 5 6 7 8 9 10
job rotation across projects	0 1 2 3 4 5 6 7 8 9 10
consultative style communication	0 1 2 3 4 5 6 7 8 9 10
command style communication	0 1 2 3 4 5 6 7 8 9 10
effective communication between marketing and technical personnel	0 1 2 3 4 5 6 7 8 9 10
inter-organizational networking	0 1 2 3 4 5 6 7 8 9 10
external consultations (direct outsider involvement)	0 1 2 3 4 5 6 7 8 9 10
participative decision-making	0 1 2 3 4 5 6 7 8 9 10

MC-Sheet 4

SECTION THREE

Section Three: introduction and instructions.

Section three of the questionnaire examines the manner in which product realization activities are characterized ***in*** ***<u>routine</u>*** ***practice***.

This section is structured in a similar way to section two, that is: in terms of the four key generic product realization activities and those sixty-four factors which have been shown to variously characterize the process. Each activity is again represented on a separate sheet and the full set of factors characterizing the overall product realization process is reproduced on each sheet. No rating scale is provided in section three, however, as respondents are merely asked to 'check off' items in this final section.

IN ORDER TO COMPLETE SECTION THREE, RESPONDENTS ARE ASKED TO IDENTIFY, FOR EACH GENERIC PRODUCT REALIZATION ACTIVITY, THOSE FACTORS WHICH NORMALLY CHARACTERIZE THE MANNER IN WHICH THAT ACTIVITY IS *<u>ROUTINELY</u>* PERFORMED BY THEIR COMPANIES
(this may be done by 'ticking' the boxes provided opposite the relevant factors).

Managers are requested to take particular care whilst completing this section of the questionnaire, that their responses are based on the <u>actual routine practice</u> of their companies - and not on personal opinions or beliefs regarding 'best possible practice' (these are adequately reflected in managers' section two responses).

<u>Example:</u>

As for section two, the first sheet in section three covers the generic activity of 'initial concept screening'.

If a respondent thinks that 'participative decision making', for example, constitutes a routine feature of 'initial concept screening' activities in his/her company, (s)he should indicate this by ticking the box opposite it.

Otherwise the respondent should make no mark in the box opposite that factor.

AGAIN, SHOULD RESPONDENTS REQUIRE FURTHER CLARIFICATION, THEY SHOULD CONTACT THE RESEARCHER AT THE ADDRESS/TELEPHONE-NUMBER PROVIDED IN THE ACCOMPANYING COVERING NOTE.

Initial concept screening

□ new technologies
□ the marketplace
□ customer orientation
□ integration of the needs of the market with technological opportunities available to fulfill those needs

□ internal sources of ideas
□ external sources of ideas

□ experience
□ capabilities
□ resources

□ risk taking
□ accepting financial risk
□ minimizing financial risk

□ complexity (e.g. of task or design)

□ clarity of goals
□ formalization
□ control
□ co-ordination
□ pre-planning
□ reducing uncertainties
□ formal specifications
□ detailed/precise specifications
□ specific screening criteria
□ well defined procedures - documented if possible
□ use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)
□ use of metrics
□ output based management
□ time based management

□ incentives
□ encouragement of ideas
□ tolerance of mistakes

□ time constraints
□ budgetary constraints
□ flexible resourcing

□ early prototypes

□ running tasks in parallel

□ proficiency
□ efficiency
□ cost-efficiency
□ regular performance checking

□ detail
□ quality

□ clarity of roles
□ a designated project leader or team
□ specific responsibilities and authorities clearly assigned to specific individuals
□ rigid team structure
□ flexible team structure
□ concentration of power
□ decentralization

□ top management commitment, support and involvement
□ leadership quality
□ shared values
□ teamwork
□ co-operation
□ few opposing factions within the firm

□ interdisciplinary approach
□ specialized skills
□ cross-functional teams
□ job rotation across projects

□ consultative style communication
□ command style communication
□ effective communication between marketing and technical personnel
□ inter-organizational networking
□ external consultations (direct outsider involvement)

Aud-Sheet 1

□ participative decision-making

Early marketing activities *(preliminary market assessment, market research)*

□ new technologies
□ the marketplace
□ customer orientation
□ integration of the needs of the market with technological opportunities available to fulfill those needs

□ internal sources of ideas
□ external sources of ideas

□ experience
□ capabilities
□ resources

□ risk taking
□ accepting financial risk
□ minimizing financial risk

□ complexity (e.g. of task or design)

□ clarity of goals
□ formalization
□ control
□ co-ordination
□ pre-planning
□ reducing uncertainties
□ formal specifications
□ detailed/precise specifications
□ specific screening criteria
□ well defined procedures - documented if possible
□ use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)
□ use of metrics
□ output based management
□ time based management

□ incentives
□ encouragement of ideas
□ tolerance of mistakes

□ time constraints
□ budgetary constraints
□ flexible resourcing

□ early prototypes

□ running tasks in parallel

□ proficiency
□ efficiency
□ cost-efficiency
□ regular performance checking

□ detail
□ quality

□ clarity of roles
□ a designated project leader or team
□ specific responsibilities and authorities clearly assigned to specific individuals
□ rigid team structure
□ flexible team structure
□ concentration of power
□ decentralization

□ top management commitment, support and involvement
□ leadership quality
□ shared values
□ teamwork
□ co-operation
□ few opposing factions within the firm

□ interdisciplinary approach
□ specialized skills
□ cross-functional teams
□ job rotation across projects

□ consultative style communication
□ command style communication
□ effective communication between marketing and technical personnel
□ inter-organizational networking
□ external consultations (direct outsider involvement)

Aud-Sheet 2

□ participative decision-making

Prototype/sample design and development

- ☐ new technologies
- ☐ the marketplace
- ☐ customer orientation
- ☐ integration of the needs of the market with technological opportunities available to fulfill those needs

- ☐ internal sources of ideas
- ☐ external sources of ideas

- ☐ experience
- ☐ capabilities
- ☐ resources

- ☐ risk taking
- ☐ accepting financial risk
- ☐ minimizing financial risk

- ☐ complexity (e.g. of task or design)

- ☐ clarity of goals
- ☐ formalization
- ☐ control
- ☐ co-ordination
- ☐ pre-planning
- ☐ reducing uncertainties
- ☐ formal specifications
- ☐ detailed/precise specifications
- ☐ specific screening criteria
- ☐ well defined procedures - documented if possible
- ☐ use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)
- ☐ use of metrics
- ☐ output based management
- ☐ time based management

- ☐ incentives
- ☐ encouragement of ideas
- ☐ tolerance of mistakes

- ☐ time constraints
- ☐ budgetary constraints
- ☐ flexible resourcing

- ☐ early prototypes

- ☐ running tasks in parallel

- ☐ proficiency
- ☐ efficiency
- ☐ cost-efficiency
- ☐ regular performance checking

- ☐ detail
- ☐ quality

- ☐ clarity of roles
- ☐ a designated project leader or team
- ☐ specific responsibilities and authorities clearly assigned to specific individuals
- ☐ rigid team structure
- ☐ flexible team structure
- ☐ concentration of power
- ☐ decentralization

- ☐ top management commitment, support and involvement
- ☐ leadership quality
- ☐ shared values
- ☐ teamwork
- ☐ co-operation
- ☐ few opposing factions within the firm

- ☐ interdisciplinary approach
- ☐ specialized skills
- ☐ cross-functional teams
- ☐ job rotation across projects

- ☐ consultative style communication
- ☐ command style communication
- ☐ effective communication between marketing and technical personnel
- ☐ inter-organizational networking
- ☐ external consultations (direct outsider involvement)

Aud-Sheet 3

- ☐ participative decision-making

Product testing

□ new technologies
□ the marketplace
□ customer orientation
□ integration of the needs of the market with technological opportunities available to fulfill those needs

□ internal sources of ideas
□ external sources of ideas

□ experience
□ capabilities
□ resources

□ risk taking
□ accepting financial risk
□ minimizing financial risk

□ complexity (e.g. of task or design)

□ clarity of goals
□ formalization
□ control
□ co-ordination
□ pre-planning
□ reducing uncertainties
□ formal specifications
□ detailed/precise specifications
□ specific screening criteria
□ well defined procedures - documented if possible
□ use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)
□ use of metrics
□ output based management
□ time based management

□ incentives
□ encouragement of ideas
□ tolerance of mistakes

□ time constraints
□ budgetary constraints
□ flexible resourcing

□ early prototypes

□ running tasks in parallel

□ proficiency
□ efficiency
□ cost-efficiency
□ regular performance checking

□ detail
□ quality

□ clarity of roles
□ a designated project leader or team
□ specific responsibilities and authorities clearly assigned to specific individuals
□ rigid team structure
□ flexible team structure
□ concentration of power
□ decentralization

□ top management commitment, support and involvement
□ leadership quality
□ shared values
□ teamwork
□ co-operation
□ few opposing factions within the firm

□ interdisciplinary approach
□ specialized skills
□ cross-functional teams
□ job rotation across projects

□ consultative style communication
□ command style communication
□ effective communication between marketing and technical personnel
□ inter-organizational networking
□ external consultations (direct outsider involvement)

Aud-Sheet 4

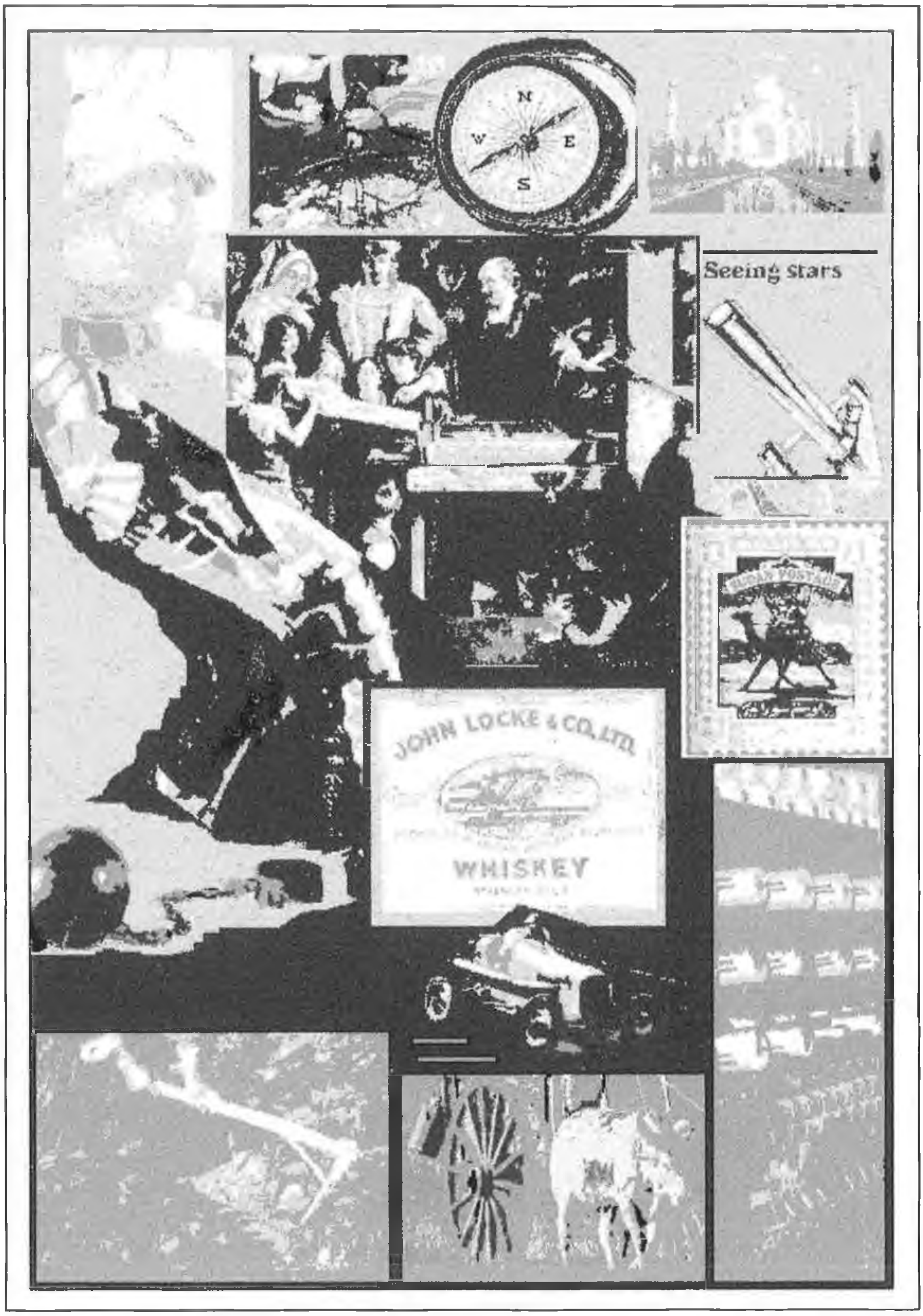
□ participative decision-making

<u>Any additional information, comments, *et cetera*</u>

APPENDIX C

Principles 01-64 in standard order listing	
1.	new technologies
2.	the marketplace
3.	customer orientation
4.	integration of the needs of the market with technological opportunities available to fulfil those needs
5.	internal sources of ideas
6.	external sources of ideas
7.	experience
8.	capabilities
9.	resources
10.	risk taking
11.	accepting financial risk
12.	minimizing financial risk
13.	complexity (e.g. of activity or design)
14.	clarity of goals
15.	formalization
16.	control
17.	co-ordination
18.	pre-planning
19.	reducing uncertainties
20.	formal specifications
21.	detailed/precise specifications
22.	specific screening criteria
23.	well defined procedures - documented if possible
24.	use of formal models and techniques (e.g. lead users, focus groups, product life cycle models)
25.	use of metrics
26.	output based management
27.	time based management
28.	incentives
29.	encouragement of ideas
30.	tolerance of mistakes
31.	time constraints
32.	budgetary constraints
33.	flexible resourcing
34.	early prototypes
35.	running activities in parallel
36.	proficiency
37.	efficiency
38.	cost-efficiency
39.	regular performance checking
40.	detail
41.	quality
42.	clarity of roles
43.	a designated project leader or team
44.	specific responsibilities and authorities clearly assigned to specific individuals
45.	rigid team structure
46.	flexible team structure
47.	concentration of power
48.	decentralization
49.	top management commitment, support and involvement
50.	leadership quality
51.	shared values
52.	teamwork
53.	co-operation
54.	few opposing factions within the firm
55.	interdisciplinary approach
56.	specialized skills
57.	cross-functional teams
58.	job rotation across projects
59.	consultative style communication
60.	command style communication
61.	effective communication between marketing and technical personnel
62.	inter-organizational networking
63.	external consultations (direct outsider involvement)
64.	participative decision-making

APPENDIX D



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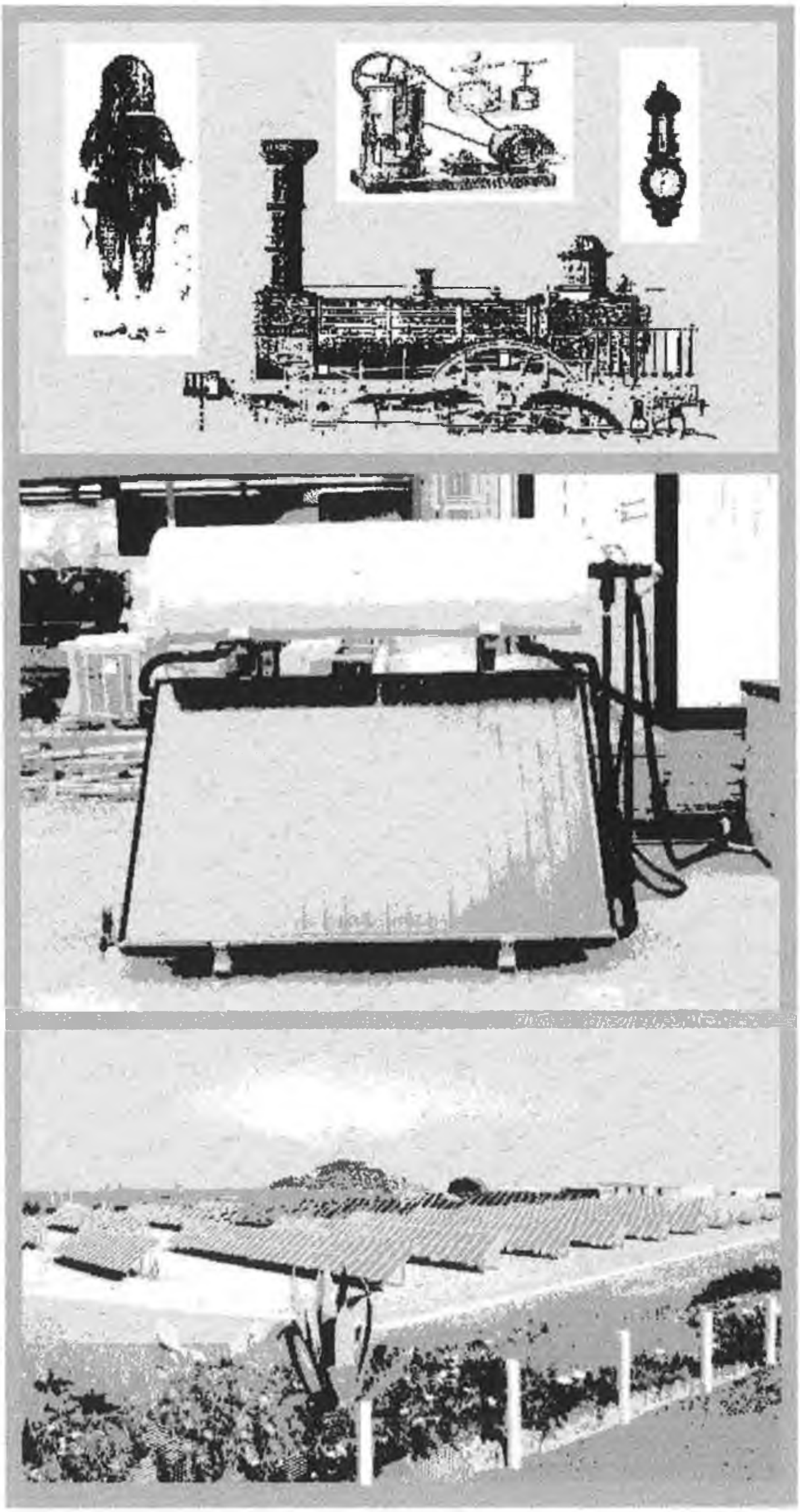
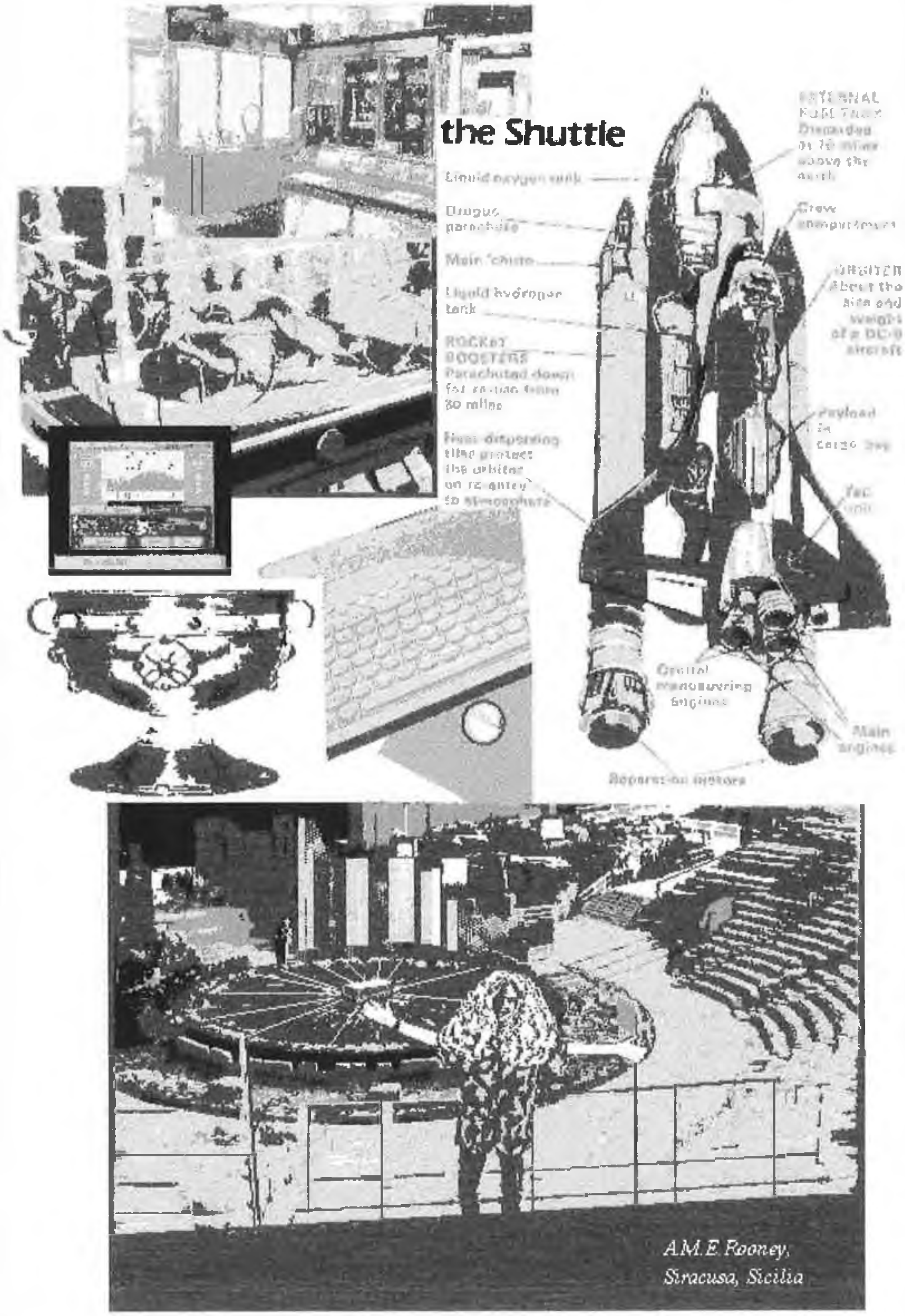


D4



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