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Innovation Performance Accounting

Financing Decisions and Risk Assessment of Innovation Processes

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Foreword

Innovation Profitability Analysis: A Challenge for Business Research and Entrepreneurial Practice

In 2007 Professor Werner Pfeiffer, the doyen of German innovation and technology management, celebrated his 75th birthday. His most well-known works are the "Allgemeine Theorie der technischen Entwicklung als Grundlage einer Planung und Prognose des technischen Fortschritts" ("General theory of technological development as the basis for planning and predicting technological progress"), Göttingen 1971, and the "Technologie-Portfolio zum Management strategischer Zukunftsgeschäftsfelder" ("Technology portfolio for the management of strategic future business areas"), Göttingen 1982, which he co-authored with G. Metze, W. Schneider and R. Amler. His two students, a grandson and a follower of the "Pfeiffer School", wanted through this book, "Innovation profitability analysis", to write a new chapter in innovation research.

Innovation profitability analysis is a theoretical approach which follows the tradition of business accounting in technology and innovation management. It uses the classic tools, techniques, key figures and data of accounting, i.e. the methods of bookkeeping, financial statements and the analysis of financial statements, cost accounting, financing and investment, but also the theory of business taxation to apply these, depending on the nature of the business innovation problem, to calculations which will form the basis of business decisions about innovations. In this way it employs "classic business management" for the purposes of innovation management. In the past innovation and technology management have tended to be characterised by strategic management, (international) innovation marketing and technology transfer, the use of creativity techniques and technical forecasting statements, technology evaluations as part of a technology philosophy, competition, patent and regulatory issues, organisational and innovation business issues and human resources problems.

The aim of innovation profitability analysis is primarily to evaluate business earnings in the form of an investment appraisal and a Balanced Scorecard and/or revenue surplus, e.g. using a future-oriented free cash flow calculation including risk factors.

Hauschildt[1] also sees that "innovation profitability analysis" should have the practical business requirements at least of a development and design department, that is, the function(s) of project, investment, planning and control accounting as well as of a profit and loss statement.

The background is the assumption that most innovations produced by a business can be planned, directed and controlled by means of R&D controlling or innovation marketing[2], to the extent that the technological innovations take place in a concrete development stage[3] or in the stage of an assembly-oriented design phase. According to the contribution of Steinhoff, who discusses the degree of innovation in success factor research, application-oriented, business issues which apply the tools and techniques of controlling, financial statements, the analysis of financial statements and financial controlling to research and technology controlling are seldom found.

In accompanying innovative engineering accomplishments from patent application through the development and design phases, production planning and innovation marketing, including patent evaluation and exploitation with business management accounting of operational and strategic controlling, through to achieving a profitable innovation, the starting point of the book is precisely here.

The basic idea of innovation profitability analysis is to provide value creation management and (competitive) success factor guidance in the sense of the Porter approach or a kind of standard "innovation process chain total accounting" for innovation processes in the company, which integrate project, investment, planning and control accounting as well as profit and loss statements. Innovation profitability analysis in the sense of an innovation process chain approach has to be quantifiable both proactively and retroactively, i.e. from development through to the potential market and vice versa. Innovation profitability analysis thus involves taking an integrated look at the product life cycle, which also has to include the future development cycle of innovation, the market life cycle and the recycling cycle as, for example, in an innovative/new generation of cars.

One example of such a "total accounting concept" is the approach of the Berlin Balanced Scorecard, which shows that strategies and success factors can be guided by innovations, e.g. by means of the technology portfolio, and quantified and, with the aid of value added statements, target costing and the generation of target prices using conjoint analysis, process costing, risk-adjusted cash flow calculations, investment appraisals, human capital calculations, break-even analyses, budget accounting, recognition of intangible assets, funds flow statements etc., present the different problem areas of an innovation process in business terms.

In following this approach, the authors of business innovation research seek to open up another application area, namely to include it in the accounting, and hence in cost-efficiency analysis and profit and loss statements. The corollary of this is that the accounting system has to cope with a new research object, raising the issue of

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[1] Hauschildt, "Die Innovationsergebnisrechnung – Instrument des FuE-Controlling", 1974

[2] Schmeisser, Kantner, Geburtig, and Schindler, 2006

[3] See contributions in this book on IFRS accounts presentation and patent valuation.

how best to apply cost-efficiency analysis and profit and loss statements to R&D, technology and innovation, while taking special account of the risks associated with the relevant technology fields and also bearing in mind the legal protection of industrial property and patent and trademark law.

When one considers that the economics side of business innovation research began with Schumpeter's theory of economic development and the innovative (inventor) entrepreneurs of 1911, and that Werner Pfeiffer, the doyen of a business function of research and development management and innovation management, introduced this into business teaching through his work on the theory of technological progress in 1971 and his "Technology Portfolio" of 1982, we are still dealing here with a very young business function.

Approaches to innovation research from the perspectives of strategic management, organisation research, personnel economics and marketing were and have been comparatively analysed since the 1970s and 1980s, e.g. by Brockhoff, Hauschildt, Trommsdorff and others.

The following topics are covered in the book:

- Whether and which success factors, dimensions and aspects of the phenomenon of "innovation" can be regarded as of central importance to an explanation (e.g. innovation as a contingency factor);
- Which are the dominant questions on the basis of prevailing knowledge and theoretical approach (technological predictions and forecasting techniques for weak signals, technology assessment, methods inventions, creativity techniques, search field analysis, assessment of research projects and research programmes, promoter model, venture capital management);
- Whether and to what extent the results of these approaches can offer practical design hints for the enterprise or for research and development management or innovation management.

Due to the heterogeneity of the individual approaches in innovation research, the practical controlling aspects of development and technology management have tended to be obscured, and since the 1990s research has been directed more at the economics of innovation (Burr 2004) than at a theoretical frame of reference.

In this book on innovation profitability analysis, the emphasis is more on business topics which discuss the methods of accounting, patent valuation and exploitation, the controllability of research results in innovation projects through qualitative tentative ideas in order to then transfer them to commercial calculations in a scenario-specific way. For this reason the discussion centres on the following points of emphasis:

(1) Innovation and technology management as a way of strategically and operationally controlling intangibles within the framework of patent valuation and exploitation, IFRS accounting for development projects and the Berlin Balanced Scorecard approach;

(2) Industry and business analysis and their valuation with the aid of selected business valuation methods and their risk factors, e.g. of the technology portfolio;
(3) Generation of target prices with the aid of selected innovation marketing methods and the cost accounting recording and control of R&D, production planning and innovation marketing activities with the support of the technology portfolio, the Berlin Balanced Scorecard, target costing, process costing and budget accounting;
(4) Analysis of the innovation process and value-added chain with a view to enabling companies to review whether a technological innovation will pay its way;
(5) Innovation controlling and integration of the legal protection of industrial property, especially patent law, into the innovation profitability analysis, and indeed from idea through to the lapse of patent and trademark protection.

If it is possible to provide superior, innovative services on a competitive basis which are important to the customer and the benefits of using them are also perceived, then their success factors must be ascertainable. Target prices can then be set for these innovative services using the tools of market research, they can be defended over time by the patent and costs can be assigned during product development.

This creed is pursued by industry in its practical controlling approaches, and this book also follows this line of thinking. If target prices, sales, market potentials, market growth, costs recognised as cash outflows etc. can be assigned to an innovation, then it becomes possible to perform cost-efficiency analysis and prepare profit and loss statements on innovations and to include intangibles such as patents and technical know-how in the balance sheet.

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Fee Steinhoff

1.1 Introduction

The overriding goal of the innovation profitability analysis is to make the innovator aware of what level of (intangible) capital expenditure the exploitation of an innovation on the market warrants. The innovation profitability analysis should also be a project, investment, planning and control plan, as well as a profit and loss forecast (Hauschildt 1994, p. 1018 et seq.). Based on the function of profit and loss forecasting, there is a close connection to innovation success factor research. Success factor research looks for the relevant criteria that make the difference between the success and failure of an innovation: For what specific reasons is one innovation successful in the market while another fails?

A glance at the track record of innovation ideas in practice makes the relevance of success factor research clear: In a cross-sector, empirical, long-term study of product innovations in 116 companies, only 0.6% of the 1,919 product innovation ideas surveyed proved to be marketable and successful. Innovation ideas are put through a stringent selection process: Not even 10% of the initial ideas reached the market as products; of those that made it, some 70% were eliminated by the market as flops . Of the products remaining in the market, 46% made a loss, 33% returned no appreciable profit, and only 21% (ultimately 0.6%, or 11 of the 1,919) were successful (Berth 1993, p. 217).

The flop rate findings highlight the need for experience of success factors of innovations in practice. A large proportion of the failures could be avoided if decision-makers had more relevant, reliable, and proven information and would use it. An interesting question in this context is: What role does the degree of novelty of innovations play? Are innovations of a low degree of novelty (incremental innovations) or those of a high degree of novelty (radical innovations) more promising? Alternatively, is product innovativeness a success factor for innovations at all? Or is it rather a contingency factor?

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This paper addresses that question. For this purpose, we will first look into success factor research (Section 1.2). Section 1.2.1 presents the state of research on the measurement of innovation success. Section 1.2.2 provides an overview of the key findings of success factor research. Section 1.3 focuses on the connection between product innovativeness and success. Based on a perception of product innovativeness as a multi-dimensional construct (Section 1.3.1), a synopsis of available empirical findings on the influence of product innovativeness on success is presented (Section 1.3.2). Finally, the question is pursued as to what extent product innovativeness can be understood as a contingency variable in innovation management (Section 1.3.3). The paper ends with a summary of significant findings (Section 1.4).

1.2 Success Factor Research

The goal of innovation management is success (Hauschildt 1991, p. 452). While appropriate management activities cannot guarantee the success of an innovation, they can substantially increase the chances for success (Lynn et al. 1996, p. 81). Both the practice and science of innovation management are therefore greatly interested in the question of what characterizes the success of innovations.

The concept of success factors stems from the empirical orientation of research established in the 1960s, which has been pursued continuously up to the present. Success factor research aims for both strategic "effectiveness " (do the right thing) and operational "efficiency " (do it right, i.e., economically). The decision to establish an innovation idea as a project is an effectiveness decision ("do the right thing"). Beyond this question of "whether to do it," the project's priority influences its effectiveness: How intensively it is pursued in relation to other activities can also be the right or the wrong thing. This decision of resource allocation must be supported by appropriate methods of analysis. The subsequent product development and marketing within a resource budget is, by contrast, not a question of effectiveness, but rather of efficiency ("do it right"; Cooper 1999, p. 115 et seq.).

In order to assess relevance of management activities for success, the question is initially posed as to what is understood to be innovation success (Hauschildt 1991, p. 452). Section 1.2.1 provides an overview of the state of the research on measurement of innovation success. Then an overview of significant findings of success factor research is presented (Section 1.2.2).

1.2.1 Measurement of Innovation Success

While innovation research has dealt intensively with the topic of the measurement of success (for an overview, see Ernst 2001, p. 165 et seq.; Hulting and Robben 1995, p. 393 et seq.), to date, no universal, context-free measurement approach has caught on (Wall et al. 2004, p. 115; Griffin and Page 1996, p. 483). What constitutes innovation success varies substantially in how it is subjectively experienced, and

success is operationalized inconsistently in the research. If the results are supposed to support strategic decisions, common key business management indicators such as ROI are not adequate. Rather, success must then also reflect long-term goals and the objectives of the relevant company or innovation project.

Available approaches for the measurement of innovation success can be differentiated by (1) the level of examination, (2) the success dimensions used, and (3) the underlying data collection method (Hart 1993, p. 23; Hauschildt 1991, p. 464 et seq.). The level of examination (1) is understood to mean the object/area to which the success measurement relates. In this context, a distinction is made between success at company level and success at project level. The examination of company-level success (e.g., sales growth, profitability; for an overview, see Venkatraman/Ramanujam 1986, p. 802 et seq.) is problematic for two reasons. On the one hand, success at company level is determined not only by innovations but also by a multitude of additional internal and external factors. This means that there is no clear causality between successful innovation management and success at company level (Cooper and Kleinschmidt 1996, p. 19; Hart 1993, p. 26). On the other hand, the measurement of success at company level represents a measurement approach based on past activity: A company's current sales and profitability figures reflect the success not of its current but its past innovation activity (Billing 2003, p. 155). As a consequence, scientific research is dominated by the measurement of innovation success at project level (Hart 1993, p. 26).

In terms of success dimensions (2), a distinction is made at project level between results-related and process-related success indicators (Krieger 2005, p. 30 et seq.; Griffin and Page 1996, p. 486). Results-related criteria are output-oriented: They reflect the results of innovation projects or their contribution to change in the economic position of a company (Gerpott 1999, p. 81). Key criteria for economic market success are profit or loss, the market share, and the image improvement of an innovation (Griffin and Page 1996, p. 485; Cordero 1990, p. 188 et seq.; Rubenstein et al. 1976, p. 17). By contrast, the technical success of an innovation and the company's gain in expertise represent significant internal success criteria (Billing 2003, p. 157; Cordero 1990, p. 187 et seq.; Rubenstein et al. 1976, p. 17). While technical success is related to the current, physical result of the R&D process (Olschowy 1990, p. 52), the strategic expansion of internal expertise can be seen as an important future-oriented success indicator (Maltz et al. 2003, p. 189; Hart 1993, p. 25).

Since a successful result presumes a successful process, concomitant process-related success criteria are frequently used (in particular for long innovation processes and in early phases). Behind this is the idea that innovation success is based on the fulfillment of partial performances which can be assessed on a phase-specific basis at predetermined project milestones throughout the entire process (Billing 2003, p. 158; Hauschildt 1991, p. 471). Process-related success criteria can be depicted by the following three goals: the quality/benefit of innovation, the associated expense, and the time needed (Krieger 2005, p. 30 et seq.; Scigliano 2003, p. 51; Pleschak and Sabisch 1996, p. 9).

Finally, the literature on data collection methods (3) differentiates between objective and subjective measurement of success. Objective success measurement is

based on value-based, absolute indicators of result- or process-related success criteria (e.g., market share as a percentage, expenses in EUR). Subjective success measurement, by contrast, is based on recording the subjectively perceived degree of target achievement of the underlying success criteria. Intuitive estimates are normally converted into numerical values (e.g., rating the degree of target achievement on a scale of 1–7; Werner and Souder 1997, p. 34 et seq.).

Although the smaller scope for interpretation and the related better intersubjective comparability represent significant advantages of objective success indicators (Venkatraman and Ramanujam 1987, p. 117 et seq.), subjective success measurement dominates in science (Wall et al. 2004, p. 96; Werner and Souder 1997, p. 35; Hauschildt 1991, p. 464 et seq.). For example, the information policy of many companies does not permit the use of sensitive objective figures (e.g., earnings) (Ernst 2001, p. 168). In addition, in contrast to objective indicators, subjective indicators can also be used to estimate future expectations of success. That is especially relevant for the assessment of projects in which the innovation has not yet or has only recently been introduced on the market. In such cases, reliable objective data are normally not yet available (Werner and Souder 1997, p. 34 et seq.). Finally, subjective criteria show a high level of validity: Strong correlations are reported between subjective and objective success criteria in empirical studies (e.g., Wall et al. 2004, p. 112; Voss and Voss 2000, p. 76).

1.2.2 Overview of the Field of Research

As already presented in the introduction, success factor research aims to identify factors that significantly influence innovation success. High flop rates of innovations in the market led to a general awareness of the problem and to the quest in management research for reasons for success and failure of new products. There is no standard method for success factor research and a wide range of empirical methods are used from qualitative interviews to standardized surveys. Normally, a random sample of cases is investigated for factors that discriminate between success and failure. Frequently, success is operationalized by one or more dependent variables, and independent variables are analyzed as potential success factors using multivariate statistics (Trommsdorff 1991, p. 182).

The current status of success factor research is based on the work of many researchers. Important early studies include the "SAPPHO" study (Rothwell et al. 1974), the "Stanford Innovation Project" (Maidique and Zirger 1984), and the continuously enhanced "NewProd-Project" of Cooper and his research team (e.g., Cooper and Kleinschmidt 1993). In addition to studies that examine a wide range of potential success factors, there are a few that undertake a deeper analysis of a limited number of success factors (e.g., Gruner and Homburg 2000).

The volume of findings concerning innovation success factors has grown to almost overwhelming proportions. Even ignoring many individual studies and focusing on the common elements from synopses and meta-analyses, the quantity of findings is difficult to grasp. However, if an attempt is made to qualitatively

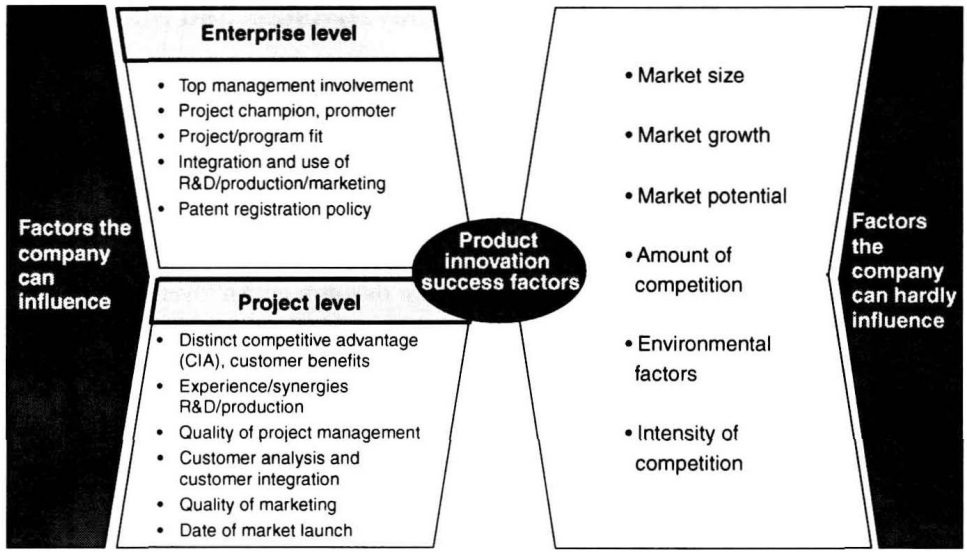

Fig. 1.1 Success factors of innovations after 25 years of research
[Source: Trommsdorff and Steinhoff 2007, p. 70 (Synopsis of numerous studies, including Montoya-Weiss and Calantone 1994; Melheritz 1999; Henard and Szymanski 2001)]

integrate them, with an eye on the prevailing findings that have repeatedly appeared with various methods and in different research contexts, it is possible to generically summarize three decades of success factor research (see Fig. 1.1). It appears that a very large portion of the success/failure variance is caused by factors that, broadly speaking, relate to marketing. Among these factors are strategic and operational marketing decisions and information from (innovation) market research that underlie such decisions.

The findings of success factor research provide great benefits for innovation management, but they have also been criticized in the past. The criticism centers on the fact that findings for the same or similar independent variables vary, in some cases significantly, in terms of the strength of their influence (van der Panne et al. 2003; Henard and Szymanski 2001). Significant points of criticism relate to the use of inconsistent and weak methods of measurement, insufficient theoretical underpinning, as well as the neglect of contextual factors (Ernst 2002; Haenecke 2002; for detailed criticism, see Steinhoff 2006, p. 19 et seq.).

In addition, the operational details of innovation management are highly complex, such that the information requirement for efficiency extends beyond the scope of success factor research. Management needs information regarding precise conditions of innovation from the specific situational analysis. For this purpose, innovation market research must deliver external information, in particular concerning the expected behavior of the target customers, partners, and competitors. Nevertheless, the results of general success factor research can be meaningfully used in practice to support the decision-making process and are substantiated by science. The list is therefore useful as a checklist that should accompany each innovation project.

1.3 Connection Between Product Innovativeness and Success

One criterion that has increasingly been taken into consideration in success factor research in recent years is the degree of novelty of innovations (Ernst 2002, p. 33; Tidd and Bodley 2002, p. 129). The question arises as to what influence this factor has on innovation success. Are slight improvements, so-called incremental innovations, more successful than revolutionary, radical innovations? The exploration of this question initially requires one to wrestle with the construct of degree of novelty. Section 1.3.1 addresses this topic. An overview of findings regarding the influence of product innovativeness on success is then provided (Section 1.3.2).

1.3.1 Product Innovativeness as a Multi-dimensional Construct

Manufacturers of frozen foods, cigarettes, and detergents like to characterize anything that corresponds to a new brand, mixture, flavor, fragrance, or even packaging as an innovation. Providers of financial services combine parameters of conditions into "new products." Each stylish variant of a clothing producer's product is an "innovation." There have been enormous revolutions in business and the economy as a result of new products such as video and CD, PC and Internet, fax and mobile telephone, catalytic converters and ABS. The following may appear fairly innovative: the entry of Mannesmann into mobile telephony, that of Deutsche Bahn AG (German State Railways) into customer-oriented services such as steward services provided by conductors in first class, that of many banks into direct banking, and the founding of countless Internet-based companies. Which of these is more innovative than the others?

An innovation is more or less novel and has a "degree of innovation" on the continuum between the smallest (incremental) change and complete (radical) revolution. The degree of novelty of an innovation (or synonymously: product innovativeness) expresses the degree of difference of an innovation in relation to the previous state (Hauschildt 2004, p. 14). In the literature on innovation management, which is strongly influenced by the United States, a great many terms exist for innovations with a high degree of novelty: radical, really new, discontinuous, architectural, evolutionary, revolutionary, highly innovative, major, break-through, and substantial. The problem is that these terms for the most part are not clearly defined and delineated and are not used consistently. As a result, the comparability of the results of scientific research and the applicability of results in practice is very limited (Garcia and Calantone 2002, p. 110 et seq.; Danneels and Kleinschmidt 2001, p. 358).

Newer approaches regarding product innovativeness conceptualize and operationalize product innovativeness as a multi-dimensional construct on the basis of an analysis of existing research approaches (e.g., Salomo 2003; Billing 2003; Garcia and Calantone 2002; Avlonitis et al. 2001; Hauschildt and Schlaak 2001; Danneels and Kleinschmidt 2001; Green et al. 1995). Considered as a whole, it becomes

clear that the novelty of an innovation is not a one-dimensional construct, but rather should be described and operationalized (1) by multiple perspectives ("new for whom?": micro- vs. macro-perspective) and (2) by multiple determinants and consequences ("new in what respect?": market, technology, organization, and environment). Based on the integrated consideration of the existing research by Salomo (2003, p. 412 et seq.) and Billing (2003, p. 30 et seq.), product innovativeness can be conceptualized with the help of the following four dimensions:

- *Degree of market innovation*: The degree of market innovation provides information on how greatly the innovation differs from existing products in the market. From the perspective of the innovating company (micro-perspective), a high degree of market innovation is connected with addressing a new market and new customer groups. Such innovations give rise to relatively high levels of uncertainty, but also to the opportunity to fundamentally improve the company's market position. From the view of the industry (macro-perspective), innovations with a high degree of market innovation offer profoundly new benefits, but are normally also connected with extensive changes in learning and behavior as well as increased adoption risk for potential customers.
- *Degree of technological innovation*: The degree of technological innovation is derived from the scope of technical novelty associated with the innovation. The use of new technological principles makes possible great leaps in performance and, as a result, frequently displaces existing technologies. Consequently, innovations with a high degree of technological innovation both at the micro- and macro-levels are associated with comparatively great technological uncertainties.
- *Degree of organizational innovation*: The degree of organizational innovation focuses on the internal micro-perspective. Profound innovations are frequently associated with new, formal, organizational structures and processes. However, they also affect informal characteristics of organizations, for example by changing corporate culture. This is reflected, for example, in intensified and more open collaboration with external business partners. Strategic realignment is also a feature of innovations with a high degree of organizational innovation.
- *Degree of environmental innovation*: The degree of environmental innovation is an aspect of the industry-wide macro-perspective that has frequently been neglected. Innovations influence not only the direct market players (in particular, providers and consumers), but also the more broadly conceived environment. Particularly radical innovations frequently demand the set-up of new infrastructure, as well as considerable adjustments to regulatory and social conditions.

The conceptualization of product innovativeness as a four-dimensional construct is summarized in the Fig. 1.2.

Product innovativeness can be determined by means of the four dimensions described. Following the approach of Garcia and Calantone (2002, p. 121), different types of innovations can be defined based on the combination of the four dimensions of product innovativeness (Salomo 2003, p. 406 et seq.): Radical innovations show comparatively high levels of discontinuity in all four dimensions. It must be