

ISSN 1613-9615

Journal of Business Chemistry

Vol. 2, Iss. 2

May 2005

Internationalisation of SMEs: A Micro-Economic Approach

Jan Smolarski, and Neil Wilner

"Sensory Fit Panel" - Development of a New Advertising Claim Support Method to Assess Aesthetic Diaper Fit Performance

Claudia Liedtke, Iris Christ, and Frank Wiesemann

High-Performance Research for High-Tech Materials

Andreas Gutsch, and Michael Dröscher

Published on Behalf of the Institute of Business Administration at the Department of Chemistry and Pharmacy, Westfälische Wilhelms-University Münster, Germany

www.businesschemistry.org

EDITORIAL BOARD

Editor-in-Chief

Dr. Jens Leker, Professor of Business Administration in the Natural Sciences, University of Münster, Germany

Executive Editors

Lars Hahn,
Stefan Picker,
Dr. Carsten Vehring

Language Editor

Madeleine Vala, PhD

SUBSCRIPTION

The Journal of Business Chemistry (Print ISSN 1613-9615, Online ISSN 1613-9623) is published every four months by the Institute of Business Administration at the Department of Chemistry and Pharmacy, University of Münster.

Online-Subscription is possible at subscription@businesschemistry.org. Free download is available at www.businesschemistry.org.

AIMS AND SCOPE

The *Journal of Business Chemistry* examines issues associated with leadership and management for chemists and managers in chemical research or industry. This journal is devoted to the improvement and development of the field of Business Chemistry.

The *Journal of Business Chemistry* offers a means for researchers and practitioners to present their results in an international forum.

ABSTRACTING AND INDEXING

Journal of Business Chemistry is covered by the following abstracting and indexing services:

- EBSCO Publishing (www.ebsco.com)
- Hamburg Institute of International Economics (online databases and print archive)
- German National Library of Economics

COPYRIGHT

Copyright © 2005 Institute of Business Administration, University of Münster

All Rights Reserved. No part of this publication may be reproduced or transmitted, in any form or by any means, electronic, mechanical, photocopying, recording, scanning or otherwise, except as described below without the permission in writing of the Publisher.

Copying of articles is not permitted except for personal and internal use, to the extent permitted by national copyright law. Requests for permission should be addressed to the publisher.

Statements and opinions expressed in the articles and essays are those of the individual contributors and not the statements and opinions of the Institute of Business Administration, University of Münster. The Institute and the University of Münster assume no responsibility or liability for any damage or injury to persons or property arising out of the use of any materials, instructions, methods or ideas contained herein. The Institute and the University of Münster, expressly disclaims any implied warranties or merchantability or fitness for a particular purpose. If expert assistance is required, the services of a competent professional person should be sought.

SERVICES

For advertisement please contact:
ads@businesschemistry.org

PUBLISHER

The Journal of Business Chemistry (ISSN 1613-9615) is published by the Institute of Business Administration at the Department of Chemistry and Pharmacy, Westfälische Wilhelms-University, Leonardo-Campus 1, 48149 Münster, Germany.

Contents

Letter from the Editors

Research Paper

<i>Internationalisation of SMEs: A Micro-Economic Approach</i> Jan Smolarski, and Neil Wilner	55
<i>“Sensory Fit Panel” – Development of a New Advertising Claim Support Method to Assess Aesthetic Diaper Fit Performance in an Objective, Reliable And Reproducible Way</i> Claudia Liedtke, Iris Christ, and Frank Wiesemann	70

Practitioner’s Section

<i>High-Performance Research for High-Tech Materials</i> Andreas Gutsch, and Michael Dröscher	89
--	----

Letter from the Editors

Defining “Business Chemistry”

What is “business chemistry”? After one successful year of the new international “Journal of Business Chemistry” we will try to answer that question in this fourth issue.

It all started seven years ago with the foundation of an interdisciplinary institute of business administration at the department of chemistry and pharmacy (University of Muenster, Germany) – as far as we know the only such construct in the academic world. Naturally research at this institute would focus on management and business questions, problems and solutions for all industries closely related to the chemical and pharmaceutical industry, with biotechnology and nanomaterials as two of the “hot spots”. Interestingly we found that this interdisciplinary field was quite new but we also found that some people were working on research questions closely related to our own. To give this whole research area a name, we choose “business chemistry”. And to support this new idea and give all people over the world a forum to publish their research, we founded the “Journal of Business Chemistry”.

The term “business chemistry” is surely not perfect, and as all new terms do, they sometimes confuse people. Misinterpretations were not uncommon – from native speakers as well as from others. Looking back to all the issues of the “Journal of Business Chemistry” we see how diversified and broad the field of “business chemistry” is. It ranges from portfolio analysis, economics and politics to financial aspects, strategies and product test systems. However, there are two things that they all have in common. First, all articles have a connection to one industry setting (making all conclusions within this field comparable). Second, all articles are interdisciplinary in nature as they combine at least two different academic spheres (giving deeper insight than conventional research does).

So what does “business chemistry” mean? “Business chemistry” is the research field which combines all aspects of business administration and management in the context of the chemical and pharmaceutical industry in an interdisciplinary approach.

Now enjoy reading the articles. If you have any comments or suggestions, please send us an e-mail to contact@businesschemistry.org. We thank all authors, reviewers and editors for their great contributions.

Stefan Picker
Madeleine Vala, PhD
Lars Hahn
Dr. Carsten Vehring
Prof. Dr. Jens Leker

Research Paper

Internationalisation of SMEs: A Micro-Economic Approach

Jan Smolarski*[#] and Neil Wilner**

* School of Business Administration, University of Stockholm, SE-106 91 Stockholm, Sweden

** College of Business Administration, University of North Texas, Denton76201, Texas, USA

Correspondence to: jsm@fek.su.se

Abstract: Internationalisation can be crucial to the long-term success of small- to mediumsized businesses, especially since they are expected to show international growth at an early stage. Our research explores whether firms using an opportunistic portfolio approach are more successful in their efforts to internationalise than are firms using the stage and network approaches. Our research may be characterized as a multi-company longitudinal clinical case study using triangulation to analyse data. The sample consists of six Nordic business-to-business, high-technology firms with sales of €100,000 to €10 million. Four of the six firms had significant revenue from the food industry, petrochemicals, pharmaceuticals, bulk and speciality chemicals and the pulp and paper industry. The results indicate that the opportunistic portfolio model provides some explanation of how firms can internationalise successfully.

Introduction

It is important to study variables and processes that affect success in internationalisation as small- to medium-sized enterprises (SMEs) are increasingly competing in the global marketplace. Internationalisation can be crucial to a firm's long-term success, and the scale of expansion and risks involved are substantial [1]. Internationalisation involves substantial monetary commitments and risks that affect long-term profitability, influence capital allocation among investors, and ultimately, affect stakeholder value. Even primarily domestically oriented SMEs must be internationally competitive to help ensure their long-term viability and success [2]. Numerous strategies for internationalizing operations have been identified and studied, but the results are mixed with regard to identifying successful and/or unsuccessful strategies. Sample selection, methodology, and the confusing effects of strategies employed simultaneously have led to these results. Therefore, applying a single theory or method of internationalisation, such as foreign direct investment, stage theory, or network theory has yielded inconsistent results across firms operating in complex environments.

The internationalisation process is especially important for SMEs that wish to become players outside their domicile. Understanding and managing the process is critical since SMEs are expected to demonstrate international growth at an early stage. Autio, Sapienza, and Almeida [3] showed that the earlier a firm internationalised, the more rapidly it internationalised. To date, most studies have focused on identifying the variables that affect internationalisation. These variables include age, size, growth rate, founder presence, ownership structure, independence, and management preference. It is furthermore important to determine which among many variables and processes affect success in internationalisation. Several studies have focused on models of internationalisation which appear suitable under specific circumstances; few studies, however, have focused on the processes associated with internationalisation. We focus specifically on how the method of internationalisation used

affects a firm's success and how firms manage the process of internationalisation.

This paper contributes to the literature in three main ways. First, it attempts to enhance existing theories by incorporating a risk/return framework. Second, it incorporates longitudinal clinical case research, which helps to enhance our understanding of how SMEs operate. Third, it further develops our understanding of how firms internationalise. We also address some of the criticism of existing studies.

We used a survey instrument combined with interviews and observations of the decision-making processes of several firms. The sample consisted of six privately held Nordic business-to-business high technology firms with sales of € 100,000 to € 10 million. We focused on the method and process of internationalisation and followed the firms for a two-year period.

The term 'success' is used throughout this paper and is defined as a percentage of total sales which are international in a one-year increment. Quantitatively, success is defined as international sales of over 30% of total sales on a sustained basis, 'sustained' being defined as not experiencing over a 30% decrease in international sales on a year-to-year basis. This is similar to how the literature defines it, with the exception of one stream of research that focuses on performance as measured by increases in share value. As a secondary measure, we consider the number of foreign customers gained by each firm during the study period. According to our measure, all firms were successful during the period of study. Other terms that we use throughout the paper include stage model, network model and opportunistic model. To provide clarity to the reader, definitions of these terms are provided. The term stage model means that firms internationalize using a staged approach. A staged approach may mean that (1) firms start exporting their products and then open offices, building production facilities et cetera. It may also indicate that (2) firms expand geographically in stages, such as first expanding into countries adjacent to the country of origin and then into countries farther away. It may also mean that (3) firms begin expanding into countries with cultural familiarity. In this paper, we



define a staged approach as it is defined in (2) above. The network model is used to describe an approach to internationalization where firms utilize networks to access foreign markets. An opportunistic portfolio approach is defined as a regional approach where opportunities within the region dictate effort. For example, a Scandinavian firm may decide to expand into the German speaking part of Europe (the region) but the entry point in the region is determined by the domicile of the first customer. This is in contrast to the stage approach where a firm may decide to expand into Germany, followed by Austria and Switzerland. We argue that this is a riskier approach since a firm may invest in an expansion into Germany without achieving a return. After failure (or success) in the German market, the firm moves into the Austrian market.

This paper is organized as follows. The first section combines a literature review with theory development. This is followed by a discussion of the hypothesis. The subsequent sections discuss the research methodology and principal results, respectively. The final section provides a summary and conclusions.

Literature Review and Theory Development

This section gives an overview of relevant research into the internationalisation of SMEs. Internationalisation has been studied extensively with mixed results. Existing literature dealing with internationalisation of SMEs can be divided into three main theoretical areas: stage theory [4], network theory [5], and foreign direct investment theory. The two former models are applicable to contemporary research in international entrepreneurship. The stage model used by Gankema, Snuif, and Zwart [6] suggests that internationalisation occurs in stages. Bell [7], however, found little support for stage theory and moreover suggested that network theory may have limited merit in explaining the internationalisation process. The network model holds that a firm's network relationships are the basis for internationalisation [5]. Coviello and Munro [8] suggested that the internationalisation process for

small software firms reflected a stage model that is driven, facilitated, and inhibited by network relationships. The foreign direct investment theory literature primarily explains investment patterns [9]. This theory appears to be less applicable to studying the behaviour of specific firms and is only briefly presented in this paper.

The results of studies applying all three of the above theories are generally mixed. Yip, Biscarri, and Monti [10] found that 'firms on average do not use a systematic approach in their efforts to internationalise', although the degree of systemisation appears to have affected firm performance. Apfelthaler [11] found some support for the foreign direct investment model, but suggested that individual bias was the major factor in the decision to internationalise. The origin of the bias was not identified. Like Yip, Biscarri and Monti [10], Chetty and Campbell-Hunt [1] also suggested that internationalisation is less likely to be pre-conceived or planned in detail. Andersson [12] found partial support for the stage model, but concluded that entrepreneurial behaviour was the most important factor in efforts to internationalise. Coviello and Martin [13] found incremental support for the network and stage models. They suggested that in internationalizing, the firms they studied used a combination of all three approaches. This indicates a pattern that is more complex than previously thought. Jones [14] found little direct support for the stage model. Instead, the firms in her sample followed their own individual, customized paths of internationalisation. Importantly, she found that resource and knowledge constraints were not as limiting as the stage and network models would suggest. This is similar to the results of Coviello and Martin [13] and Autio, Sapienza, and Almeida [3].

McDougall and Oviatt [15] and Coviello and Martin [13] maintain that there is little consistency in the results of existing research. This inconsistency leads us to believe that researchers need to explore alternatives. We are thus putting forward a fourth model of internationalisation, which we shall term the opportunistic portfolio model (OPM). OPM is based on a portfolio approach where risk is reduced through



diversification when a firm enters several countries simultaneously.

Crick and Jones [16] found significant opportunistic behaviour on the part of UK firms attempting to internationalise. Coviello and Martin [13] also found opportunistic behaviour among firms that were in the process of internationalisation. Jones [14] found considerable variation among firms' internationalisation efforts that could not be explained by firm characteristics. Anecdotal evidence from Jones' study suggested that market opportunities played an important role in internationalisation. Westhead, Wright, Ucbasaran, and Martin [17] maintained that UK firms in the process of internationalisation did not systematically evaluate alternative entry modes, suggesting widespread use of opportunism.

These studies specifically point to opportunistic behaviour in efforts to internationalise, and suggest that entrepreneurs and owners may view the decision to internationalise as a risk–return decision rather than one based on resource constraints, organizational learning, and networks. Das and Teng [18] suggest that opportunistic behaviour may play an important part in entrepreneurial behaviour, and that long-term entrepreneurial behaviour tends to limit risk-taking while attempting to maximize wealth. Their findings support similar arguments made by Kaish and Gilad [19].

It follows that the OPM approach to international expansion would be most appropriate if entrepreneurs are risk averse or risk controlling. Several recent studies have challenged the assertion of Palich and Bagby [20], who found no difference in the propensity to take risks between entrepreneurs and non-entrepreneurs. Saravathy et al. [21] maintain that the success of entrepreneurs is closely tied to the perception and management of risk. They argue that entrepreneurs focus on controlling outcomes for a given level of risk. Forlani and Mullins [22] found that entrepreneurs tended to select ventures with lower risk profiles. Chicken [23] maintains that entrepreneurs face risk in all aspects of their operations. Major risk factors include economic risks, technical risks, resource related risks, operational risks, and socio-political

risks. Brunsson [24] argues that uncertainty will affect decisions about investments, such as decisions to internationalise. Diversification, a form of risk reduction, has also been studied extensively. Qian [25] suggests that firm performance is positively related to early product diversification. Rugman [26] maintains that international diversification offers significant risk-reduction advantages. Kim, Hwang, and Burgers [27] argue risk and return play an important role in diversification within an internationalisation framework.

This paper is primarily concerned with operational risk, specifically with the risk associated with international expansion. We postulate that wealth-maximizing entrepreneurs will try to select the method of internationalisation with the lowest risk while attempting to achieve the greatest level of return; this suggests that risk–return trade-offs play a role in how SMEs internationalise.

Risk–return reward behaviour has been studied extensively in various literatures, such as those dealing with economics and finance. Research into entrepreneurial risk behaviour is inconsistent according to Das and Teng [18]. In 1952, Roy [28] presented his safety-first theory, which suggested that investors attempt to minimize the probability of ruin or failure. Provided that entrepreneurs and financiers are wealth maximizing, they would choose the method of internationalisation that minimizes risk while maximizing return. Markowitz [29] argues that investors should maximize the discounted value of future returns. Markowitz's argument goes as follows. Suppose an entrepreneur decides to expand into two countries. Theoretically, if the two countries present equal risks, internationalizing the company's operation in both countries at the same time results in lower risk. Markowitz also argued that this principle applied to investor rather than speculative behaviour. While Markowitz developed his theory to deal with constructing an optimal portfolio of securities, Lopes [30] developed a psychological theory of choice under uncertainty specifically applicable to choices that affect personal wealth. Lopes [30] refers to her theory as the SP/A theory where 'S' stands for security, 'P' for potential, and



'A' for aspiration. Lopes's definition of security is similar to that of Roy [28]. Shefrin and Statman [31] refer to Lopes's security definition as a general concern about avoiding low levels of wealth. In our case, we refer to security as the degree of wealth or level of poverty that describes the value of the firm. In a discrete sense, we can think of a firm as having a high or low value. 'Aspiration' refers to a goal and 'potential' refers to the goal of achieving high levels of wealth [31]. These variables may take on different values, but it is reasonable to expect either a high or a low value. In Lopes' framework, fear affects the attitude toward a risky outcome and hope affects the individual's disposition toward potential. Risky outcomes are evaluated using two variables. The first variable is the expected value of wealth, and the second variable is the probability that a certain payoff will be larger than other alternatives.

Shefrin and Statman [31] have developed a behavioural portfolio theory (BPT), similar to that of Markowitz [29] and Roy [28]), built upon Lopes's [30] framework. According to BPT, most entrepreneurs want to avoid failure while increasing firm value. This suggests that they want to avoid poverty and therefore avoid expansion that results in failure. As a result, the theory suggests that entrepreneurs will make decisions that minimize the risk associated with international expansion for a given level of return by taking offsetting positions. We argue that SMEs expanding into two or more countries are taking offsetting positions. Expanding into one country may help in achieving limited aspirations but does not necessarily help the entrepreneur avoid poverty; failure in one country may leave the entrepreneur in considerable difficulty. Expansion into only one country may not allow entrepreneurs to achieve high aspirations within the customary time frame assigned by venture capitalists. Firms financed by venture capital may therefore exhibit a greater propensity to expand into several countries simultaneously. This argument is consistent with the findings of Keh, Foo, and Lim [32], who argue that entrepreneurs feel able to influence future outcomes and may take appropriate actions to hedge risks. Our argument is equally applicable to investors, and we will now discuss how this framework fits into modern portfolio theory

(MPT). The main difference between BPT and MPT relates to correlation and covariance: covariances are not explicitly taken into account in BPT, while they are integral to MPT.

Modern portfolio theory suggests that entrepreneurs will select a set of options that maximizes returns for a given level of risk. The presence of risk means that the entrepreneur cannot associate a payoff with making a single investment decision. Instead, the payoff must be described as a set of outcomes and their probability of occurrence. If the returns from investing in internationalisation in each of several countries are not entirely correlated, then significant risk reduction will be achieved through diversification. Expansion into several countries may thus be a vehicle for diversifying. The characteristics of the return from internationalizing into several countries can also differ from that of a single-country investment. In summary, we argue, along with Shefrin and Statman [31], that MPT and BPT are complementary and that both are applicable in the case of SME international expansion.

International expansion is a major risk since it involves scarce human and technical resources, time, opportunity costs, and capital. Rapid expansion is dangerous and involves substantial increases in the number of employees, including management resources [1]. It follows that one way to minimize risk while maximizing wealth is to use a diversified global approach. A global approach means that the entrepreneur would internationalise into several regions, expecting that expansion into certain countries would be more successful than expansion into others. We will now discuss our model.

The opportunistic portfolio model (OPM) describes how firms internationalise using a multi-country approach. We refer to this as the global approach, consistent with the terminology of Chetty and Campbell-Hunt [1]. An important difference from the stage models is that OPM explicitly takes into account risk and return. Network models are not consistent across the literature with respect to risk and return, since network models view risk implicitly, e.g. [8] by

assuming that a network provides protection against risky internationalisation. The opportunistic portfolio model tolerates isolated failures since it views internationalisation as a portfolio of opportunities. Risks are minimized by the multi-country approach, where the failure of expansion into a single country is offset by success in other countries. It is of course possible to achieve a mixture of both success and failure in each country, but what we are looking at is net success. Our approach is consistent with that of Chetty and Campbell-Hunt [1], who argue that manufacturing firms select either a narrow regional approach or a global approach depending on the overall strategy configuration.

In summary, methods of internationalisation have been studied extensively. Existing research is primarily based on foreign direct investment theory, the stage model, and the network model. The results are generally mixed; the support found for the latter two models under various circumstances suggests a more complex pattern than expected. We argue that risk and wealth maximization are important to SMEs when they decide to internationalise their operations. We will now discuss an exploratory hypothesis, which is being used to refer to a research hypothesis in an early stage of development. We are not testing hypotheses in a traditional sense.

Hypothesis

Our theory suggests that entrepreneurs attempt to maximize returns while controlling risk through a portfolio approach. In the context of internationalisation, entrepreneurs select an approach that ensures the maximum likelihood of success while minimizing risk. We hypothesize that firms using an opportunistic portfolio model of internationalisation are more likely to succeed in their efforts to internationalise, within a specific time frame, than are firms using either the stage or a combined model. Risks are explicitly minimized, since with a multi-country approach, the failure of expansion into one country is offset by success in another. Our measure of success, as previously stated, is international sales as a percentage of total sales in one-year increments. We also take into

account how many countries the firms have entered successfully.

Methodology and Sample

International entrepreneurship research has been criticized for lacking a uniform approach and a clear theoretical and methodological direction [15]. This study attempts to remedy problems encountered in the existing literature. To address the issue of uniformity we use a more homogeneous sample, as described below in the section entitled 'Sample'. We also use a research methodology suitable for small data sets and attempt to address the inconclusive results found in many studies that examined large data sets.

To address theoretical and methodological concerns, we are following the suggestion of Low and MacMillan [33] by incorporating an evolutionary approach and developing a theory of internationalisation that considers the context in which the internationalisation takes place. As suggested by Coviello and McAuley [5], we used multiple methods of data collection and analysis. This is described more fully in the section entitled 'Methodology'.

Sample

We employed the following guidelines to obtain a sample consistent with our research objectives. First, the companies studied must have sales of € 100,000 to € 10 million. One firm depended entirely on the food industry for its revenue, two firms did not derive any revenue from the chemical sector and the remaining three firms derived a substantial portion of their revenue from large petrochemical, pharmaceuticals, bulk and speciality chemicals and pulp and paper firms. Second, the companies also had to be in the initial phases of internationalisation, so the authors could observe the entire process from the beginning. Third, firms were selected from the Nordic region (a narrow geographic focus is consistent with the practise found in the existing literature). Fourth,

only business-to-business (B2B) software firms were selected so as to achieve homogeneity of business and revenue models among the sampled companies. Excluding business-to-consumer (B2C) firms improved the sample compared with those of previous studies since a number of factors such as length of sales cycle and revenue models differ significantly between these two groups. Fifth, only those software firms with complex products were included. We argue that software firms are good proxies for other firms with complex products, such as food, chemical, and pharmaceutical companies, because software development is subject to a number of complexities, including the development process itself, implementation, and post-implementation service and upgrading. Sixth, firm size, as measured by sales, was kept as uniform as possible to prevent atypically large private or public firms from skewing the results. While uniformity in the size of the firms was important, their size as measured in terms of revenue did differ. Seventh, company funding by means of venture capital was consistent across the sample, although the level and characteristics of this funding differed. Significant venture funding helped minimize the impact of resource constraints on the process of internationalisation.

Total sample size was six firms in Sweden, Norway, and Finland. Data were collected by observation, interviews, questionnaires, meetings, and examination of written internal and publicly available material. A total of 18 interviews and multiple questionnaires were completed for each firm over a two-year period. In all, the research lasted from 1996 to 2001. Multiple-item measures and multiple respondents were used to enhance internal consistency [34], an approach that obtains more complete information [35].

Methodology

This study was a multi-company, longitudinal case study. Chandler and Lyon [36] suggested that future entrepreneurship research incorporate longitudinal research to a greater extent. The research methodology is largely based on Schein [37][38] and Mårtensson [34]. Schein [38] argues

that gathering data from natural situations is important. He defines clinical research as the observation, elicitation, and reporting of data that are available when actively studying an organization in its natural setting. Clinical research is an extension of active research, the main difference being that the researcher enters the situation in response to the needs of the organization, not the researchers' need to gather data [38]. The result is that the object of the study does not feel under investigation, since the research is unobtrusive. This study is an example of clinical rather than action research because one of the authors was providing advice to the firms, enabling a non-obtrusive approach. Benbasat [39] defines case study as the examination of a phenomenon in its natural setting, employing multiple methods of data collection to obtain information. Yin [40] states that a case study is suitable for studying an event over which the researcher has little or no control.

Kimberly [41] defines longitudinal research as those techniques, methodologies, and activities that allow the observation and description of organizational phenomena. The obvious question in longitudinal research is how long the study should last. The existing literature supports the notion of both single- and multi-period studies depending on what is being examined. A multi-period approach was deemed appropriate here since the authors were interested in observing changes in ongoing processes.

The results from the data collection were analysed primarily by using data triangulation, triangulation being defined as comparing different types of information [34]. The goal of triangulation is not to determine the objective truth, but to add breadth and scope to the analysis. Coviello and McAuley [5] have suggested that triangulated research methodologies offer a better opportunity to capture complex issues involved in internationalisation. Mårtensson [34] regards 'triangulation as means of alternative interpretation rather than a search for absolute truths. The results are analysed through a process of interpretation based on empirical sources, empirical material, and empirical description followed by conclusions'. In this study, the authors investigate phenomena and

events over time and as they occur in different cases. The term ‘analysis’ as used in this paper refers to an iterative process that follows this approach.

Findings and Discussion

To address the research question articulated previously, we will present our findings and discuss the internationalisation process of each company. Then we will compare three of the sampled firms: A, E, and F. The firms in the sample are divided according to their method of internationalisation; tables I and II show characteristics of the sampled firms.

E did take technology risk into account but did not consider other business risks in their decision-making framework. While firms B and D took risk into account, this was not formalized within their respective decision-making frameworks to the same extent as in firms A, C, and F. None of the firms relied on partners or joint ventures to any great extent, reflecting the general belief of management that product and market complexities made transfer of knowledge to partners costly.

The overall results of the study support the opportunistic portfolio model. Firms using an extremely aggressive opportunistic approach were more successful than firms using a stage or combined approach. Similar to Bell [42] and Coviello and Munro [8], we found that the

<u>Firm</u>	<u>Industry</u>	<u>Method of Internationalisation</u>	<u>Main Geographic Area of Expansion</u>	<u>Initial Geographic Dispersion</u> ¹	<u>Ending Geographic Dispersion</u> ¹
A	Software	Stage	Europe	One	Two
B	Software/services	Stage	Europe	One	Two
C	Software/services	Combined	Europe	One	Two
D	Software	Combined	Europe	One	Two
E	Software	Opportunistic	Europe/US	One	Four
F	Software	Opportunistic	Europe/Africa/ Middle East/Asia	Two ²	Eleven

1. Number of countries

2. Same customer in two countries

Table 1: Characteristics of Studied Firms

Firms A and B used a classic stage approach in their efforts to internationalise. Firms C and D utilized an opportunistic portfolio approach combined with elements of a traditional stage or network model, while firms E and F used an opportunistic portfolio approach. To establish the reliability of the results, the authors analysed the details of each firm’s business, including regulatory filings such as board reports and financial statements. Based on interviews with management, all firms except firm E used business risk analysis in their efforts to internationalise; this was especially pronounced in firms A, C, and F. Firm

network model had some merit, although we found less support for this than did previous studies. It is important to note that all firms operated in highly volatile markets characterized by rapid growth and technological change. Therefore, it was perhaps not unreasonable for the firms to take risk into account.

The level of success appeared to depend on the level of aggressiveness combined with formal risk assessment, since firms using the combined approach tended to be less successful than firms using an opportunistic approach. Initially it

appeared that a size effect, as defined by annual revenue, was present, since the two most successful firms were the two largest. Closer inspection of the firms showed that, using European GAAP, one of the large firms recognized research and development as a revenue item, which accounted for approximately 40% of total revenue. This suggests that while size may be a factor, it does not appear to be as significant as the authors had previously thought. Initially, all firms in the sample had less than €3,000,000 in revenue.

management meetings and to the board. The company implemented a policy of pre-screening sales prospects and generally did not follow up sales leads that did not meet the pre-determined criteria. Sales efforts were generally planned in advance, although the company made some effort to accommodate firms that were deemed interesting. So the opportunistic sales target would be removed. Firm A established two foreign subsidiaries during the time frame of the study.

<u>Firm</u>	<u>Method of Internationalisation</u>	<u>Beginning Period Sales</u>	<u>Ending Period Sales</u>	<u>Beginning Foreign Sales</u> ^{3,4}	<u>Ending Foreign Sales</u> ^{3,4}	<u>Amount of Financing</u>
A	Stage	€0.9	€1.2	~ 10 %	~ 20 %	€1.0
B	Stage	€0.1	€0.3	~ 5 %	~ 5 %	€1.0
C	Combined	€0.25	€0.7	0 %	~ 10 %	€7.0
D	Combined	€0.6	€1.5	0 %	~ 30 %	€3.0
E	Opportunistic	€3.0	€9.5	~ 20 %	~ 70 %	€5.0
F	Opportunistic	€2.0	€10.0	~ 20 %	~ 80 %	€10.0

1. Firm revenue and foreign sales data are presented so as not to reveal the names of the companies.

2. Firm revenue and financing quoted in €million.

3. As a percentage of total sales.

4. We show approximate the geographic sales breakdown since not all firms used consolidated accounting.

Table 2: Revenue Data of Studied Firms [1, 2]

Resource constraints were minimised since all firms had significant venture capital funding; resource constraints were not eliminated since the authors observed personal, management, and board preferences in imposing artificial resource constraints on the firms' operations. Based on the judgement of the authors, firm E also appeared to have more resource constraints than did the other firms in the sample. We will now discuss the results in detail. Please recall that all of the firms were characterized as successful during the time frame of the study.

Firm A used a classic stage approach. Initially, the company expanded sequentially into each Scandinavian country followed by Luxembourg and Switzerland. Interestingly, the company obtained a customer in Germany but did not formally attempt to enter this market, supporting our argument that the firm did not consider expanding opportunistically. The firm conducted thorough marketing research using third-party vendors, as evidenced by presentations made in

In the Nordic region, the firm achieved some success using the stage method but was unsuccessful in generating revenue from its pan-European efforts. The researchers did not note any obvious confounding factors upon closer inspection of the organizational structure, clients, products, and competitors. The products were well received, as evidenced by the growth in the sophisticated Scandinavian markets. The client list was substantial with a number of well-known brand-name clients. The competitive landscape was deemed reasonable from the authors' perspective: the European market space was served by 10 to 15 companies, the largest of which had sales of approximately €80 million. Resources were not a constraining factor, and firm operations were highly structured in comparison to other firms in the sample. We will discuss this issue later in the paper.

Firm B also used a classic stage approach, but for several reasons achieved only limited success in its internationalisation efforts. First, firm B did not



have a solid domestic revenue base, which could potentially have reduced its credibility with international customers. No foreign subsidiary was established during the period of study. Under-investing in the process of internationalisation did not appear to be the problem. The firm did have fewer managers than did the other sampled firms, but this seemed appropriate, given that the firm was the smallest in the sample. At the same time, the authors did not notice any tangible differences in the quality of management, though we did not study this factor extensively. Faulty or incomplete execution of the stage model did not appear to be the problem. The company used external marketing data in its decision-making processes, used appropriate marketing tools, and had a product that appeared competitive. The competitive landscape was favourable with three pan-European competitors. There were additional local competitors, but none that the authors encountered had a dominant market position.

Firm C had an established customer base in its domestic market where it was ranked as the number one supplier. Firm C used a combined stage and opportunistic approach in expanding outside its domestic market. The stage model was used primarily in Scandinavia, while the opportunistic portfolio approach served as the platform for expansion into Europe. Within Europe, the company focused its efforts in the Germanic-speaking and Mediterranean regions. The stage model was largely ineffective in expanding within Scandinavia, as the company did not receive any orders within the time frame of the study. The European expansion efforts resulted in a single large contract within 12 months of initiating expansion, and as a consequence, one foreign subsidiary was created. The firm used a moderately aggressive approach in its efforts to internationalise. We further analysed the potential reasons for management's perceived lack of success in European and, especially, Scandinavian markets. It became evident that certain parts of the organization had not been prepared for the internationalisation, suggesting mental and physical under-investment. A common theme in informal discussions with the firm's middle management was a perception that it was unnecessary to expand outside the Nordic markets because major

opportunities were available there. Also, senior management believed that the sales cycles were unrealistically short, further supporting under-investment in specific sales leads and client projects. In discussing the firm's strategic efforts, we noted that the firm had resource constraints in the technical area, which resulted in technical development being diverted to domestic customers compared to potential customers in non-domestic markets. While this may have had an effect, we feel that the European customer would not have purchased the product if it was internationally non-competitive or if there were significant development issues in bringing the product up to a satisfactory standard. Nevertheless, technical resource constraints may have played a role. In addition, one country-specific market collapsed during the time frame of the study. It is also important to note that the period of study corresponded to a downturn in the specific market space served by Firm C, and this may have affected the results it obtained.

Firm D provided some interesting insights into the process of internationalisation. All owners were active managers in the company. The company had ample funding available to strengthen management, technology, and sales. Prior to the study period, the firm established itself as one of the top two domestic companies in its field before initiating internationalisation efforts. After doing formal market research, the company embarked on expansion efforts using a combined stage approach within Scandinavia, and network and opportunistic approaches in Europe. In Europe, the company started two subsidiaries, including one in the UK which pursued a network-based approach. In continental Europe, the firm used an opportunistic approach. The combined approach resulted in significant revenue in a second Scandinavian country, as well as in two continental European countries, but not in the UK. During the period of the study, Firm D did not achieve any revenue in the UK. The authors noted that firm D consistently under priced its products relative to those of its competitors in order to gain access to international markets. This strategy was also conspicuously used by the other firms in the sample, but not on a consistent basis. It could indicate that firm D's market space was



highly competitive or that its product was inferior. In discussions with senior management, it became evident that personal preferences played a role in locating an office in the UK. Management perceived the UK market to be difficult, but believed that this would be mitigated by strong networks of large local and global consulting firms. The company also faced significantly greater competitive pressures in the UK market compared to other markets in Europe and Scandinavia. The authors also noted a lack of product focus and an overall lack of focus in the company.

Firm E used an extremely aggressive opportunistic portfolio approach in its efforts to internationalise and was able to develop markets in Scandinavia, Spain, the UK, Germany, and the USA. During the observation period, the firm established three foreign subsidiaries. The firm used a highly unstructured and opportunistic approach with little formal follow-up of its market and sales activities, unless there was a personal interest on the part of the owners. The company did not produce formal plans for its internationalisation, nor did it try to localise its products before entering a new market. Interestingly, compared to Firm F, the company did not have a solid domestic revenue base. While the initial customer was domestic, all subsequent customers within the time frame of the study were non-domestic. In firm E, the owners were heavily involved in the day-to-day operation in sales, marketing, and product development. Since the company had not standardized its products, a significant amount of human and financial resources went into software development. The company therefore had some financial resource constraints, and had under-invested in certain areas of its expansion efforts, including administration, professional management, product development, and internationalisation. The efforts to internationalise were characterized by 'lumpiness', which refers to both a lack of consistency in decision-making that affects the company's rate of expansion, and a lack of follow-up to its sales and marketing activities. While technology risks were explicitly taken into account, other business risks were not explicitly considered within the decision framework.

Firm F also used an extremely aggressive opportunistic approach in its efforts to internationalise. Firm F initially obtained four domestic customers, which were internationally well-known and could serve as reference customers. One of the customers implemented firm F's product in two locations in Scandinavia, perhaps providing the initial impetus to internationalise. This lends some support to network theory. The owners were involved in the day-to-day running of the firm, mostly working on technology-related issues, but also active in strategy development and in the strategic marketing of the firm's products. The firm hired a salesperson of international calibre when it had six employees. Some initial research was performed before marketing the products in each country, although this primarily focused on regulatory aspects, which differed substantially from country to country. Initially, no other person was involved in the efforts to internationalise, except in the technical support capacity in the domestic office. The internationalisation efforts were consistently very aggressive and opportunistic, and the company initially marketed its products in Europe, the Middle East, South Africa, and certain parts of Asia. While the company did not especially want to sell its products in the USA, it nevertheless participated in US trade shows and opportunistically visited potential North American customers. Sales meetings were scheduled without qualifying the sales leads. When sales suspects became prospects, the company became very formal in the process leading up to the signing of the contract, but still maintained significant flexibility to accommodate different styles on the part of the sales prospect. This was in great contrast to the initial sales process, which was extremely flexible from the company's point of view.

Firm F generated revenue in Scandinavia, Switzerland, the UK, Netherlands, Germany, and Belgium, and in countries outside Europe (South Africa, two countries in the Middle East, and one in Asia) within the time frame of the study. Five international subsidiaries were established during this time. Attending management and board meetings and holding discussions with senior management revealed that the company



deliberately pursued an opportunistic strategy. The main reason given was that the sales cycles were lengthy and that many variables affected the sales process, most of which were beyond the control of the company. In addition, the owners of the company stated that the company's value would be enhanced by showing that the firm's products were suitable for various international markets. This was verified by the authors in discussions with two investment banks.

In comparing firms E and F, several differences emerged. First, firm F had better capital. Second, while both firms used an opportunistic approach in their initial sales and marketing efforts, firm F used a more structured approach to following these up, resulting in less lumpiness compared to Firm E. Both firms suffered from lack of management depth, and focused on acquiring technical and sales personnel during the period of study. Increasing management capacity and skill level was explicitly considered secondary by the firms, although the authors noted that firm F strengthened its management during the time of study; firm E, by contrast, made no efforts either to develop its management ranks or to increase the functional skills of existing management. Finally, firm E's products required less local adaptation than did those of firm F.

order to discern whether level of flexibility affected the success or failure of efforts to internationalise. Tienari and Tainio [43] maintain that firms exhibiting organizational rigidities are less able to cope with volatile environments, such as those encountered by internationalizing firms. All three firms exhibited differences with respect to organizational rigidities and structures. Table IV shows how the firms differed in these respects.

Firm A generally used a highly inflexible and highly structured approach to conducting business. Its sales and marketing processes followed a pre-determined rigid approach and once a customer was acquired, a highly structured approach implemented the product and dealt with customers. Firm E used a highly flexible and highly unstructured approach. Firm E used a highly opportunistic approach in acquiring customers, but had very little structure in dealing with implementation issues and customers in general. Firm F was classified as highly flexible and structured. It used a highly opportunistic approach to customer acquisition and a highly structured approach in product implementation and customer relations. In addition, Firm F, like Firm A, had a significant domestic customer base; Firm E did not have a large domestic revenue base.

<u>Firm</u>	<u>Structured/Unstructured</u>	<u>Rigid/Flexible</u>
A	Highly structured	Highly rigid
E	Unstructured	Highly flexible
F	Unstructured	Highly rigid

Table 3: Organizational Rigidities and Structures

In our research, we noted that the degree of organizational rigidity differed among firms and appeared related to the degree of success. We conducted additional analysis of our data that is not related to our research hypothesis. Firms A, E, and F offered us unique opportunities because the target customers of these firms were the same, although sales efforts did not necessarily target the same departments. This analysis was undertaken in

Of the three firms, Firm A was the least successful in internationalizing within the time frame of the study. The firm had at least three possibilities of acquiring foreign customers during the two-year period, but chose not to do so mainly because of its organizational structure and rigidities. The firm focused on activities that fit its pre-programmed approach to internationalisation rather than focusing on acquiring customers. Firm E acquired



several international customers, but was generally unable to capitalize significantly on these opportunities. An unstructured approach prevented it from expanding its customer revenue effectively, while its highly flexible approach prevented it from focusing.

Firm F also acquired several international customers. Its primary method of acquiring international customers was initially unstructured, but was generally followed by a structured and highly rigid post-acquisition approach in maintaining and enhancing its customer relationships. Although this analysis is limited in scope, the results indicate that organizational flexibility and level of structure affect internationalisation success for firms with long sales cycles and complex products.

The implications of this study are that software firms with complex products do not use networks and partnerships to a large extent in their efforts to internationalise. The most successful firms used an opportunistic approach to customer acquisition, while following a structured approach in dealing with customers during the post-acquisition period. In addition, firms that operate in volatile markets, experience rapid growth, and encounter rapid technological changes appear to take risk explicitly into account in their efforts to internationalise.

Summary and Conclusions

The purpose of this longitudinal clinical case research was to further our understanding of how firms internationalise their operations. To achieve the aim, we studied six Nordic software firms, each of which had a complex software product to sell to other businesses. Our findings suggest that there are other factors in addition to those presented in existing stage- and network-based research. Specifically, we found that integrating risk and return issues further develops the theory of how SMEs internationalise, and that integrating network models into an explicit risk and return framework enhances our understanding of the decision-making processes of internationalisation. Our findings are consistent with those of Chetty

and Cambell-Hunt [1], as we found that global firms that use an opportunistic portfolio approach appear more successful in their internationalisation efforts.

Three important contributions of this paper relate to the sample selection, the choice of methodology, and further theory development. In addition, the study focused on the process of international expansion using a risk and return framework. Our research builds on Chetty and Campbell-Hunt [1] by analysing success in the internationalisation efforts of small Nordic software firms with complex products. We found weak support for Coviello and Munro's [8] conclusions that networks play a role in international expansion.

There are several important findings of this study. First, it provides further evidence that the stage model is insufficient to explain how firms expand internationally. Second, contrary to Coviello and Munro [8], we found weak support for the operation of the network model in the development of market-development activities. Coviello and Munro [8] studied four software firms in New Zealand, where it is possible that transaction cost issues and the distance to major markets necessitated a network approach. While our research found some support for the utility of small software firms making simultaneous use of multiple and different modes of entry, firms using an opportunistic approach tended to be more successful than firms using either a classical stage approach, a network approach, or a combined approach. We found preliminary indications that use of an opportunistic or diversified approach in the initial phases of internationalisation followed by significant structure in organizational processes enhanced success. Third, risk and return was taken into account by most of the firms; we found support for the risk framework presented by Lopes [30]. Fourth, sample selection, the choice of clinical research methodology, and the use of an interpretative approach represent additional contributions. Data access is always a difficult area in gathering non-public information, and many traditional models are not suitable in these cases.

There are several implications for chemical and pharmaceutical firms. It is evident from this research that the stage or network approach is sub-optimal in gaining a significant presence in international markets. This may be especially true for firms dealing with complex products where sales cycles may be lengthy. A single country expansion may also be sub-optimal in cases where “natural” multi-country groupings occur. This does not mean that single country expansion is obsolete at all times. South America provides a good example: Brazil may be a single country expansion since it is linguistically or culturally somewhat different from some of other South American countries. Argentina, Chile, Uruguay and Paraguay form a multi-group expansion opportunity, however. This leads us to the most important implication. Risk assessment should always play a role in international expansion. Risk is mitigated by looking at international expansion as a portfolio of opportunities. A portfolio of opportunities allows firms to expand into several countries in an opportunistic fashion. Earlier in the paper, we spoke about the German speaking part of Europe. An expansion into this region using an opportunistic approach makes it more likely that the firm will succeed, *ceteris paribus*, since the risk of not gaining a market foothold is spread across three or four countries. Using a staged approach, failure to gain a foothold is costly both in time and money because it would require the firm to begin expansion into a second country after failing in the first.

In this study, we are primarily reporting on software companies that sell and market their products to food, chemical and pharmaceutical firms. However, we believe that our conclusions can be generalized to all firms with complex products, especially food, chemical, and pharmaceutical firms that are attempting to expand internationally.

There are several limitations associated with clinical research. First, clinical research and an interpretative approach often do not examine the external conditions that give rise to certain meanings and experiences [34]. Although care was taken to analyse confounding variables and aspects, it is possible that these affected the results of this study. Second, the results are difficult to

generalize until other researchers have performed similar analyses using different-sized samples across different countries over time. This is important, not only to validate the results, but also as a step toward formulating testable hypotheses and theories that apply across settings [44]. Finally, the interpretative approach is subjective and two researchers may not interpret the findings the same way.

Our study opens up a set of opportunities for researchers willing to commit time and resources to the in-depth exploration of factors and processes affecting efforts to internationalise. These include studies across samples in different countries. In-depth analysis of other factors affecting success in internationalisation is also needed. Applying the clinical research and interpretative methodologies to different settings and variables would also be fruitful. The results of this study also indicate that researchers may also want to look at contingency variables. How organisational rigidities affect internationalisation appears to be an interesting area of further research.

References

- [1] Chetty, S. and Campbell-Hunt, C. 2003. Paths to internationalisation among small- to medium-sized firms: a global versus regional approach, *European Journal of Marketing*, 37 (5/6): 796–820.
- [2] Wright, W. and Ricks, A. 1994. Trends in international business research: twenty-five years later, *Journal of International Business Studies*, 25 (4): 687–701.
- [3] Autio, E., Sapienza, H. J. and Almeida, J. G. 2000 Effects of age at entry, knowledge intensity and imitability on international growth, *Academy of Management Journal*, 43 (5): 909–924.
- [4] Johanson J. and Wiedersheim-Paul, F. 1975. The internationalisation of the firm—four Swedish cases, *Journal of Management Studies*, 12: 305–322.



- [5] Coviello, N. and McAuley, A. 1999. Internationalisation and the small firm: a review of contemporary empirical research, *Management International Review*, 39 (3): 223–256.
- [6] Gankema, H., Snuif, H. and Zwart, P. 2000. The internationalisation process of small and medium-sized enterprises: an evaluation of stage theory, *Journal of Small Business Management*, 38 (4): 15–27.
- [7] Bell, J. 1995. The internationalisation of small computer software firms—A Further Challenge to ‘Stage Theories’, *European Journal of Marketing*, 29 (8): 60–75.
- [8] Coviello, N. and Munro, H. 1997. Network relationships and the internationalisation process of small software firms, *International Business Review*, 6 (2): 361–386.
- [9] Lu, J. and Beamish, P. 2001. The internationalisation and performance of smes, *Strategic Management Journal*, 22 (6/7): 565–586.
- [10] Yip, G., Biscarri, J. and Monti, J. 2000. The role of internationalisation process in the performance of newly internationalised firms, *Journal of International Marketing*, 8 (3): 10–35.
- [11] Apfelthaler, G. 2000 Why small enterprises invest abroad: the case of four Austrian firms with U.S. operations, *Journal of Small Business Management*, 38 (3): 92–98.
- [12] Anderson, S. 2000 The internationalisation of the firm from an entrepreneurial perspective, *International Studies of Management and Organization*, 30 (1): 63–92.
- [13] Coviello, N. and Martin, K. 1999. Internationalisation of service smes: an integrated perspective from the engineering consulting sector, *Journal of International Marketing*, 7 (4): 42–66.
- [14] Jones, M. 1999. The internationalisation of small high-technology firms, *Journal of International Marketing*, 7 (4): 15–41.
- [15] McDougall, P. and Oviatt, B. 2000. International entrepreneurship: the intersection of two research paths, *Academy of Management Journal*, 43 (5): 902–906.
- [16] Crick, D. and Jones, M. 2000. Small technology firms and international high-technology markets, *Journal of International Marketing*, 8 (2): 63–85.
- [17] Westhead, P., Wright, M., Ucbasaran, D. and Martin, F. 2001. International market selection strategies of manufacturing and service firms, *Entrepreneurship & Regional Development*, 13 (1): 1–34.
- [18] Das, T. and Teng, B. 1997. Time and entrepreneurial risk behaviour, *Entrepreneurship Theory and Practice*, 22 (2): 69–88.
- [19] Kaish, S. and Gilad, B. 1991. Characteristics of opportunities of entrepreneurs versus executives: sources, interests, general alertness, *Journal of Business Venturing*, 6 (1): 45–61.
- [20] Palich, L. and Bagby, D. 1995. Using cognitive theory to explain entrepreneurial risk-taking: challenging conventional wisdom, *Journal of Business Venturing*, 10: 425–438.
- [21] Sarasvathy, D., Simon, H. and Lave, L. 1998. Perceiving and managing risks: differences between entrepreneurs and bankers, *Journal of Economic Behaviour and Organization*, 33: 207–225.
- [22] Forlani, D. and Mullins, J. 2000. Perceived risks and choices in entrepreneurs’ new venture decisions, *Journal of Business Venturing*, 15: 315–322.
- [23] Chicken, J. 1996. *Risk* (London, UK: International Thomson Business Press).
- [24] Brunson, N. 2000. *The Irrational Organization: Irrationality as a Basis for Organizational Action and Change* (Bergen, Norway: Fagbokforlaget).
- [25] Qian, G. 2002. Multinationality, product diversification and profitability of emerging us small- and medium-sized enterprises, *Journal of Business Venturing*, 17: 611–633.
- [26] Rugman, A. 1976. Risk reduction by international diversification, *Journal of International Business Studies*, 7: 75–85.
- [27] Kim, W., Hwang, P. and Burgers, W. 1993. Multinationals’ diversification and the risk return trade-off, *Strategic Management Journal*, 14: 275–286.



- [28] Roy, A. 1952. Safety-first and the holding of assets, *Econometrica*, 20: 431–449.
- [29] Markowitz, H. 1952a. Portfolio selection, *Journal of Finance*, 6: 77–91.
- [30] Lopes, L. 1987. Between hope and fear: the psychology of risk, *Advances in Experimental Social Psychology*, 20: 255–295.
- [31] Shefrin, H. and Statman, M. 2000. Behavioral portfolio theory, *Journal of Financial and Quantitative Analysis*, 35 (2): 127–151.
- [32] Keh, H., Foo, M. and Lim, B. 2002. Opportunity evaluation under risky conditions: the cognitive processes of entrepreneurs, *Entrepreneurship Theory and Practice*, 27 (2): 125–148.
- [33] Low, M. and MacMillan, I. 1988. Entrepreneurship: past research and future challenges, *Journal of Management*, 14: 139–161.
- [34] Mårtensson, P. 2001. *Management Processes: An Information Perspective on Managerial Work* (Stockholm, Sweden: The Economics Research Institute).
- [35] Ramirez, M. and Escuer, M. 2001. The effect of international diversification strategy on the performance of spanish based firms during the period 1991 to 1995, *Management International Review*, 41 (3): 291–315.
- [36] Chandler, G. and Lyon, D. 2001. Issues of research design and construct measurement in entrepreneurship research: the past decade, *Entrepreneurship Theory and Practice*, 25 (4): 101–113.
- [37] Schein, E. 1987. *The Clinical Perspective in Fieldwork*, *Qualitative Research Method Series* (Newbury Park, CA: Sage Publications).
- [38] Schein, E. 1991. *Legitimizing Clinical Research on the Study of Organizational Culture*, *MIT Working Paper Series*, WP# 3288-91-BPS (Cambridge, MA: Sloan School of Management, Massachusetts Institute of Technology).
- [39] Benbasat, I., Goldstein, D. and Mead, M. 1987. The Case Research Study in Studies of Information Systems, *MIS Quarterly*, 23 (1): 369–386.
- [40] Yin, R. 1994. *Case Study Research: Design and Methods*, *Applied Social Methods Research Series* (Thousand Oaks, CA: Sage Publications).
- [41] Kimberly, J. 1976. Issues in the design of longitudinal organizational research, *Sociological Methods and Research*, 4 (3): 321–347.
- [42] Bell, D. 1995. A contextual uncertainty condition for behaviour under risk, *Management Science*, 41 (7): 1145–1150.
- [43] Tienari, J. and Tainio, R. 1999. The myth of flexibility in organizational change, *Scandinavian Journal of Management*, 15: 351–384.
- [44] Eisenhardt, K. 1989. Building of theories from case study research, *Academy of Management Review*, 14 (4): 532–550.

Research Paper

“Sensory Fit Panel” – Development of a new Advertising Claim Support method to assess aesthetic diaper fit performance in an objective, reliable and reproducible way.

Claudia Liedtke*, Iris Christ** and Dr. Frank Wiesemann** #

* University of Ulm, Inorganic Chemistry II, 89073 Ulm, Germany

** Baby Care-Diapers, Baby Care, Procter & Gamble Service GmbH, Germany

correspondance to: wiesemann.f@pg.com

Abstract: For the product design of diapers, the fit on the baby plays a significant role. In particular, innovation in the areas of fit and freedom of movement have become increasingly important as lower order needs like leakage are sufficiently met by most products. Today’s methods to measure diaper fit focus on technical measurements (engineering and technical fit) and parents’ subjective perceptions. While these methods are useful tools for product development purposes, they are not seen as sufficient for Advertising Claim Support needs. However, when a new fit innovation should be advertised, particularly when this is done in a competitive way, a robust technical support is needed to defend this claim in case of challenges by competitors or regulatory bodies. For this purpose, methods need to be objective and technically sound in order to be acceptable to advertising regulatory bodies. Independent, objective ratings would substantiate claims on a more reliable and reproducible base. To meet this need, the diaper fit sensory panel method was developed. This test reapplies the established sensory methodology used, e.g. to assess taste or smell in food and beverages.

Introduction

Nowadays, unlike in the past, most consumer goods are fully developed technically and consumers no longer buy a product based only on its leading position concerning technical attributes. Related to Maslow's hierarchy of needs, the basic concept depends on two groups: deficiency needs and growth needs. That means that the deficiency need in a lower hierarchy level must be satisfied, before the deficiency need of the next level is detected [1]. In the case of diapers it means, that all basic needs (the first five levels in fig.1) are today satisfied and hereby the new level of aesthetic needs is reached.

Because of this fact, branded products are no longer only created on a technical basis. The design and the aesthetics are what make a product unique and unmistakable. Therefore, one marketing strategy for brands in the mature state of the product life cycle is the "strategy of a better styling" [3].

In case of "Pampers," the "product life cycle" started with the product introduction in the German market in 1973 [4], followed by a big growth phase that reached maturity; on the one hand, this caused the biggest turnover, but on the other hand, Pampers suffered as competitors copied their product and came up with their replicas [5]. This means that with the "strategy of a better styling," the advertising of a consumer good like "Pampers" is focused on superior aesthetics and design related factors such as thickness of a diaper.

This advertising needs to be supported by technical data delivered via a robust Advertising Claim Support strategy. A claim is considered as any communication by an advertiser about a product, that consumers are likely to understand to be a representation of fact. This is related to any type of external communication about products independent from the media. External requirements (laws, regulations) as well as company guidelines (e. g. Procter & Gamble's Advertising guidelines) require that claims need to be supported by sound technical and scientific data, and that this support is properly documented. This documentation conforms to legal and regulatory requirements, defined in most countries' marketing laws and controlled often by regulatory bodies. False claims can lead to civil fines or even criminal convictions. In addition, false claims are a significant public relations risk, as claims detected as false and misleading can create negative media coverage, which can damage relationships to governmental bodies and competitors and can even destroy consumers' trust in a brand. Therefore, advertising claim support is an essential part of any advertising development.

To support a claim in a subjective area, like taste or wearing comfort, still an objective and reproducible method is required to support the claim. In the case of diaper fit performance, a method was developed, which measures the subjective impression of aesthetics in an objective, reliable and reproducible way. This method is called "Sensory Fit Panel" and it is building on the established method of sensory testing known, for instance, from food and beverages. The aims which go beside the initialization of such a new

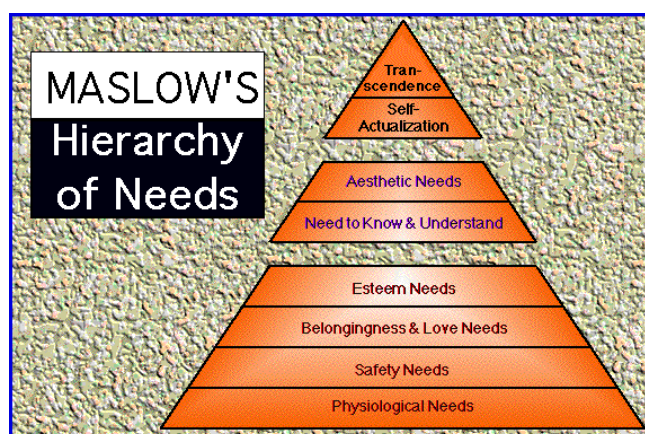


Figure 1: Maslow's hierarchy of needs [2]

objective method are the knowledge if all test instruments are necessary and whether the questionnaire can be abbreviated.

In this paper the first outcomes of this new assessment method are presented, structured as followed. In the first part, background information about Advertising Claim Support, the different definitions of fit and sensory testing are given. In the second part, the idea, realization and accomplishment of "Sensory Fit Panel" is explained, followed by the results of this pilot study. In the final part, we confirm that the first results of the new method meets the requirements for Advertising Claim Support; a comparison with commonly used consumer panels is presented to relate the test to reality.

2. Background and Current Situation

In the diaper industry claims concerning fit have become more frequent in recent years. This is a reaction to the evolution of consumer needs towards higher order needs.

In general diaper fit can be split into three areas: engineering fit, technical fit and aesthetic fit.

2.1 Fit

2.1.1 Engineering fit (fit elements related to the mechanics of a diaper)

Engineering fit is the mechanics of the interaction between the diaper and the child. Therefore, measuring the strength and location of diaper pressure on the body, as well as force distribution throughout the diaper is necessary.

2.1.2 Technical fit (fit elements related to the sizing)

Sizing includes two aspects. The first one is the range, a product's geometry can accommodate technically, for example via it's dimensions and elastic parts. The second aspect is the consumers' perception of size, which does vary between regions because of cultural differences and different habits.

2.1.3 Aesthetic fit

Aesthetic fit is difficult to quantify in terms of chassis attributes and properties. It can be driven by colour, style, cut, softness, etc. Also regional bias, like chassis design, plays in this case an important role. All these items are difficult to measure and quantify.

These definitions were achieved by fit studies, which generate qualitative and quantitative learnings. Fit studies are used for various reasons such as: issue resolution, screening of multiple design options, collection of baby measurements to develop design criteria, development of a technical fit model, test or confirmation of a hypothesis and generation of consumer and technical data.

To achieve these two kinds of data three different methodologies exist, which are technical/lab methods, consumer studies and on-baby tests. The first area creates technical data by using objective methods, for example material properties regarding stretch performance of elastics. In contrast to this, the consumer studies use subjective measurements. Hereby panels are placed with consumers to compare diapers under real conditions. Diapers are given to a representative number of parents with children that use the same diaper size. During the usage period, the parents are asked to fill in a questionnaire to assess the product performance

On-baby tests are currently the best test method to support the reliability of the claims on diapers, because it simulates real life conditions in a controlled environment. In these methods usually a combination of subjective and objective measurements are used. Part of this is, for instance, skin dryness measurements using standardized bio-engineering methods on real babies.

If fit is measured with these different kinds of data generations, the differences between the various types of fit get visible (fig. 2). For engineering and technical fit accurate models can be constructed. By the use of these models, product geometry has been optimized to deliver "just right" regarding technical fit over a selected range of babies. At any rate, there is a big gap between engineering, technical and the unknown

features of aesthetic fit. Looking at fig. 2, two different products have the same progression for technical fit, but not for aesthetic fit. Thus, it appears that if technical fit is evaluated with “just right”, there is no guarantee that aesthetic fit is rated in the same way with “excellent”. The widely unexplored factor of aesthetic fit influences the fit perception of mothers in a strong way.

To introduce standardized methods to assess the influence of aesthetic fit, where so far only experimental approaches have been made, the “Sensory Fit Panel” was developed. The idea was to build this method on the methodology of sensory testing, an established approach in assessing properties in the food and beverages industries for example (e. g wine tasting).

2.3 Sensory Testing

“Sensory Test is an examination of some or all aspects of products that are perceived by the five senses” [7]. Sensations, such as vision, hearing, smell, taste and touch, are a functional basis for life and survival. The human sense organs are very specific, very sensitive and easily available. Since these are the best conditions of a measuring instrument, the idea of sensory methods is to use the human senses as measuring instruments.

Human and physical instruments work in a comparable manner: each of them detects a stimulus, for instance, a noise. The physical measuring instrument uses a detector and the raw data is sent via an amplifier to the computer that processes the data and hands the result out to the printer, which makes it visible for other people. The process is the same as for a human measuring instrument. For example, noise is detected with sense cells in the ear and the raw data is transmitted via the nervous system to the brain. There the raw data is processed into the results and turned into action, e. g. sent to the hand, which writes them down.

However, there are also a lot of differences between those two instruments. The single components of a physical measuring instrument can be freely chosen and combined in a way concerning the solution of the problem. Furthermore it can be specifically programmed. This is in contrast to the human measuring instrument, which works as a unit and is already programmed from life experience. However, humans can also be chosen, motivated and trained. To achieve the best results in sensory testing, the panelists must be trained and calibrated, because “an observer must be put in the frame of mind to understand the characteristics and what he should measure” [8]. This is the most important thing to

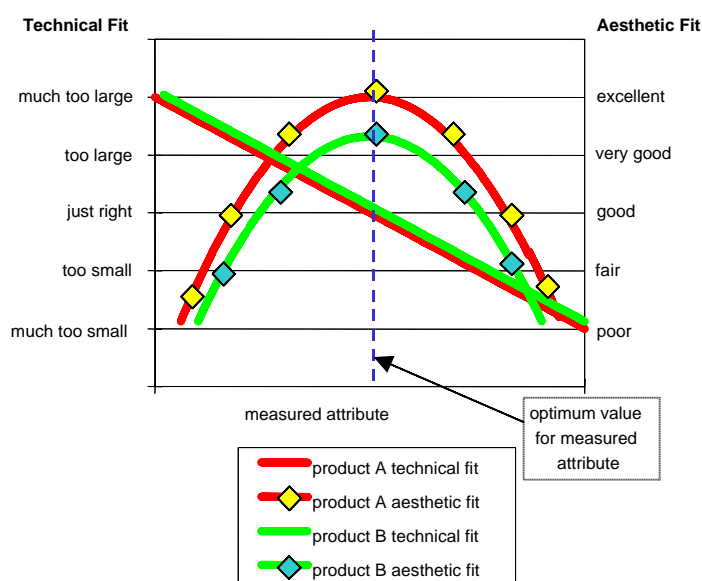


Figure 2: Technical and aesthetic fit [6].

achieve good results [9]. Human measuring instruments are mostly used in areas where there is no other way to measure properties in an objective way, for example the design of a product.

3. Sensory Fit Panel

The fundamental idea of the “Sensory Fit Panel” is to apply sensory testing to evaluate the appearance of a product, in this case the appearance of a diaper while it is used by a baby. The test objective was to allow an objective comparison on the fit of different diapers and an analysis of the attributes influencing this difference. The initial set-up was based on earlier global studies [10] done to explore the attributes of aesthetic diaper fit.

3.1 Realization of the Sensory Fit Panel pilot test

3.1.1 Brain writing

The first step for building up a panel is the recruitment of the right panelists.

3.1.1.1 Panelists

The demands on the panelists are the accuracy of discrimination, the interest to work with their own sensations, the ability to think analytically in complex situations, and a strong personality to achieve a reproducibility of the results without bias. Furthermore, they must have good availability, be communicative and have a good relationship to the panel leader. Additional requirements in the case of the “Sensory Fit Panel” are that the panelists must be female, because they normally have a stronger look on details as well as a stronger observation. As a last requirement, they have to have children in aged approximately five years. Thus it is guaranteed that they have experience with the basic technology of modern diapers, but also that they are not involved in the current diaper market.

3.1.1.2 Brain writing session

To select panelists meeting these requirements a brain writing session was initialized.

Brain writing is similar to brain storming, but the people write down for themselves what comes spontaneously to mind. They were looking at four completely different types of diapers, which were presented on a torso as well as on babies. The different babies, regarding weight and size, represent the large variety of baby dimensions and make the brain writing more reliable and credible. The babies wore each diaper first 15 minutes unloaded and afterwards 15 minutes loaded with 180ml warm saline solution. The diapers were completely different regarding chassis and core design.

As a result we found, that the 15 panelists all found consistently the same design attributes important for diaper fit. Due to the fact that these attributes could only be detected by persons who meet the required and above mentioned characteristics, this brain writing confirmed that comparable (and consistent) panelists had been chosen.

3.2 Questionnaire Development

To measure the subjective perception of aesthetic fit in an objective way a questionnaire was developed. It is based on the design attributes worked out by the panelists. The questionnaire consists of two parts. The first part was called “subjective” and is composed of hedonic questions, for instance “How well do you like the fit in general?” or “How well do you like the fit at crotch?”. The panelists have to rate on an eight point rating scale, going from poor to excellent.

In the second part, the panelists compare different attributes of the diaper with the images of a morphing scale. The morphing scale is used as reference and allows an objective assessment of the individual impressions. For example, for the objective question “Please, assess the height at waist,” the panelists compared the images with the diaper on the test instrument and rated for instance, image number five, which means she rated also point five of the rating scale.(fig.3)



Figure 3: morphing “height at belly”

Further examples of questions regarding this part of the questionnaire are: height and thickness of the diaper concerning the different fit attributes, like crotch, belly, bottom, etc.. The two anchor points of the objective questionnaire represent two extremes. For example for “height at belly” these two points are “low” and “high”. The left side represents the lower distinctive attribute and the right side the higher distinctive one.

For both parts of the questionnaire a rating scale with an even number of points is used instead of the common rating scale with uneven numbers (typically 5, 7 or 9), because it was desired that the panelists decide between the two halves of the scale to get distinctive results. The two parts of the questionnaire were linked together via a factor regression analysis.

3.3 Test Instruments

In this pilot study, the samples were presented with three different test instruments--baby, picture and torso--to allow for the best presentation of the test products. One part of the following analysis focused on finding out whether all three instruments were really necessary.

3.3.1 Baby

The first test instrument is the baby, where aesthetic fit can be rated under realistic, dynamic conditions. This means, that it is for instance possible that the diaper slips during movement. While this test instrument represents the reality in the best way, the acting baby can cause deflection of the panelists. For enabling the reproducibility of the test, all babies must have the same stage of development. With the different stages of development the baby shape change. For example a lying baby usually has a big abdomen and chubby legs, while walking babies tend to have thinner abdomen as well as thin legs. For this test only babies that could already walk were chosen. But even between walking babies are usually big differences, a baby could be small and thick or tall and thin.

In previous work within Procter & Gamble it was found, that babies can be divided into 9

groups all representing different shapes and weight/height relationships. In the case of this pilot study only the average group of babies were taken--those with middle height and middle weight.

In a future study, the results of the pilot study will need to be confirmed for the remaining groups.

3.3.2 Picture

Pictures of diapers on babies make the evaluation perfectly reproducible over the years if consistent lighting on all pictures ensures the comparability of the pictures. For each of the different questions of the questionnaire, another combination of pictures was shown. For instance, regarding the attribute “fit in general,” the subjective part of the questionnaire showcased four pictures; front-, back-, left- and right side (fig. 4). The pictures were presented to the panelists via special software that allows the panelists to watch the pictures and input their rating to the different questions at the same time.



Figure 4: Picture for “fit in general” as it appears in the software.

3.3.3 Torso

The torso represents only the body area from thigh to belly, which is important for a diaper. To achieve comparability with the other test instruments only torsos sized for the average diaper were used. In the context of on-baby testing, it is important not to stress the babies. Therefore torsos are a useful tool, because panelists can have a closer look on them without fazing the babies, which could cause stress. Furthermore some details are easier to assess on the static torso, than on a moving baby.

3.4 Training Session Design

The training was designed to sensitize and calibrate the panelists best, concerning objective diaper fit assessment, without overloading them. For this reason, it was split into three training sessions. Through short tests (cut-outs of the questionnaire) the panelists grew accustomed to the questionnaire, the rating scale and the general assessment. A complete test followed with usage of all three test instruments in the order picture, torso and baby. To prevent negative impacts in terms of e.g. misunderstanding of questions and lack of motivation, a single- and group evaluation took place after each test. The training session sequence was as follows:

First Training Session

- short explanation of a diaper
- ranking of three most important attributes concerning diaper fit performance
- familiarization with questionnaire
- mini- test via torso and pictures including single- and group evaluation

Second Training Session

- assessment of diaper fit attribute via pictures and whole questionnaire (each panelist on her own) and afterwards single- and group evaluation
- assessment of diaper fit attributes via torsos and whole questionnaire (again each panelist on her own) and afterwards single- and group evaluation

Third Training Session

- use of software
- assessment of diaper fit attributes on torsos
- familiarization and complete test with babies as last test instrument

3.5 Sensory Fit Panel Test-Accomplishment

The Sensory Fit Panel pilot test was composed of three parts regarding the three test instruments. Each part took place on one day. The test room requirements for the third test instruments, the babies, were completely different from the others. To allow all panelists to watch the baby at the same time, the room had to be big enough that fit all panelists, babies, and mothers. To meet the claim of reliability, the test had to be randomized. The available nine out of 15 experts were split into three groups. The following figure (table 1) shows the order the groups evaluated the diapers on the different instruments. The test was applied with two competitive products.

As controls underwear (Golden Standard = positive control) and a cloth diaper (Worst Case Standard = negative control) were added, The Golden Standard is an unreachable good anchor point, which shows where the best ratings of the attributes can be this is cryptic at best. The cloth diaper represents the opposite anchor point. The panelists rated the subjective part only with wet diapers and the objective one with dry and wet diapers.

	torso	picture	baby	torso	picture
Group1	1st	2nd	3rd		
Group2		1st	2nd	3rd	
Group3			1st	2nd	3rd

Table 1: "Sensory Fit Panel" test sequence

This was done to exclude the panelists who were swamped with too many questions and therefore the concentration, which would lead to wrong results.

Regarding the on-baby testing, all nine panelists had to assess the diaper performance on the babies at the same time, because a diaper on a baby looks never similar, even with the same baby and the same diaper. These panelists were split into two groups, five experts rated one baby and four the other one. The products on the babies were labeled with two different colors. One baby used products with yellow labels and the other one products marked blue. To allow best possible randomization concerning the order of the diapers, two on-baby tests took place. Five experts rated the aesthetic fit of a diaper on baby blue in the first on-baby test; in the second on-baby test, they rated the diaper fit performance on the yellow baby. For the remainder of the panelists, it was the other way around. Herewith, it was guaranteed that every expert (=panelist) could assess the products on both babies.

4. Results

The test was designed for Advertising Claim Support needs.

To satisfy those needs a reproducible, reliable and objective method had to be created. Successful criteria for fulfilling this were that the test instruments must be able to distinguish between different products in a comprehensible order.

The second objective was to prove if all three test instruments are necessary.

The third aim was to clarify how the objective questions relate to the subjective ones and to what extent.

Also, any unnecessary questions should be discovered and eliminated in the following tests. As a final part of the analysis, a comparison with consumer data was made.

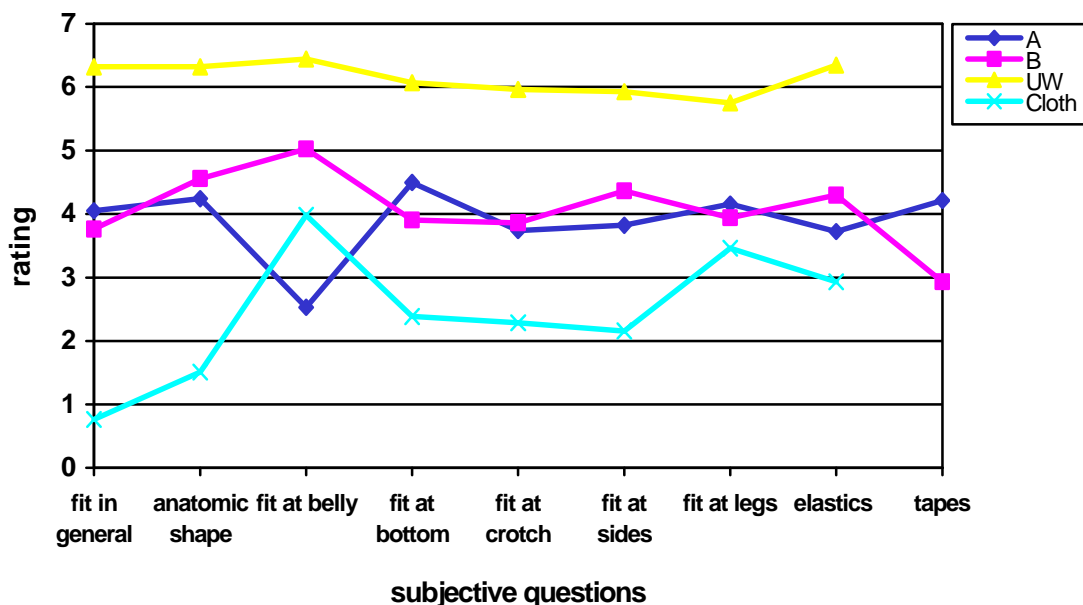


Figure 5: Rating results for diapers (all test instruments)

Subjective questions	Results
fit in general	$A_w > B_w > C$
anatomic shape	$A_w B_w > C$
fit at belly	$B_w > C > A_w$
fit at bottom	$A_w > B_w > C$
fit at crotch	$A_w B_w > C$
fit at side	$A_w B_w > C$
fit at leg	$A_w > C, A_w B_w C B_w$
Elastics	$B_w > C, B_w A_w, A_w C$
Tapes	$A_w > B_w$

Table 2: results for single subjective questions (Aw= diaper A wet, Bw=diaper B wet, C=Cloth)

4.1 Does the method work?

For a simple answer: yes, it does. This question is answered by calculating the average of all three test instruments regarding the single diapers for the subjective part of the questionnaire. Hereby it becomes visible that the diapers A and B are clearly different from the controls (figure 5, table 2), except for the question “fit at belly”. For this attribute, the cloth diaper is rated surprisingly well, which is explainable by the cloth diaper’s covering with an elasticated pant to prevent leakage. The elastication of the pant lead to the good rating for “fit at belly”.

The variance method, a statistical method to identify outliers, was used to look at the results in more detail. No outlying panelists nor a lack of concentration among the panelists was detected. This was analysed by the variance method, which examined consistency of ratings during the whole test period.

4.1.1 Comparison of the test instruments

To compare all combinations of test instruments two analyses were done: 1.) a chart comparing the single test instruments for the two parts of the questionnaire and 2.) an analysis of the results via the variance method. To get an overall

impression of whether one test instrument differed from the others or if all three were not in line, the average of all diapers for the different test instrument were calculated. The subjective part’s results revealed that all test instruments lie overall in one area (fig.6).

This is in contrast to the average of diapers in the objective part (fig. 7), where the test instruments were overall not in line. This can be explained by people’s closer scrutiny of details in the objective method, so that the different pros and cons of each test instrument are more emphasized. The same results were found by using the variance method.

4.1.2 Checking panelists and test instruments together

As a method to check both panelists and test instruments together, the dry and wet stage of one type of diaper were compared for each test instrument (one example is given in table 3). The results are as expected. For example, for the attribute “height at belly,” the wet diaper was lower than the dry one, showing the slipping of the heavier product. On the other hand, for attributes not related to the diaper load, like core length, the results for the dry and wet diaper were the same. Only a few deviations from the predictions were found, but all of them were explainable by properties of the used test instrument.

4.1.3 Need for all Test Instruments

To decide which test instruments work and whether all are important, it is necessary to know their behaviour regarding the different questions.

The baby reflects reality in the best way and therefore the torso and pictures were compared with the baby. Before this could happen, the results achieved using the two babies had to be compared by the “variance method”. Hence, the results for similar questions concerning the two babies were compared: the result of question one from baby blue was compared with the result of question one from baby yellow.

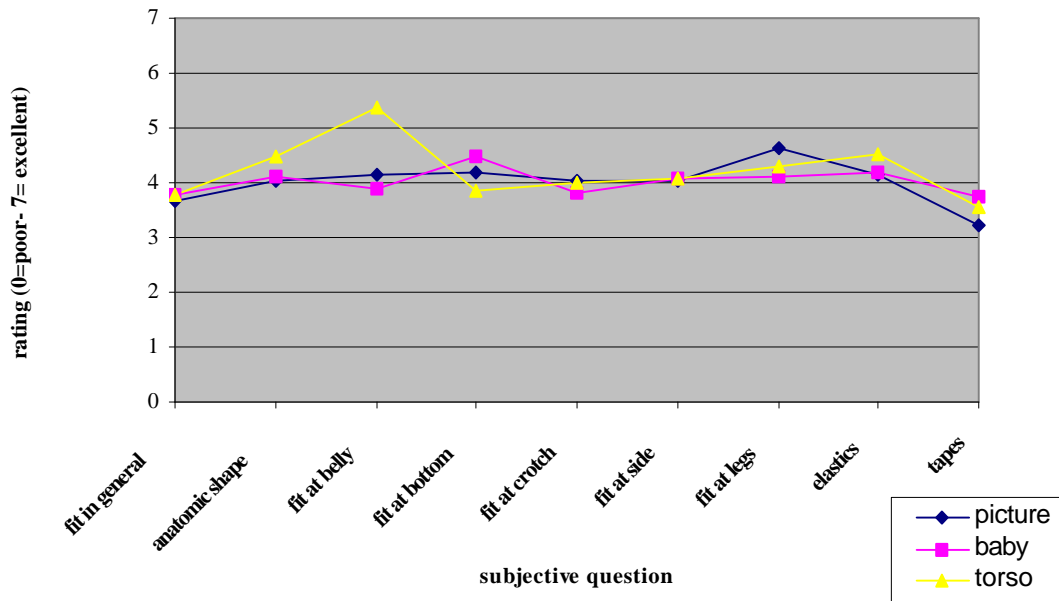


Figure 6: Comparison all test instruments regarding all diapers (subjective part)

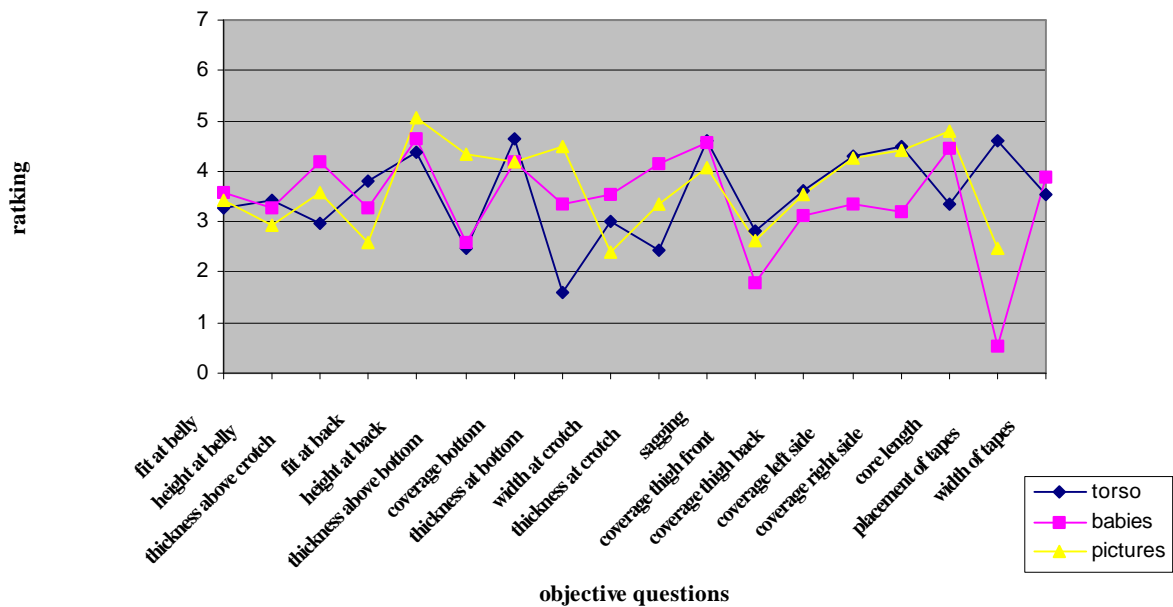


Figure 7: Comparison test instrument regarding all diapers (objective part)

The conclusion was that the babies gave the impression of the same body dimension for the panelists, as predicted in the study from B. Seitz (P&G fit expert). Based on this fact, the average of the two babies were taken and handled in the whole study as one baby. In general, in the subjective part, there are no large differences between the assessment methods (table 4). Regarding the similarity of the test instruments in the subjective and objective parts of the test, it could be assumed that pictures could be most likely left out.

On the contrary, results differ in the objective part (table 5). This has to do with panelists' closer look to detail. In the objective part, the variance method helped to determine that the test instrument picture is significantly closer to the baby than the torso. Because the different objective questions influence each test instrument differently (which also plays a role for the subjective part), it became clear that for the moment, no test instrument can be left out.

4.2. Connection between subjective and objective part of the questionnaire

The subjective and objective parts were linked together to know which objective factors, in detail, influence the subjective perception of attributes.

In principle, a "regression analysis" can link these two parts. However, the correlated nature of the objective questions leads to multicollinearity problems. To solve this problem, a factor analysis was performed on the objective questions, leading to a set of non-correlated factors.

A factor analysis is a statistical method where similar questions are summarized to one factor.

In the analysis of the Sensory Fit Panel, these factors were regressed against the subjective questions; this mathematical method is called "factor regression analysis". This analysis was applied on each test instrument.

Question	Method			Result	Torso	Picture	Baby
	Effect	effect	Interaction				
fit in general	Yes	No	No	U > AwBw > C	U > AwBw > C	U > AwBw > C	U > BwAw > C
anatomic shape	Yes	No	No	U > AwBw > C	U BwC, AwBw C	U > BwAw > C	U > BwAw > C
fit at belly	Yes	Yes	Yes	U > Aw > C > Bw	U > Aw	U > BwC > Aw	U > Bw > C Aw
fit at bottom	Yes	No	Yes	U > Aw > Bw > C	UAw CBw	U > AwBw > C	U > AwC, Bw > C
fit at crotch	Yes	No	Yes	U > AwBw > C	U > C Bw	U > AwBw > C	U > BwAw > C
fit at side	Yes	No	No	U > BwAw > C	U > C	U > AwC, BwAw > C	U > AwBwC, Bw > C
fit at leg	Yes	No	No	U > AwBwC	U > BwC, Aw > C	U > BwAwC	
elastics	Yes	No	No	U > BwAwC, Bw > C	U > AwBwC	UBw > AwC	U > C
tapes	Yes	No	No	Aw > Bw	Aw > Bw	Aw > Bw	

Table 3: Ratings for the different diapers with the different test instruments-subjective part (U=underwear, C= cloth diaper, A0 diaper A dry, Aw= diaper A wet, B= diaper B dry, Bw=diaper B wet)

4.2.1. Factor analysis

95.53% of the original 14 objective questions were explained by 10 factors (table 5).

These factors were regressed against the subjective questions. The probability that the subjective questions are explainable by the suitable factors is represented through a so called R^2 . A reliable R^2 for a pilot study should be $> 50\%$, and the maximum expected R^2 is about 75% . Additionally, a stepwise regression analysis for each test instrument was applied to split the important factors from the unimportant ones.

Torso

After splitting the R^2 of the subjective questions concerning the test instrument torso, the following subjective questions could be best explained by the following objective factors: “fit in general”

($R^2=66.9\%$), “fit at bottom” ($R^2=66.5\%$) and “fit at legs” ($R^2=54.7\%$). See for example figure 8.

The subjective questions were split into their describing objective factors considering the percentage of each component. For example, the subjective question “fit in general” is composed of the objective factors “coverage at side”, “thickness at crotch”, “thickness at bottom” and “fit at belly”. The ratings from the expert panelists showed directional differences between products in the subjective part (table 4). For one question, “fit at bottom”, not only a trend, but a significant difference was found.

The following step was to compare these results to the objective part of the questionnaire. Regarding the first component “coverage of side”, product A has the trend to cover more than product B. For “fit at belly,” B has the trend to fit narrower at belly than A (figure 9).

Question	Product effect	Method effect	Interaction	Method differences	Torso	Picture	Baby
fit at belly	Yes	Yes	Yes	PBT		Aw>ABCbWU	Aw>A>uBwBC
height at belly	Yes	Yes	Yes	T>BP	U>ABC>AwBw	A>U>B>aw>C>Bw	BA>AwUBw>C
thickness above crotch	Yes	Yes	Same	BP>T	BwAw>BCAU, BC>U	CBwAw>BAU	CBwAw>BA>U
fit at back	Yes	Yes	Yes	T>B>P	BPUCBwAw	AUAwBBwC	A>BwBC, AwU>C
height at back	Yes	Yes	Yes	P>TB	AwAUBC>Bw	AwA>BwCU, BBwC>U	AAw>BUBw>C
thickness above bottom	Yes	Yes	Yes	P>BT	CAw>BABw>U	C>BwAwBA>U	C>BwBAwAU, Bw>AU, BAwA>U
coverage bottom	Yes	Yes	No	P>BT	C>UBABwAw, U>Aw	C>UBBw>Aaw	C>UBBwAwA, UB>AwA, Aw>A
thickness at bottom	Yes	Yes	Yes	T>P, TB, BP	C>BBwAU, Aw >U	C>AwBAU, BwAU, AwBA>U	C>BwAwABU, BwAw>BU, AB>U
width at crotch	Yes	Yes	Yes	P>B>T	CAwBwAB>U	C>AwBw>BUA	C>BAwAU, Bw>AwAU, AwA>U
thickness at crotch	Yes	Yes	Yes	B>T>P	BwAw>BCAU	AwBwC>BA>U	BwCAw>BA>U
sagging	Yes	Yes	No	BTP	U>BACAwBw, A>Aw	U>Bw	U>BABwAwC
coverage thigh front	Yes	Yes	Yes	TP>B	C>UBwAAwH	C>UBwAAwB, U>AwA	C>UBwBAwA
coverage thigh back	Yes	No	Yes	TPB	C>BUBwAwA, BU>AwA	C>BBwU >A>Aw	C>UBBw>AwA
coverage left side	Yes	Yes	Yes	TP>B	C>UABwAwA, U>H	CU>A>Aw>BwB	C>UBAAwBw, U >AwBw
coverage right side	Yes	Yes	Yes	TP>B	C>UBwAwAB, U>AwAB, Bw>B	C>AAwBwB, UA>AwBwB	C>U>BAAwHw
core length	Yes	Yes	Yes	P>B>T	AAw>BBw	AA>BBw	
placement of tapes	Yes	Yes	Yes	T>P>B	BwB>A>Aw	B>Bw>AwA	BwB>Aaw

Table 4: Ratings for the different diapers on the different test instruments (objective part) (U=underwear, C= cloth diaper, A0 diaper A dry, Aw= diaper A wet, B= diaper B dry, Bw=diaper B wet)



Factor 1	coverage left and right side
Factor 2	thickness at crotch
Factor 3	thickness at bottom
Factor 4	coverage at bottom and back of thigh
Factor 5	height at back
Factor 6	fit at back
Factor 7	fit at belly
Factor 8	Width at crotch
Factor 9	height at belly
Factor 10	coverage at front of thigh

Table 5: Meaning of the single factors

Furthermore, B has the trend to be thicker at crotch and regarding the last component “thickness at bottom”, diaper A has a strong trend, leading to a probably statistical significance if more data points were used. The second subjective attribute “fit at bottom” is predictable up to 66.5%. It is composed of the objective factors in the following percentages: “coverage of side” (14.9%), “coverage bottom and back of thigh” (5.2%), “height at back” (21.6%) and “height at belly” (24.8%). The first factors are already described in the subjective part “fit in general”. Regarding “coverage at bottom and back

of thigh”, again the two ratings of the diapers were compared and the result is that product B has the trend to cover more than product A. A has the trend to be higher at belly than B, and looking at “height at back,” there is even a significant difference. The last subjective attribute with a R² over 50% is “fit at legs”, which is composed to 13.3% of “thickness at crotch” to 12.7% “thickness at bottom” (12.7%), to 17.2% of “height at back” and to 11.5% of “coverage front of thigh”. Concerning “coverage at front of thigh,” product B has the trend to cover more than product A.

Summarizing the test instrument torso it can be said that concerning the three relevant subjective questions--“fit in general”, “fit at bottom” and “fit at legs”--only for “fit at bottom” does a significant difference between the two diapers appear. For Copy Claim Support, only the significant similarities or differences are important. Therefore, concerning the torso, the subjective question “fit at bottom” is essential, revealing that product A fits better than product B. The objective factor “height at back” is also significant, showing A higher than B. The same procedure was used to determine the significant results on picture and baby.

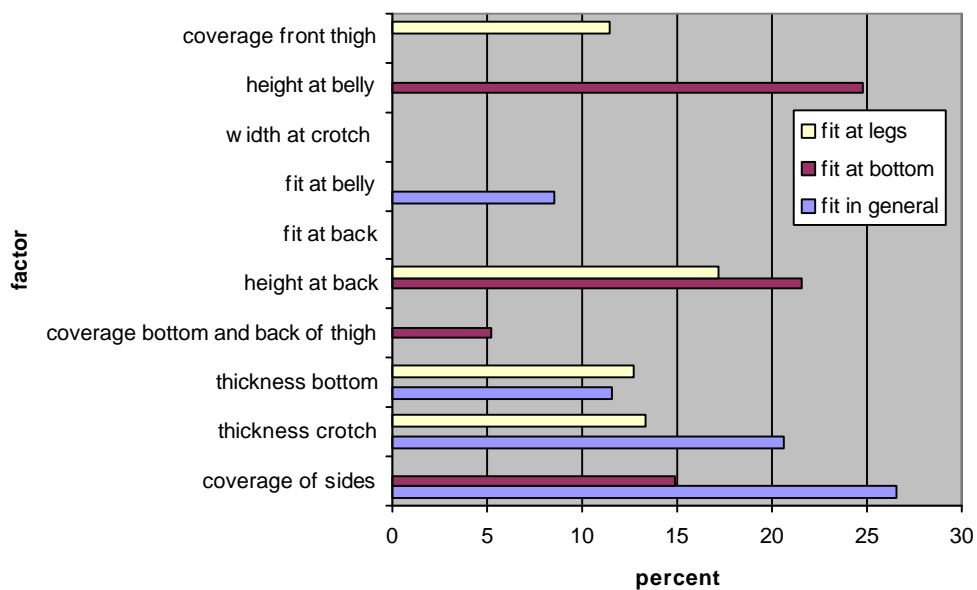


Figure 8: Percentage of the single factors for the subjective questions (torso)

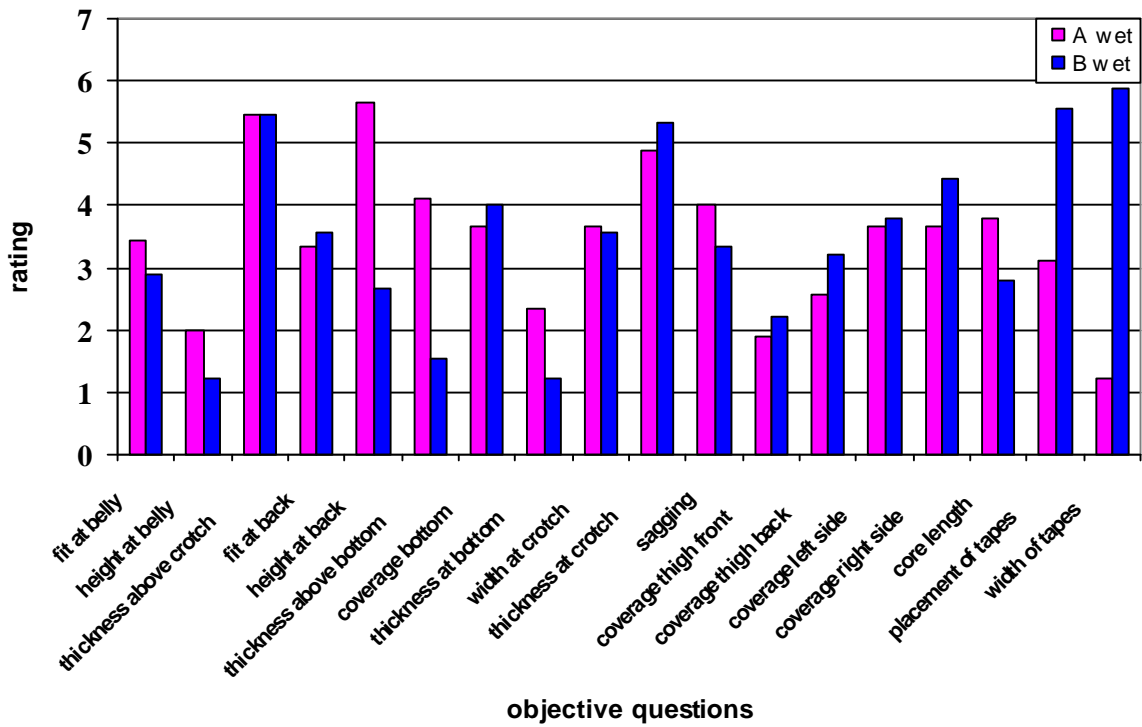


Figure 9: Comparison of diaper A wet and diaper B wet for torso (objective part)

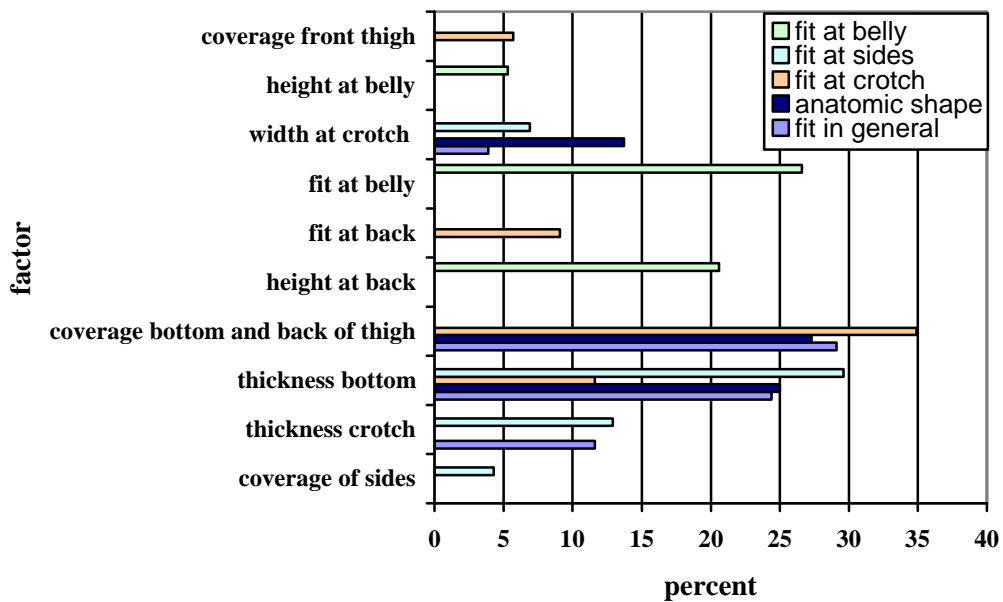


Figure 10: Percentage of the single factors for the subjective questions (picture)

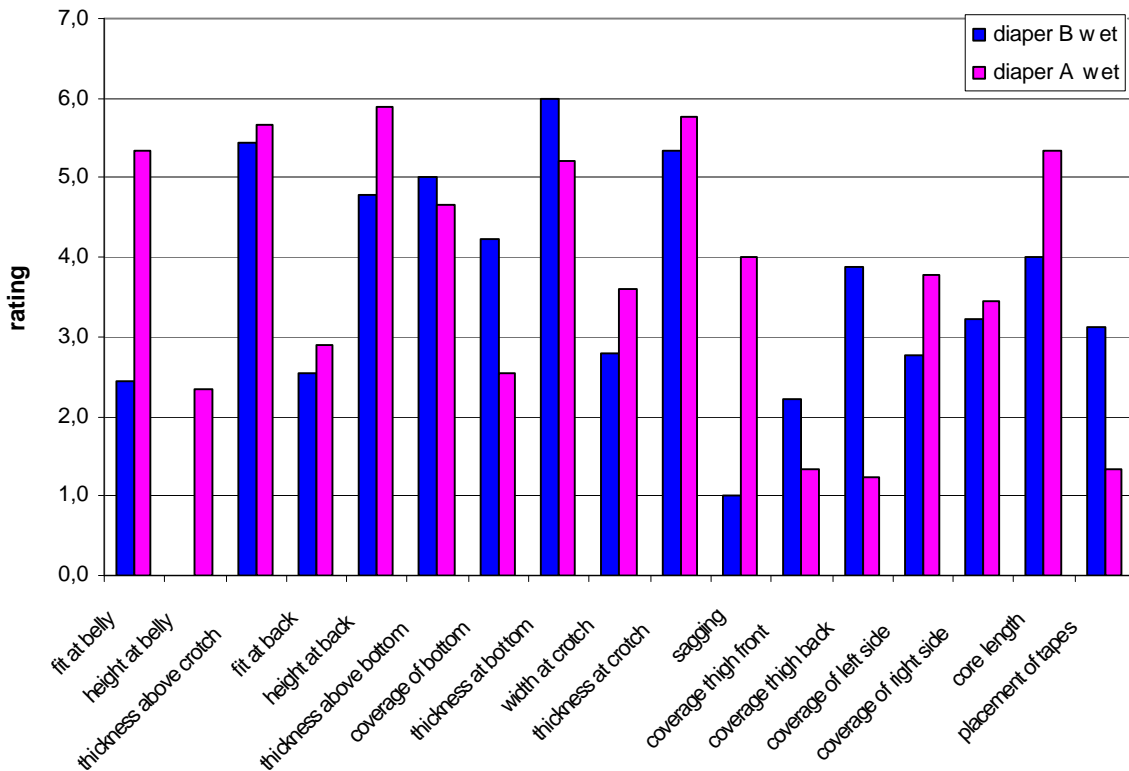


Figure 11: Comparison diaper A wet and diaper B wet for picture (objective part)

Picture

Each test instrument receives good correlations on different subjective questions. For pictures, the subjective questions with an acceptable R^2 are “fit in general” (69%), “anatomic shape” (66%), “fit at belly” (52.5%), “fit at crotch” (61.3%) and “fit at side” (53.7%). See figure 10.

Regarding “fit in general”, “anatomic shape” and “fit at crotch”, B and A show few trends. This means that with a higher base size of panelists, these points could reveal real trends. Regarding “fit at sides,” there is already the trend that product B fits better than product A (figure 11). The only significance appears at “fit at belly”, where B fits significantly better than A. Looking at the describing objective factors, product A is also significantly higher at the back than product B.

Baby

The meaningful and best explainable subjective attributes on babies are “fit in general” (76.6%), “anatomic shape” (76%), “fit at bottom” (61.6%), “fit at crotch” (51.9%) and “fit at sides” (62.7%). See figure 12.

Regarding these attributes, only low to moderate trends are visible that B fits better than A, which could change with a higher base size of panelists.

This summary shows that at the moment all test instruments are needed and further studies will evaluate up whether different test instruments should be used for different attributes, because some attributes are better visible on a static body and others need movement for good assessment (see also figure 13).

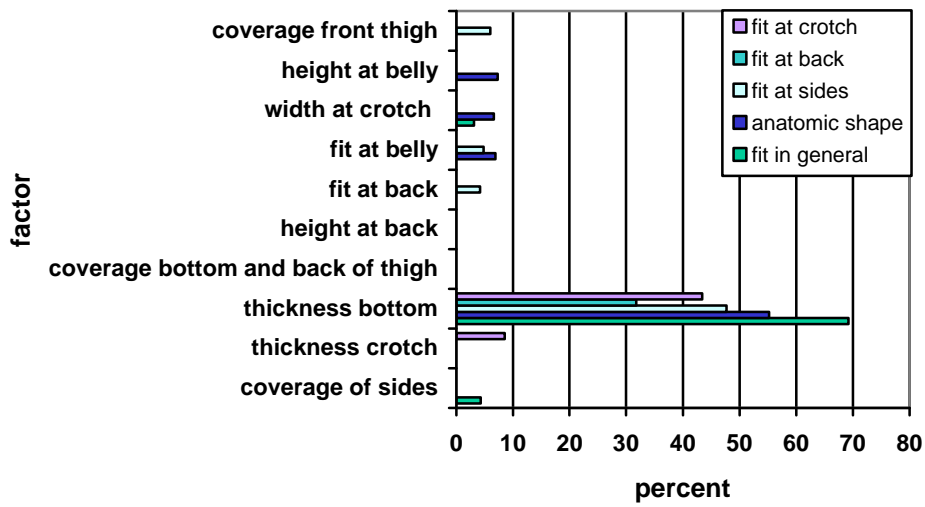


Figure 12: Comparison of diaper A wet and diaper B wet (objective part)

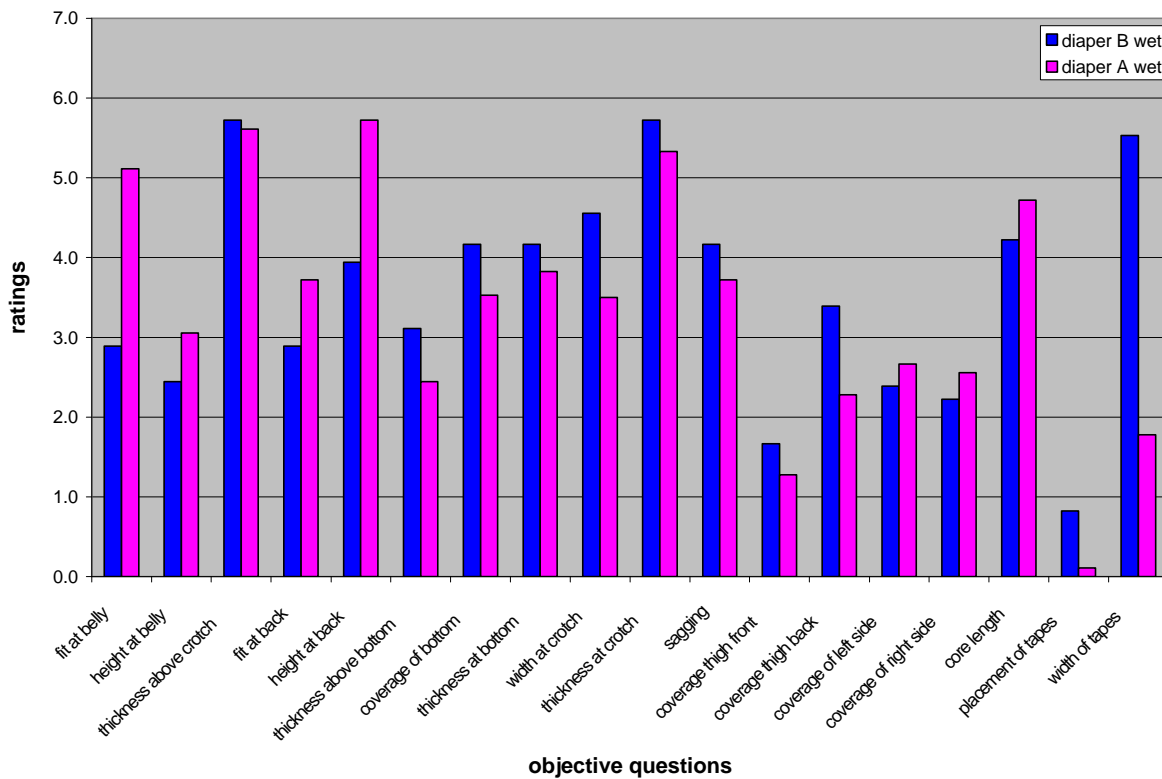


Figure 13: Comparison of diaper A wet and diaper B wet for baby (objective part)

4.3. Important questions

Another aim of the “Sensory Fit Panel” pilot study was to find out which questions are important and whether some could be left out. Therefore, only the unexplainable subjective questions with a R^2 under 40 percent were considered. This limit was set because with more panelists producing a higher amount of data, the questions around and over 40 percent can reach the 50 percent limit and herewith they would become explainable.

The conclusion was that the subjective attributes “elastics” and “tapes” were irrelevant.

4.4. Confirmation of results

4.4.1. Comparison with consumer test

As a final confirmation for this method, we compared the results to data from a so called Concept & Single Product Identified Test (C&SPITs) conducted by P&G in the U.K. [12]. This country was chosen because both tested products are marketed there. A C&SPITs is a test using panelists with children wearing the same size of diapers. These mothers receive diapers for a certain period and then are asked for their opinion about these products afterwards.

In this C&SPIT, two test groups tested each one of the products used in the pilot study (table 6, 7).

The voluntary comments of the panelists about these products were compared to the results of this pilot study. In contrast to the “Sensory Fit Panel” ratings, which were given only in wet stages, these comments are given for diapers in dry and wet stages. The results are separated in the different test instruments. The ratings of the “Sensory Fit Panel” pilot test question “fit in general” was compared to the similar question in the C&SPIT study. The ratings were also translated into a 100 point rating scale (table 8-10)

For the subjective part, there is a good correlation with the “Sensory Fit Panel” results regarding the test instruments torso and pictures, but not with the test instrument babies. The reason for this could depend on the low amount of panelists, which can influence the results. Therefore, the objective questions were also considered.

In table 11 an overview is given, with results regarding each test instrument; they agree with the results from the C&SPIT.

Diaper B users	Diaper A	Diaper B
Rating (0=poor to 100=excellent)	66	65

Table 6: “well fit” on wet diaper rated by diaper B users

Diaper A users	Diaper A	Diaper B
Rating (0=poor to 100=excellent)	68	58

Table 7: “well fit” on wet diaper rated by diaper A users

“Sensory Fit Panel” torso	Diaper A	Diaper B
Rating (0=poor- 100=excellent)	60	46

Table 8: “fit in general” results of the wet diapers from “Sensory Fit Panel” on torso

“Sensory Fit Panel” picture	Diaper A	Diaper B
Rating (0=poor- 100=excellent)	59	54

Table 9: “fit in general” results of the wet diapers from “Sensory Fit Panel” on pictures

“Sensory Fit Panel” baby	Diaper A	Diaper B
Rating (0=poor- 100=excellent)	56	59

Table 10: “fit in general” results of the wet diapers from “Sensory Fit Panel” on pictures

The results from the test instrument “pictures” agree in all objective points with the results of the voluntary comments. Results from “torso” are in line with three points and “baby” in two points. “Does not agree” means that the two results are approximately similar. “Does agree” means the test instruments have the same trends. To understand the results for the different test instruments, the following points must be considered. These results were achieved by the low base size as well as the different kinds of questions (trained panelists vs. consumers). Another point is that the voluntary comments of the consumers are for dry and wet diapers instead of the “Sensory Fit Panel” results, which were only generated for the dry diapers.

Considering these points, it becomes clear that the method works, but a higher base size is needed to change the hints from this pilot study into sound facts.

5. Conclusions

Looking at the results of the “Sensory Fit Panel” it becomes clear that a subjective impression can be measured in an objective, reliable and reproducible way. However, more studies have to follow to consolidate the basis of the pilot study. The base size of the panel must be raised to 15 experts. These experts have to rate dry and wet diapers in the subjective part on all three test instruments, and these results have to be compared with the results from the C&SPIT again. Additionally, the test has to be compared with all kinds of boundary babies and different types of diapers, because it could then become clearer, which test instrument is useful for which attribute.

	Torso	Picture	baby
“height of diaper”	X	X	X
“width of tapes”	X	X	X
“thickness at crotch”	O	X	O
“overall thickness”	O	X	O
“sagging”	O	X	O
“overall fit” (wet diaper)	X	X	O

Table 11: Comparison of results with C&SPIT (X = does agree with sensory testing)

Acknowledgements

Thanks to Prof. Dr. Rieger and Dr. Höhne from the University of Ulm, who made this diploma thesis possible, to P. Bowtell and W. Schöler for their statistical support, and to U. Podbielski for the sensory benefit of this project. Also thanks to N. Rauch and B. Seitz who created the morphings and helped to see the project from a fit point of view.

References

- [1] A. Maslow, 1987, *Motivation and Personality*, 3rd ed., Hapercollins College Div., New York
- [2] Huitt G., 2004, *Maslow’s hierarchy of needs*, Educational Psychologies Interactive, Internet:
<http://chiron.valdosta.edu/whuitt/col/regsyps/maslow.html>



- [3] Kotler/Bliemel, 1992, *Marketing-Management*, chapter 13, p. 241, C.E. Poeschel Verlag, Stuttgart
- [4] Richer C., 2004, *Diaper History-50 years of evolution*-,Internet:
<http://www.gpoabs.mx/cricher/history.htm>
- [5] Kotler/Bliemel, 1992, *Marketing-Management*, chapter 13, C.E. Poeschel Verlag, Stuttgart
- [6] Seitz B., 2003, *Technical Training Program: Fit Studies, Baby Measurements & Level I Fit/Size Models*, page: Fit & Sizing Terminology and Understanding, P&G Technical Training
- [7] Esomar- *Glossary of Marketing Research Terms*
Internet:
<http://www.esomar.org/web/show/id=137136>
- [8] Meilgaard, Civille, Carr, 1991, *Sensory Evaluation Techniques*, 2nd ed. , p. 38, CRC Press, Boca Raton, Florida
- [9] Schweizerisches Lebensmittelbuch, 1990, *Grundlagen zur sensorischen Prüfung*, Internet:
<http://www.slmb.ch>
- [10] Kenelly L., "Key Elements of Design", P&G internal study CMK #WW031419
- [11] *Virtual Perception System*, P&G software for hair color rating
- [12] *P&G study*, 2004, C&SPIT UK 2004, P&G Test- No. GB041382

Practitioner's Section

High-Performance Research for High-Tech Materials

1. Degussa's Science-to-Business Center Nanotronics

2. Four Percent for the Future

Dr. Andreas Gutsch^{*}, Prof. Dr. Michael Dröscher^{**}

* Head of Creavis Technologies & Innovation, Degussa AG, Marl, Germany

** Head of Innovation Management Corporate Division, Degussa AG, Düsseldorf, Germany
correspondence to: karin.assmann@degussa.com

Abstract: High-performance research for High-tech materials is an article about Degussa AG's research efforts and strategy. Degussa AG, Germany, has decided to increase investment in research and development significantly—from 3.1 percent of sales revenue in 2004 to 4 percent by 2007. How is the firm going to achieve this goal? The paper is divided into two parts. First Dr. Andreas Gutsch gives newest insight into the Science-to-Business Center Nanotronics. Second an interview with Prof. Dr. Michael Dröscher answers questions about research strategy and project portfolio management.

1. Degussa: Science-to-Business Center Nanotronics

Degussa AG, Düsseldorf, the world's leader in specialty chemicals, opened its new Science-to-Business Center Nanotronics at the Marl Chemical Park in April 2005. The Science-to-Business Center is a consequential enhancement of the project house philosophy. Its concept is based on integrating a close network between the fundamental research at the universities and the industrial application and marketing expertise. As it can significantly reduce the time from invention to market-ready product, this approach has clear competitive advantages.

Scientists from universities and research institutes, from small- and medium-sized enterprises, and from Degussa will all work in close cooperation in the Science-to-Business Center. The Center will also temporarily integrate the employees of universities and research institutes, thereby combining excellent scientific expertise with industrial project management and the infrastructure of an advanced chemical site. Furthermore, the Science-to-Business Center will strengthen practical scientific education, since the acquired know-how will flow directly back to the participating universities and research institutes.

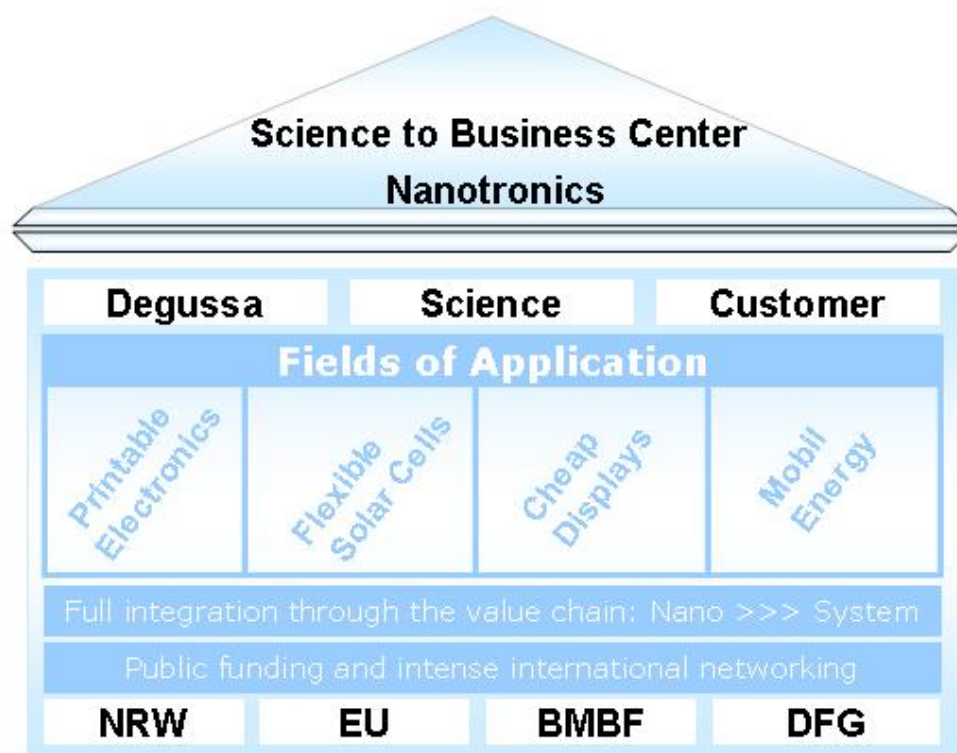


Figure 1: Organizational Innovation the „Science-to-Business“ Concept

System solutions for the electronics industry

Degussa is focusing on "Nanotronics" for its first Science-to-Business Center, the close interaction between nanotechnology and electronics. Nanotronics was selected because the development of innovative system solutions based on nanomaterials for the electronic industry promises to be a highly profitable business. The Science-to-Business Center will primarily develop electronic systems and elements whose core components consist of new types of electrically functional nanomaterials and nano-coatings. Some of the fields of application include printable electronics, low cost displays, flexible solar cells and mobile energy systems.

Printable electronics

Two of the Center's projects aim at electronics based on printing techniques. Radio frequency identification (RFID) technology, for example, allows data to be stored and read without being seen or touched. The cost of using RFID chips are too high up to now, from being widely adopted in transactions for mass applications as a replacement for bar codes on packages.

The current practice of vaporization of transparent and highly conductive oxide coatings onto displays and monitors is also expensive and time-consuming today. The involved scientists are convinced that both—RFID chips and oxide coatings—can be produced far less expensively with high-end printing technology.

The approach to these projects is a prime example of the R&D philosophy and innovative structures of the Science-to-Business Center. The application is the objective and starting point at the same time, because the "begin-at-the-end" mindset immediately helps to visualize all developmental problems. The search for a suitable printing technique is a good example: Currently, there is no technology available that can print layers in the range of several thousandths of a millimeter quickly and at a high resolution. The triad of industry, science and customer also plays an important role in solving these problems. In printable electronics, the relevant basic knowledge

about nano-silicon comes from the universities. Degussa has the essential know-how in chemical and process engineering to be able to convert nanoscaled silicon from a powder to a liquid, and then to a type of printing paste. The customers contribute their knowledge about the printability of packages and the requirements of the oxide coating for displays and monitors.

Flexible solar cells

In a third project that has just begun, Nanotronics researchers are working on making solar energy simple and cheap, in order to meet the increasing demand for regenerative energy sources. The idea behind the project is to make conventional silicon spreadable with the help of nanoparticles, which will then allow the production of flexible solar cells. Cells of this type would be less expensive to produce, and their use—the generation of electricity from solar energy—could increase considerably. This project also follows the R&D philosophy of the Science-to-Business Center: As with all other projects, the focus here is on the marketing of a system solution and economic considerations playing an important role from the very first moment.

SEPARION[®] ceramic foils

The "Separion" project, which involves ceramic separator foils, is one project that has advanced considerably further. Batteries require separators to separate the anode from the cathode. SEPARION[®] separator foils from Degussa consist of a polymer non-woven material inside, which on either side is coated with an extremely thin layer of a metal oxide mixture. This ceramic coating consists of nanoparticles. The actual competitive advantage is the sintering process, during which the ceramic material is anchored and reinforced on the plastic. In the case of the SEPARION[®] foils, this is successful at temperatures of 250°C, up to 1,000 °C lower than conventional sintering processes.

The idea of combining a continuous ceramic coating with a low-cost polymer substrate is as new as the unique manufacturing process itself. In the past, ceramics could be sintered only in individual batches in kilns at significantly higher temperatures. Degussa's novel low-temperature

sintering method not only allows for continuous production, but is also considerably more economical.

The initial application of the foils in new types of lithium-ion batteries is also promising. Because lithium-ion batteries are lighter, smaller and more powerful than other battery types, they have already captured as much as 99 percent of the mobile communications market, including cell phones, camcorders, and laptops. But a great challenge remains ahead, because plans are to use the innovative accumulator batteries as a power source for electric powered and hybrid vehicles. Such vehicles are already extremely successful in the United States, where Toyota alone will sell over 500,000 models in 2005.

For automobile applications, the performance of lithium-ion batteries will have to be increased by a factor of at least five. In the mobile industry, however, the demand for the safety of these "power packages" is growing just as fast. Traditionally, semi-permeable membranes made of polymers (polyethylenes or polypropylenes) have been used in lithium-ion batteries to separate the anode from the cathode. They have some serious disadvantages: They are flammable; the batteries are unsafe if a fire occurs; above 140°C they lose their temperature stability, and at low temperatures their ability to become wet with liquid electrolytes is severely restricted. Their life cycle is also limited. Intensive tests using SEPARION® foils have shown that all these limitations can be overcome by using the new types of ceramic foils.

Given the existing opportunities, the foil production will increase tenfold this year. An additional plant has been set up in the pilot plant of the Nanotronics Center to meet this demand. With a capacity of 2 million square meters per year—the equivalent of nearly 300 soccer fields—the plant completes the step from pilot to commercial production. And that's just the beginning of an extraordinary success story. The goal for Degussa is clear: to become the preferred system supplier for the mobile electric energy of tomorrow.

Permanent project control

The Science-to-Business Center is characterized by close cooperation across disciplines and industries: It allows the development of a system solution to be approached from different angles, and integrates each link in the entire value-added chain. Twice a year scientists, controllers and marketing experts review the projects together to make sure they are still on course and on schedule. The aim is not only to show successes but to discover early on if a project is headed for a dead end.

The novel focus of the Science-to-Business Center, however, also calls for a special kind of employee—scientists with an outstanding education, who also have a highly developed sense of business trends and markets.

The Center's laboratory and pilot plant equipment is perfectly geared to the central nanotronics technology platform, which covers all levels in the value-added chain, from the chemical raw materials to the end customer's products. From the first laboratory test to pilot production in the pilot plant, the Center contains equipment and machines for the manufacture and characterization of functionalized nanomaterials, dispersions and formulations, hybrid and composite materials, functional layers, semifinished products, and demonstrators.

The projects of the Science-to-Business Centers Nanotronics are co-financed by the European Union and are financially supported by the state of North Rhine-Westphalia in Germany and other public institutions. This reveals the fundamental importance of this concept also outside Degussa.

2. Four Percent for the Future

Introduction

Following is an interview with Prof. Dr. Michael Dröscher, head of Degussa AG's Innovation Management Corporate Division, on research and innovation management.

Degussa AG, Düsseldorf, Germany, has decided to increase investment in research and development significantly—from 3.1 percent of sales revenue in 2004 to 4 percent by 2007. With sales revenues at €11.2 billion and research investments at €348 million in 2004, the research budget will be increased by some €100 million to €450 million by 2007.

What is Degussa aiming for with this considerable increase in research expenditure—and why 4 percent?

We're expecting more added value with new, innovative products, and 4 percent is in the upper range of the amount that our competitors are investing.

If you invest more in research—won't this mean a deficit somewhere else?

We're planning to spend more money on research under the condition that Degussa continues to grow the way we expect. We're not planning to give up other things for this, but we want to have a portion of our growth in earnings flow into research too. We're thus investing in the future. And we even aim to generate more sales and EBIT—earnings before interest and tax—in the short term by mobilizing resources.

Could you tell us what you mean by “mobilizing resources”?

Luckily, we have more ideas than resources to make them a reality. This means that the increase in investment doesn't get used to find new ideas but to strengthen the processes we use to transform our expertise more effectively into profit. With a larger budget we can encourage and accelerate even more innovation—speed is an important factor in innovation. Of course, you can't do it without ideas. But if we have more money at our disposal, we can also be more daring, and take a chance on riskier research subjects,

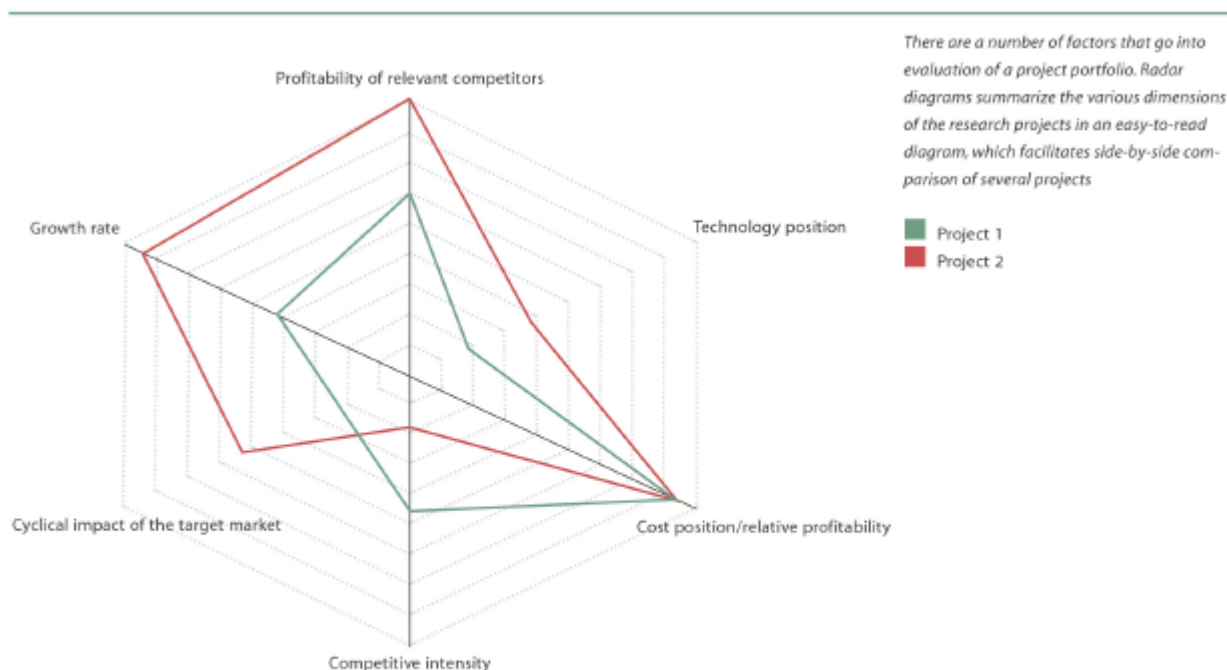


Figure 2: Evaluation of a project portfolio

implement projects faster, and support projects that one business unit couldn't afford to do by itself. Our goal is to generate faster additional, profitable sales, and therefore more organic growth.

How are you going to spend the additional funds specifically?

We're going about it in four different ways. On the one hand, the business units will increasingly conduct research and invest where new business segments are lying dormant.

But we also want to play a more active role in publicly funded partnerships, and make headway in fields that are new for Degussa—the way we have with our new Nanotronics Science-to-Business Center in Marl, for example. Nanotronics refers to the development of nanomaterials-based system solutions for the electronics industry. The centerpiece of our Science-to-Business concept is the idea of science and industry working together under one roof. We want to work more closely with research institutes and universities, and plan to step up corporate funding to make this possible. Currently, corporate-backed projects are financed up to 50 percent by the Group and up to 50

percent by the business units. They carry more risk and last longer than is typical for the research of the business units, which tend to take on projects that have a goal of three years to market launch. The Group finances longer projects that take five years to reach market maturity. The project houses, for example, which develop complete technology platforms for the Group, are also financed up to 50 percent by the Group. It also advances internal start-ups, in which we go to market with entirely new products. We want to work on this aspect even more in the future.

A third complex in which we want to invest more is improving the utilization of our knowledge, and strategically expanding it. For example, if a customer patents a new product of ours for his area of application, we can no longer sell that product to other customers. This is why we want to focus more energy on selling an individually tailored service, and retain the basic application patent internally.

Last, item 4 on our list deals with buying expertise. We plan to deal more with start-up companies, and try to integrate the scene of the small, research companies financed with risk capital more into development. And not just in Germany but internationally. We're also currently

Portfolio management with the InnoToolbox:

a The pipeline diagram summarizes data on the opportunities, risks, progress, and market environment of the individual projects, displayed here as points. At a glance, it shows each project's probability of success, its stage of development, and its projected commercial value (proportionate to point size)

b The time-to-market diagram provides additional information on the market maturity of the individual projects, and thus on the sustainability of the research portfolio

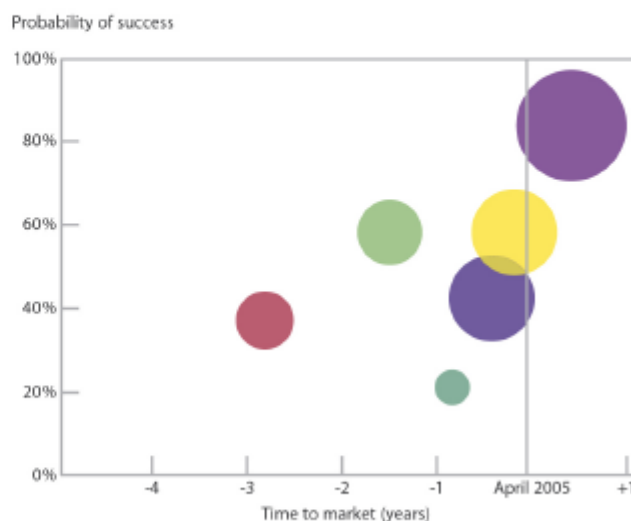
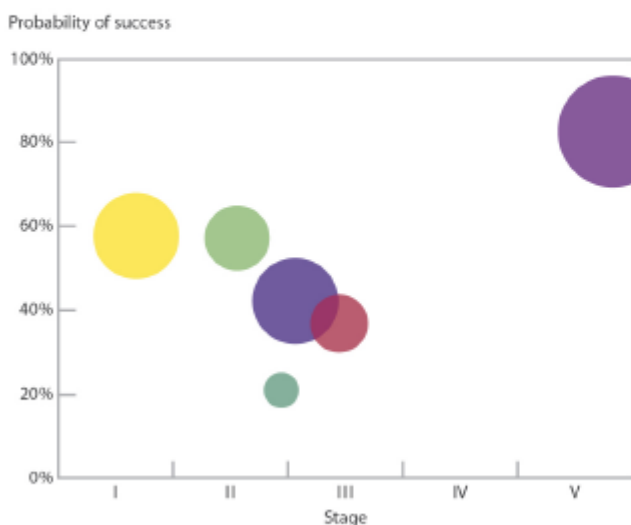


Figure 3: Portfolio management with the “InnoToolBox”

building research partnerships in China, and have just opened a research center there. We maintain these kinds of partnerships in Eastern Europe, as well. We see a lot of potential for our company there.

How will you ensure that the right ideas are selected from a sea of possibilities?

We have to develop a clear strategy that defines search fields and finds growth markets. The question must always be: Where can I sell my expertise on the market in the form of new products faster than the competition?

Surely you won't be relying on your instincts alone?

We have now decided to use an electronic tool Group-wide, the "InnoToolBox." The tool combines classical project management with business-plan factors, and enables us to vary different independent variables. This allows us to improve the classification of individual projects and better evaluate the entire research portfolio. Typical questions are: What happens if the plant is more expensive than we planned? If we're spending more? If the price of the product drops on the market?

The answers lead us to a key figure, the "net present value" of the project. It tells us how much value can be created with the project if it is successful. But because there's no guarantee of the success of a project, we also have to consider the possibility of technological success, and the probability of market success. And, of course, time-to-market also plays an important role. At the end of the analysis, we have four key figures with which we can integrate a project into the portfolio and evaluate it. This gives us added security that we're doing the right thing the right way.

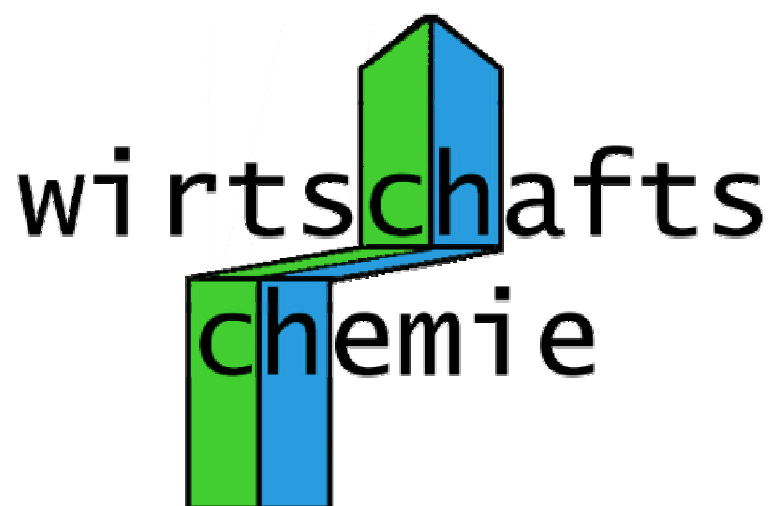
Copyright © for this article only covers scientific publications. The Degussa AG is allowed to publish this article (or parts of it) in 'non-scientific' journals which are published by Degussa AG itself.



*A part of the EBSCO
Information Services group.*

www.ebsco.com

EBSCO Publishing / EBSCOhost is the registered trademark of EBSCO Publishing.



Journal of Business Chemistry

www.businesschemistry.org