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Abstract

Title:	Funding Model Strategies – a Case Study on a German MEMS Start-up
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Supervisors:	Ola Alexanderson, Department of Industrial Management and Logistics, Lund Institute of Technology. Bernd Schünemann, Business Development Manager SMI
Key words:	Strategic Alliance, Private Equity, High-tech Market, Funding Model and MEMS Industry.
Purpose:	The purpose of this thesis is to investigate the strategic consequences of using strategic alliance, as an alternative to private equity to satisfy SMI’s short and long term funding and growth.
Methodology:	The thesis is based on a single case study within the sponsor company. Action research with a scenario based questionnaire was used to collect empirics, primarily from the management group but also other stakeholders.
Theory:	Theory about high-tech markets is used to explain industry specific symptoms. The resource based view gives the framework for the theory and guides the discussion about key resources and the theory about strategic alliances and private equity high-light advantages and drawbacks between them.
Empiric:	The empiric is driven by the scenario questionnaire and the deep-interviews and examines the industry background and strategic issues at the sponsor company. The identified key resources are explained and studied. Strategic alliances and private equity examples from the MEMS industry is illustrated.
Conclusions:	The authors propose a business model for SMI and how this should be combined with venture capital and private equity to get the best leverage on controlled resources and acquire missing resources.

Foreword

This master thesis is written within the field of Industrial Management and is the finishing part in our degrees in Master of Science with a major in Industrial Management for Carl and Electrical Engineering for Henrik. These finishing lines are written about five months after the work began in a late-summer warm Hamburg and since then a great deal has changed. Hamburg was an unfamiliar city for both of us and our companionship was based on a project course nearly two years ago, where we were fellow-students. Today Hamburg has become a preferred city for both of us and we have already returned several times and the companionship has grown to a friendship that will last long after the conclusion of the thesis. We would like to thank those who made this Master thesis possible and those who made our journey to Hamburg to such a pleasant time.

Many people have contributed to this study. Throughout the working process we have received great support and help from several persons with in the studied company. This reception did not only provide us with valuable information for the study, but also great personal experience from working in a European high-tech company. For this we would especially like to thank Peter Draheim, Bernd Schünemann and Wolfgang Weggen.

We would also like to thank for the support given by our supervisor Ola Alexanderson, Assistant Professor at the Department of Industrial Management and Logistics, Lunds Institute of Technology. Who assisted the study through valuable input and guidance.

Hamburg and London, February 2005

Carl Andersson & Henrik Nilsson

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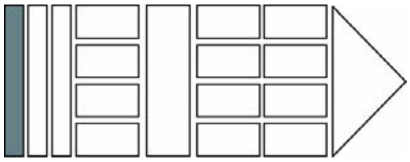
1 Introduction

This chapter sets the framework for the thesis. First, a presentation of the background and a problem discussion ends up in a purpose. Furthermore the delimitations, target group and disposition of the thesis are settled.



1.1 Background

The semiconductor industry has, since it changed the entire technology industry in the 60's, been one of the world's fastest growing industries. Personal computers, space shuttles and Internet connection are examples of products impossible to realize without semiconductors. (Thomke & von Hippel, 2002) The semiconductor, often denoted as a chip, is a complex electronic structure made of silicon. With enormous development costs for a new chip structure and state-of-the-art plants with substantial construction costs, the business could seem unfriendly. Still, considering a global demand, plants and chip structures designed for mass-production and raw material obtained from regular sand, companies make great business out of semiconductors.

The demand for smaller, faster and more consumer friendly products have encouraged the industry to constantly search for new chip technology features. One of the most promising technologies, called MEMS[1] is to combine the electronic structure of the chip with a mechanical structure. This opportunity was discovered shortly after the commercial break-trough of semiconductors, but has, due to limitations in the production process, remained relatively unexplored until the mid 90's. (Eloy, 2004a) The general idea is to integrate mechanical sensors and actuators with micro-electronics on a single chip. The need to measure and effect physical quantities is present in a wide range of products. Today, this is mainly accomplished with assembled products. The main advantages with MEMS are similar to the semiconductor industry, cost reduction through mass-production and miniaturization. The smallness of the chips also allows the design of completely new products. (SMI, 2004a)

The MEMS industry was recently established and there are only a small number of MEMS based products that has reached a commercial break-through, e.g. ink jet

[1] Micro-Electronic Mechanical Systems

printer heads and airbag accelerometers. System suppliers for the automotive or electronics industry generally produce these large volume standard products in-house. (Finkbeiner, 2004) For small and medium volumes, the industry is characterized by a large number of development companies that purchases external manufacturing capacity. Their products are often early stage products with great potentials but also high risks. The annual turnover for the industry in 2002 was around € 5 billion (SMI, 2004a) and its forecasted future growth is estimated to be 18 percent annually.

In 1998 the Dutch based company Philips and the American semiconductor manufacturing company Standard MEMS formed the joint venture SMI to capitalize on the opportunities of the MEMS market. SMI's headquarter was situated in Itzehoe northwest of Hamburg, Germany. The nearness to the Fraunhofer Institute[2] division in Itzehoe and Philips Semiconductors in Hamburg as well as government controlled financing regulations was important factors behind this decision. SMI's business model was MEMS design and manufacturing process development, with production capacity contracted to the Fraunhofer Institute's fab[3]. The design and process skills are used to source other companies' silicon manufacturing needs, a business model known in the silicon industry as a foundry (Thomke & von Hippel, 2002). After a couple of years the American company was set under observation due to financial problems and left the joint venture short before it declared bankruptcy. Philips was left alone as sole owner of SMI, a company in need of capital injection.

1.2 Problem Discussion

The MEMS industry is still a business committed to great uncertainty both in technology and market. The technology is unexplored and protection by intellectual property rights and a low degree of standardization make the ongoing technology development hard to predict. The majority of the MEMS products have not yet reached the mass-market segment and many customers still believe that the price per chip is too high. Due to the uncertainty of the market and technology, Philips as sole owner of SMI, is committed to a large financial risk. (Schwartz, 1999) Considering that sole ownership is not in line with Philips portfolio strategy and risk management, SMI is currently looking for additional external funding and ownership. In addition to the reduction of Philips' ownership, SMI is in need of a capital injection to invest in further growth of the company.

[2] German contractual research institute, partly funded by government subsidy
[3] manufacturing facility for silicon structures

External finance can be acquired from different sources and with various aims from the investors. SMI is operating on an emerging market where both the return on investment and the financial risk are difficult to evaluate. Funding in this kind of situation is in general provided from private equity[4] investors, i.e. venture capitalist and angel investors. In recent years, strategic alliances have shown to be a feasible solution for start-up companies in need of early stage funding (Nielsen, 2002). There are several ways to form a strategic alliance and some of them could involve equity transfer between the involved companies.

A more traditional way to raise capital is to issue bonds or make an initial public offer, but none of these solves both the main issues of this study. Bonds do not reduce the financial risk held by Philips and an initial public offer in the start-up phase is not likely to increase the company's total equity and does thus not solve the funding issue. Therefore both of them are excluded from this study.

The choice of funding strategy for a start-up company is highly dependent on the company's present resources and lack of ditto. The problem is two-folded; to be able to select a funding strategy a company has to be aware of which resources they are looking for. Concurrently, to attract funding a company has to justify in what way their new set of resources are about to reinforce their competitive position. Hence, a funding decision is closely linked to the strategy of the company and this research has a strategic approach to the funding decision (SMIth & SMIth, 2000).

As argued above, the present strategy affects the funding strategy of a company but it is also important to be aware of the upcoming strategic implications given by the funding decision. (Jemison, 1987) Different funding models will be able to provide different resources but will also make the company committed to contractual constraints. These tradeoffs and risks must be taken into consideration when choosing funding model.

The background and problem discussion leads to three areas of inquiry.

[4] equity investments in privately held non-quoted companies

1.3 Areas of Inquiry

Our *first* area of inquiry is to understand SMI’s present situation, the resources existing internally and their position in the market.

The *second* area of inquiry is to understand SMI’s vision of their future and what resources that are needed to get there.

The authors’ *final* area of inquiry concerns what resources the different funding models can contribute with and what trade-offs that are to be made when choosing one of them.

1.4 Purpose

The purpose of this thesis is to investigate the strategic consequences of using strategic alliance, as an alternative to private equity to satisfy SMI’s short and long term funding and growth.

1.5 Deliverables

The output will be a document with recommendations for the search of external funding for SMI. The academic contribution will be an evaluation of different funding models, with private equity and strategic alliance, for high-tech start-up companies.

Furthermore, two final presentations will be held in addition to the written paper. During these presentations the authors will be accessible for feedback and questions from our target group. One presentation will be held at Lund Institute of Technology, with examiner and supervisor and opposes present. This presentation will also be open for other students and stakeholders. A second presentation will be held at SMI for a selected group of stakeholders.

1.6 Confidentiality

The background information and data in this thesis is confidential. In the thesis published on-line, the actual company names and some other information have been changed or removed.

1.7 Delimitations

The focus of this thesis will be on SMI's future funding. The authors will not take Philips opinions on the form of the funding strategy in consideration, since this thesis will be used as a basis for SMI's funding discussions with Philips. However potential conflicts of interest will be highlighted. The authors also leave to others to evaluate legislate and tax issues connected to different forms of ownership.

1.8 Target Group

The thesis will have both academic and commercial target groups. SMI is the sponsor and has, in interaction with authors, taken initiative to this thesis. Thus they are considered as our primary target group. The academic target group is mainly final year students with options taken in business administration.

1.9 Disposition of the Thesis

The thesis will be organized according to Figure 1.1, where the different chapters are mapped. The areas covered in the theory will return in the corresponding chapters in the empirics and analysis. The conclusions will bring together the different areas into a final recommendation.

Figure 1.1will be presented, in a smaller form, in the preamble to the chapters with a marking over the current chapter.

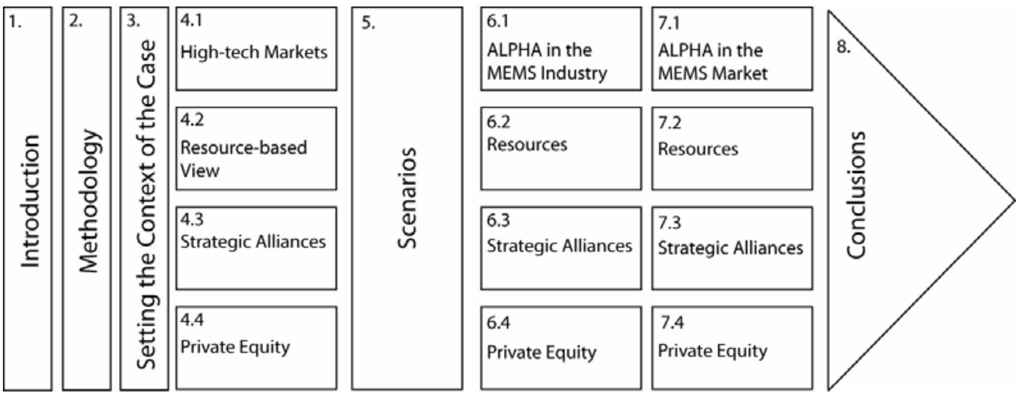


Figure 1.1 Overview of the thesis' chapters

Chapter 1 is the introduction of the thesis, where the background and problem discussion leads to the areas of inquiry and purpose of the study. Delimitations and confidentiality issues are also discussed.

Chapter 2 describes the methodological considerations done and what implications these will have on the outcome of the study.

Chapter 3 will provided a short description of the market and technology surrounding the studied case company.

Chapter 4 is intended to set up the theoretical framework that will be used in the empirics and analysis. The chapter is divided into four subchapters concerning theory on high-tech markets, the resource based view, private equity and strategic alliances. The theoretical findings are the foundation of the scenarios described in chapter 4.

Chapter 5 presents the scenario-based study that is the link between the theoretical and empirical studies. The results of the questionnaire focus the study on a limited set of future images of the company and a limited set of resources.

Chapter 6 consists of the empirical studies of the four areas used in the theoretical studies. The issues high-lighted in the scenarios have been further investigated during both internal and external interviews and the results will be compared with theoretical finding in the following analysis.

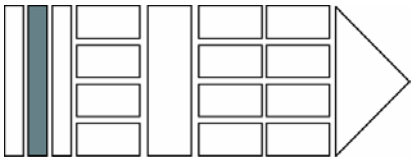
Chapter 7 is the analysis and will be divided in four subchapters similar to the ones in the theory and empirics.

Chapter 8 is the conclusion of the thesis and will, through a number of recommendations, answer to the purpose described in Chapter 1.

References and an appendix with the scenario questionnaire with belonging charts can be found after these chapters.

2 Methodology

This chapter describes the methodology of the thesis. First, the choice of company is discussed followed by the methodological approaches used. Drawbacks and limitations implied by the choices made are described.



2.1 Case Company and the Subject

The choice of case company was not made by random selection. One of the authors had prior contacts with managers in the selected company through his participation in a case competition sponsored by Philips. After the case competition the authors initiated contact with Philips regarding the possibility to conduct a master thesis. The request was forwarded to SMI's Business Development Manager, Bernd Schünemann who accepted the proposition.

At an initial meeting, where four different areas of investigation were discussed, the subject of the thesis was chosen by the authors in consensus with the company. The choice reflects the authors' preferences as well as their educational options and addresses an issue currently faced by the company. The supervisor Ola Alexanderson at the Department of Industrial Management and Logistics at Lund Institute of Technology also approved the topic.

2.2 Methodological Considerations

The choice of case company and the early start-up phase will affect the authors' knowledge generation during the research period. The lack of independence from the studied company and characteristics of the purpose precludes a positivistic approach in the research. Instead a hermeneutic approach will be applied. (Lunddahl & Skärvad, 1999) Thus the authors' prior knowledge and experience will impact how data is collected and interpreted. This is a common research approach in social science and the interaction between the studied context and the authors will bring new dimensions to the study. With a hermeneutic approach Neumann (1997) argues that a qualitative research method is preferred.

2.3 Methodological Approach

The theoretical coverage of evaluation processes regarding funding of start-up companies is incomplete (Barney, Wright & Ketchen, 2001). Combined with the authors' initial lack of knowledge in the researched area as well as the case company, this study is of an emerging and unfolding type. This is closely linked to the nature of the purpose, which calls for a mainly exploratory research. (Lunddahl & Skärvad, 1997) Although, some chapters will be of a descriptive and explanatory character in order to provide a background image and support the analysis. The purpose also implies a normative point-of-view, since explicit recommendations should be included in the conclusion to meet the expectations of the commercial target group.

2.3.1 Qualitative Analysis

Due to the hermeneutic approach chosen and the complexity of the question at issue, the use of a qualitative data collection method is superior. There are more variables affecting the outcome than there are available data points and the relationship between the variables is unknown (Lunddahl & Skärvad, 1997). Guided by interviews and models, connections between separate data points could be revealed. The choice of a qualitative research method does not exclude that numbers and figures, often linked to quantitative research methods, are collected and influences the study. Furthermore, the qualitative data collection is evolving and flexible and enables a continuously response to changing conditions. This is an important feature in a real-time conducted study (Lunddahl & Skärvad, 1997). A vast amount of different designs of qualitative research methods are available. Since they share a lot of attributes they can be combined to fit the purpose. This thesis will employ Case Study to address the empirics and Action Research to define the interaction between theory and empirics.

2.3.2 Case Study

The nature of the framework surrounding the thesis makes a case study research approach appropriate. A case study research is an empirical inquiry that investigates a contemporary phenomenon within its real-life context, especially when the boundaries between the phenomenon and context are not clearly evident. (Yin, 1994) Phenomena, which affect the funding strategy decision, are impossible to separate from the company itself.

Considering the fact that the authors will draw their conclusions from one single case, in which they have a specific interest, the research is classified as an intrinsic case study (Stake, 1995). The case could not be seen as a sampling unit, and therefore a statistical generalization cannot be drawn from the analysis. Instead, the authors believe that the approach and course of action to this kind of study could be applied for similar issues with other case objects.

The described method is also well suited for the exploratory main purpose of the thesis, given that it allows the collection of data from a wide range of sources. Evidence from multiple sources will be verified in a triangulating fashion. The codification of data is not stipulated in advance but can be guided by prior development of theoretical propositions. (Yin, 1994) A case is a specific unit that is studied and information can rarely be obtained through theoretical studies, the approach is therefore reliant on "how" and "why" questions to fully understand the context. To fulfill the purpose of this study "how to" questions are needed as well. Therefore, the authors intend to use action research methodology as a complement to the case study.

2.3.3 Action Research

There is a close relation between case study and action research, some researchers even claim that action research is a subset of case study (Benbasat et al., 1987; Galliers, 1991), but others (Vreede, 1995) highlight differences between the two approaches. Action research is likely to include cases, but a case study can, without doubt, avoid action research. Hence, the authors will treat them as separate forms. By asking "how" and "why" questions the authors intend to understand the environment affecting the studied company whereas "how to" questions is used to interpret the collected data. The "how to" questions thereby create a foundation from which the authors perform their analysis.

2.3.4 Defining the Case

To set up an action plan and boundaries, Yin (1994) proposes five components supporting the definition of the case.

1. The study's question.
2. The propositions.
3. The unit of analysis.

4. The logic linking the data to the propositions.
5. The criteria for interpreting the findings.

Chapter 1 in this thesis is derived from these five components in order to set the framework for this study. With regard to the reader the headings used in Chapter 1 differs from the one stated above, for the benefit of standard working paper notation. All five components are set in the case study methodology and the two final components are also supported by the action research methodology.

2.4 Data Collection

2.4.1 Primary and Secondary Data

The Case Study relies on primary data, e.g. interviews, as its main source of data. Data from the interviews is then sorted, categorized and evaluated. Primary data is gathered through interviews with a selection of key personnel at SMI as well as external interviews. The personnel are selected from their area of competence in order to get a full coverage. Triangulation and information saturation are important aspects in action research and case study (Yin, 1994). This is achieved through deep interviews focusing at both general and competence specific questions. Empirics obtained through internal interviews are more numerous than those obtained through external interviews. External interviews are more of a guide lining and verifying character.

Secondary data will consist of internal documents, management literature, articles and Internet sources. Internal documents, such as annual reports, technologic and strategy roadmaps and market analyses will give a quantitative verification to the qualitative nature of the primary data.

2.4.2 Pre-study

To set the purpose and delimitations for the thesis, a number of interviews and discussions where held with the Business Development Manager, the Sales Manager, the Marketing Manager and the Chief Financial Officer at SMI. These meetings have been carried out during several different occasions, starting in June 2004 in order to get a wide perspective and understanding of the company’s intentions with the study. From the authors’ point-of-view the meetings were intended to obtain sufficient insight in the company and the MEMS-industry. Between the interviews, theoretical studies on funding strategies, silicon manufacturing and MEMS-technology has been conducted. This early connection between theory and empirics has been important for the methodological approach of the study.

2.4.3 Main Study

When trying to penetrate a new market and a new technology during a short period of time, the importance of identifying key areas is large. The key areas can then be focused on and deeper investigated. The scenarios will allow the authors to get the management team's view on what these key areas could be and how they affect the context of the studied object. The analysis will be focused on these key areas and a lot of the validity of the study is dependent on a correct identification of the key areas.

The identification of the key areas will be made through a scenario questionnaire, where the management team of SMI is asked to reflect on four pre-study based, by the authors fabricated, scenarios, seen in Appendix 2. The fabrication of the scenarios is made through a reversed root cause analysis (Keil & Kim, 2003) where four root causes were decided on and certain findings and symptoms were mapped to each root cause. The causality of the different factors is obviously hard to define in a proper way but the scenario answers will show the accuracy. The scenarios cover different aspects of SMI's internal and external present and future situation. Each scenario contains a number of questions between the paragraphs. Most of the questions are constructed as a statement together with multiple-choice options regarding the validity of the statement. This technique is supported by the action research theory where provocation is an important ingredient (Schwartz, 1999).

> *"Thus, in writing scenarios, we spin myths – old and new – that will be important in the future [...]. These myths in scenarios help us come to grips with forces and feelings that would not otherwise exist in concrete form. They help us describe them, envision them, bring them to life – in a way that helps us make use of them"* (Schwartz 1999)

The choice of scenarios to proceed with will be based on the replies given by the management team. The smallness of the interviewed group and the complexity of the market might result in more than one preferred scenario. Should this be the case, the most supported scenarios will be investigated in parallel and the personal interviews will give the authors a stronger notion on what specific issues that the management supports in the different scenarios.

The main study's primary focus is on conducting individual interviews, which is further supported by e-mail and telephone correspondence. Subjects treated during the interviews are both of a general nature and specific for the interviewee's area of competence. The general questions are semi-structured and open and are used in order to reach a high level of topic coverage and get inputs for further inquires. When approved by the interviewee, the discussion is recorded and transcribed by the authors. If not, the authors take notes during the interviews.

2.5 Theoretical Frame of Reference

In Case Study, the theoretical material is seen as a framework applied as a tool to be able to perform the analysis. The time limits under which this study is conducted have forced the authors to, shortly after pre-study, choose the theoretical framework. The authors concluded that, in order to rise funding and support growth, SMI's resources and competitive advantage is important to investigate. This research area has two distinctive schools of approach, Porter's five forces model (1985) and Barney's resourced based view (1991). The most significant difference is whether external conditions or inherent company attributes have the largest impact of company's competitive advantages. Barney's approach relies on two important assumptions; first, the control of strategic resources in a business is heterogeneous and second, these resources are not perfectly mobile.

Based on the prediction of Barney, the authors expect that companies' resources will have a central bearing on their ability to rise funding. In an emerging business as the MEMS-industry it is likely that resources are heterogeneous distributed and immobile. The authors also expect that internal company resources are more crucial than business specific conditions in the fund rising process.

2.6 Sources of Criticism

2.6.1 Objectivity, Reliability and Validity

A hermeneutic research methodology implies lack of objectivity. The commercial target group requests a normative and subjective opinion from the authors, which this method allows. The induced theories, mainly directed at the academic target group, calls for an objective research.

The financial compensation the authors receive from the company is independent of the outcome of the study and the authors do not know the desired results. Hence, the compensation will not affect the conclusion of the study.

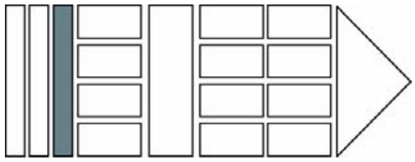
Reliability brings forward the question, whether a measurement is accurate. The information and contacts is to a large extent controlled by the sponsor company, potentially resulting in a biased study. However, the nature of the subject gives little incitement for the company to provide skewed data. In addition, the authors collect information from several internal and external sources. When using interviews as a data source, the risk of misunderstanding and misinterpretation is extensive. This is particularly present in this study, where neither the respondent nor the interviewees are using their mother tongue. To reduce this risk, transcriptions of recordings from discussions are sent back to the respondent for revision. Preconceived notions with the internal personnel about the funding strategy could result in skewed information. External sources and triangulation prevents arranged answers.

Validity brings forward the question, whether the study actually measure what is supposed to be measured. In a qualitative analysis of a complex case there are different schools, advocating different approaches to the core issue. Due to the limitations in time an initial theoretical framework is applied. By using multiple sources of literature and articles in the early study phase different aspects of the question at issue is evaluated. Anglo-Saxon authors have written the majority of the literature, therefore only a partial validity on the German market could be assumed. Articles describing studies conducted in Germany is used to highlight country-specific conditions.

The validity is also affected by the choice of sponsor company (Lunddahl & Skärvad, 1997). Since the authors did not chose the company by random and not to be studied for a specific phenomenon it is unlikely that the results is valid for start up companies in general. This is a common research difficulty but not strong enough to dismiss a study. The authors are convinced that empirical approach and results can be used as an insight in a related research area and be approved by other studies.

3 Setting the Context of the Case

In order to give the reader the understanding of the context in which the studied object operates, this chapter will provide a picture of the technology and market structure.



3.1 Technology

MEMS is a technology derived from the semiconductor industry. As focus was directed towards the miniaturization of silicon-based IC[5], the silicon's material properties was further investigated. The silicon was shown to have characteristics, above its electrical attributes, that enabled manufacturing of small mechanical devices. The silicon has a diamond-like crystal structure that makes it stronger than most metals and alloys with no plastic deformation in room temperature, which leads to stable and robust applications.

MEMS technique can be used to integrate sensors and actuators with microelectronic logics on a single chip. By measuring physical quantities, processing data and actuating on a micro-level, the macro-level can be affected

The main advantages with using MEMS instead of macro-systems include (Judy, 2001):

1. *Advantageous scaling properties,* a number of physical phenomena have higher performance when miniaturized to a micro-scale.
2. *Batch fabrication,* mass production of MEMS enables heavy cost reduction.
3. *Circuit integration*, better performance can be derived by integrating intelligent circuits with the mechanical structures, e.g. on-chip pre-amplification and local closed loops.

[5] Intergrated circuits. An electronic circuit on a semiconductor chip. The circuit includes components and connectors. A semiconductor chip is usually molded in a plastic or ceramic case and has external connector pins.

The design and manufacturing of MEMS demand highly qualified technicians from a large number of scientific domains; the downscaling to microscopic structures makes completely different physical forces significant, compared to structures on the macro-level. Other technological obstacles are packaging and testing. Packaging is a part of the final product and is made to protect the chip from contamination and changes in the external climate. However, the chip still needs to be in contact with the environment to be able to sense and actuate on it. Testing in the traditional semiconductor industry is typically a straightforward electrical process, where a signal is applied to the chip, processed and the output-signal is compared to a reference signal. Testing MEMS is in general a great deal more complex; both input and output from the chip is commonly physical forces that have to be simulated and measured in order to perform a valid test. (Kowalski, 2004)

The technical constraints on the market are still numerous; the lack of standardization and design tools makes the development cycles considerably longer than in the IC industry. Foundries have initiated development of design modules and boundary conditions, but the complexity of the systems makes a full standardization extremely difficult.

3.2 Applications

MEMS applications start where the IC applications end. MEMS is a technology enabling an interface between the digital world, dominated by IC and the analog physical world. Due to the large number of physical quantities interesting to measure and affect, the applications for microscopic and cheap transducers are virtually limitless. To this day the commercially successful MEMS devices include airbag accelerometers, micro-mirrors, ink jet printer nozzles and blood pressure sensors. Forecasted areas of big growth are RF MEMS[6] for mobile communication and micro-fluids MEMS for lab-on-a-chip applications.

3.3 Market

In 2000/2001 the MEMS market was booming from the expected returns in the optical telecommunication market, a prediction that during 2002/2003 showed to have been seriously overrated. Optical MEMS was believed to replace electrical switches in opto-fiber communication, with higher performance to a fraction of the cost. Technical constraints and over-capacity in the fiber-networks postponed the returns indefinitely. This sudden turn in the market forced a large number of MEMS companies out of business. Today's market is more stable and is expected to grow from € 5 billion in 2002 to € 12 billion in 2007. (SMI, 2004)

3.4 Industry Structure

Due to the relative novelty of the market, the positions of many actors have not definitely been settled and parts of the market are highly fragmented. The top 30 MEMS manufacturers have a market share of over 60 percent whereas the remaining 40 percent is divided between more than 200 companies. (Eloy, 2004).

The market research and strategy consulting company Yole Développment has identified three main business models and seven sub groups.

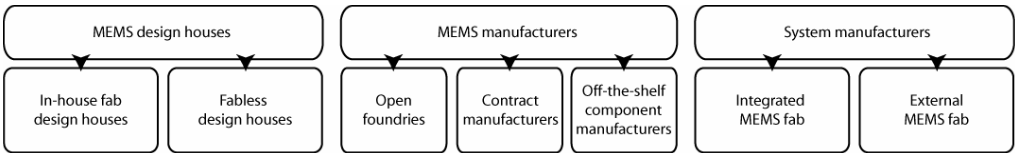


Figure 3.1 The MEMS business models (Eloy, 2004a).

The MEMS value-chain resembles a standard manufacturing chain, but the individual parts are highly complex and technology intensive. As stated above, the positions of companies in the market is not completely settled and it is not unusual that companies are involved in a number of steps in the value-chain. Raw-material suppliers are not always considered as a part of the MEMS value chain, but the authors believe that by incorporate them, the reader reaches a higher level of understanding. Research institutes and universities are also players in the MEMS business, although their services are non-industrial, they are included.

[6] Radio Frequency MEMS. E.g. silicon solutions for integrating the switching between the tranSMItter and reciever.

3.4.1 Raw-material Suppliers

The MEMS industry uses almost the same raw materials as the semiconductor industry. Wafers[7] are the most crucial raw material and are the base substrate for MEMS production. The wafers used for MEMS production are the same as for common IC manufacturing and are today an off-the-shelf product. MEMS structures can also be applied directly on wafers with pre-fabricated IC. MEMS producers also need supply of metals and alloys for the mechanical part of the MEMS circuit. This requires a new group of suppliers with specific knowledge in micro-conditions of metals and alloys. (Hoffmann, 2004)

3.4.2 Design-houses

Some MEMS applications can be considered as off-the-shelf products, but most MEMS are highly specialized and are in need of a tailor-made design to fit with the environmental conditions of the application. The design-houses are often small companies, with contractual links to a specific foundry and with explicit knowledge in design and physics. Design-houses begin with a conceptual draft for the performance of the system and then choose a foundry for manufacturing. In collaboration with the chosen foundry, the design-house develops a detailed blueprint for the system. Some design-houses have their own fab and can therefore design directly for production. (Hoffmann, 2004)

3.4.3 MEMS Manufacturers

MEMS manufacturers are producers with either an own manufacturing plant or with contractual access to a fab. Research and development among manufacturers are often concerning manufacturing processes and module development. Contractual manufacturers' market segment is to produce low-volume products for niche markets, with high added value for their customers. These products are either internally developed or contractually manufactured. Foundries have open facilities usually for high volume production and develop and produce their customers' own chips with established processes, but with their own set of modules. Modules are predefined elements that can be arranged in different ways to create specialized MEMS, which decrease costs and set boundaries for the design-houses choice of design. Off-the-shelf component manufacturers produce high-volume components e.g. ink-jet printer heads or blood pressure sensors. These companies often have a strong involvement

[7] a thin disk of semiconducting material, commonly silicon, that forms a base on which a number of identical chips can be built

from semiconductor companies giving synergies to existing products. (Hoffmann, 2004)

3.4.4 Packaging

Packaging is to encapsulate the separated MEMS circuit in a cover that both protect the circuit from contamination and enables its function. Specialized packaging companies face this challenge with great knowledge in physics and material design. Laurell says that difficulties in packaging has been largely underestimated by the industry and is today considered as one of the main threats against successful commercialization of new MEMS products. The MEMS market has no standard for encapsulation and consequently, some new products cannot reach a high-volume segment. (Hoffmann, 2004)

3.4.5 Testing

Different from IC, the majority of MEMS circuits cannot be subject to pre-packaging testing, since the package commonly has an active function. Therefore the malfunctioning chips can only be detected after the value of the packaging has been added. The function of MEMS as transducers between physical quantities and electronics calls for testing conditions that closely simulates the intended forces and external conditions. The registration of the output of the device is also committed to large obstacles. (Hoffmann, 2004)

3.4.6 System Manufacturers

System manufacturers are often large consumer market companies, like Nokia and Samsung in the mobile communication business or OEM[8] like Bosch in the automotive area. Some of them have their own production facilities and others are fabless companies with contractual links to one or more foundries. System manufacturers with an integrated fab generally work as a foundry for business units belonging to their corporation. Contractual links to foundries are sometimes used for second source fabrication and fabless system manufactures are dependent on a connection to a foundry.

System manufacturers have their research efforts concentrated to system development and integration, to leverage the MEMS device's impact on system level. Fabless system manufacturers have their greatest challenge in finding the right partners for

[8] Original Equipment Manufacturers

producing the MEMS devices without high start-up cost and IP migration to competitors (Eloy, 2004b). System manufacturers with integrated fab today represent the most profitable business model of the MEMS industry.

3.4.7 Research Institutes and Universities

Research institutes and universities are important players in the MEMS business with a broad span of research areas. In Germany, the Fraunhofer ISIT[9] is one example of a research institute working on MEMS technology. These research institutes often have a close connection to a university with pure research and development in MEMS technology but are focused on making prototypes and the initial batches for industrial customers. Small players in the business with contacts to a research institute benefits of the production capacity provided. (Hoffmann, 2004)

3.5 Actors

The different business models seen in Figure 3.1 are generic models that have been identified in the MEMS-market. The positions are not entirely settled and actors can have adopted elements from more than one of these business models. To give the reader a brief insight in the choices made by different actors in the industry and get a notion of the competitive climate on the market addressed by SMI, a short competitive analysis follows below. This is by no mean a complete competitive analysis; it should be seen as examples of how different companies have chosen different business models and what resources they are trying to capitalize on.

3.5.1 Colibrys

The Suisse company Colibrys is one of the worlds leading suppliers of MEMS and MOEMS[10] and act as an integrated provider of services in the whole value chain. They have an in-house design unit that develops products that are sold under their own brand. They also provide contractual manufacturing of customers' products. Their fab has a capacity of 100k wafers per year and the company also provides dicing, assembly and testing in-house.

[9] Institute Siliziumtechnologie
[10] Micro Optical Electro-Mechanical Systems, MEMS application with optical componants such as micromirrors and lenses. Typically used in switches for optofiber communication.

Colibrys' main markets are navigation, telecommunication, life sciences and industrial applications. Their strategy is different from SMI's independent foundry model and they also acts on slightly different markets. However the size of the company as well as the strength and reputation of their shareholders, e.g. Intel Capital makes them a potential threat. Colibrys' MEMS sales in 2003 reached twelve million euro. (Eloy, 2004b)

3.5.2 Infineon/Sensonor

The German semiconductor manufacturer Infineon acquired the Norwegian MEMS system manufacturer Sensonor in 2003. The acquisition made Infineon an important player in the micro sensor market, especially focused on the automotive industry and microphone development. Infineon is a company active in a large array of markets and are likely to have enough resources to make future entries, with MEMS based solutions, on all of them. They are also a well-known company in the semiconductor industry, qualifying them to get orders from leading customers.

3.5.3 Motorola/Freescale

Motorola is active in both mobile communication and semiconductors and has devoted resources to MEMS development in the spin-off company Freescale. Motorola have recently distributed all of its remaining stock in Freescale, making it a completely independent company. The collaboration with Motorola is however still strong. Wireless sensors for motion, smoke and temperature are some of the applications developed by Freescale. The internal knowledge about the communication market and the closeness to Motorola makes them a credible company in the markets addressed by SMI. (Eloy, 2004b)

3.5.4 SensorDynamics

SensorDynamics was founded in 2002 as a spin-off company from AME[11]. Their business model is to work as a general contractor in micro sensor systems. That is to be a nodal company with core competencies in integration and interfaces between different components in the micro sensor value chain. The company has 35 employees and during their first full year in business, sales reached € 1.5 million, mainly from engineering services to customers supplying the automotive industry with sensors.

[11] Austrian Micro Electronics

To be able to supply turnkey solutions, mainly for the high-volume automotive and industrial sensor market, SensorDynamics has a large partner portfolio including STMicroelectronics, Teradyne and ASE. They plan to manufacture MEMS silicon externally, in the same Fraunhofer ISIT fab that SMI is currently using.

SensorDynamics will probably not be a competitor in the foundry market, but could with their focus on general contracting and integration services compete with SMI. The fact that the two companies share the same production facility could potentially also lead to rivalry, but also give them a natural contact point for future collaboration. (SensorDynamics, 2004)

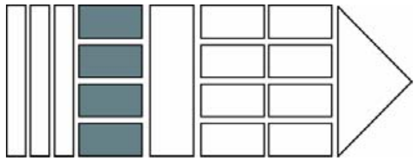
3.5.5 Silex Microsystems

Swedish Silex Microsystems is an open foundry that recently attracted enough venture capital to complete their medium-volume fab in Stockholm.

Silex Microsystems works in close collaboration with customers from wireless telecommunication, life science and other high-tech industries to jointly develop MEMS solutions. The business model is similar to the one adopted by SMI and considering the cluster of telecommunication and medical companies in this region of Sweden; it is likely to believe that the market focus will be alike. (Silex, 2004)

4 Theory

This chapter describes the frame of reference used in the thesis. Characteristics of high-tech markets in general are presented followed by an introduction to the resource based view. General theories concerning private equity and strategic alliances complete the chapter and leads to the scenario discussion.



4.1 High-tech Markets

The technological development during the last couple of decades has lead to new markets that are driven by fast technological changes. These markets have been shown to follow a new set of economical rules different from the standard process industry. The semiconductor industry was one of the first successful high-tech markets. (Thomke & von Hippel, 2002)

The foundry business of the semiconductor industry emerged in the early 80's as a result of changes in the business structure. Some semiconductor manufactures started to co-develop new semiconductors along with their customers. The general idea was to involve the customers in the design of new semiconductors in order to reduce costs and shorten development times. Later, these processes were purified and companies that only focused on contractual manufacturing were founded. In 2003 this market had grown to more than € 13 billion in sales and is thereby an extensive part of the semiconductor market. The emerging of this business is described by Thomke & von Hippel (2002) and they identified three major signs that were valid for the pre-foundry market.

1. Customer asking for customized products.
2. The manufacturer and customer need many integration activities to result in a solution
3. The use of computer-based simulation and prototyping tools increase.

The previous chapter gives that all the above outlined conditions are valid in the MEMS market and a development of the MEMS foundry culture could be expected.

Another characteristic that the MEMS market has in common with the semiconductor market is the increasing rates of return (Arthur, 1996). Contrary to standard process industry, the margin cost of producing one extra unit is close to nothing and a company that have gained a volume advantage against its competitors are very likely to increase this advantage. Losses in volumes increase the cost per manufactured unit and the company enters a negative spiral. Arthur identifies three main reasons for this phenomenon.

> *Development costs*. High-tech products are costly to develop and launch at the market where as the manufacturing costs per unit are low. The development cost per unit decreases as volume increases.
>
> *Network effects.* Many high-tech products have to be compatible with other products or equipments and a company that launches a product that other suppliers will choose to compatible with will have a large advantage. As this advantage grows, more producers will use this compatibility and a standard will be set. A release of a new product family will drive other companies to also develop new products.
>
> *Customer relations.* High-tech products typically calls for integration between the buyer and the supplier and the switching costs are therefore higher than in the standard industry. This lock-in effect gives a leading company an even larger advantage and as volumes increase, the cost per unit decreases.

The large challenge for companies active on this kind of market is the risk for a fast value migration towards new technological solution. A technological development can remove the possibility of value creation in a whole industry or just shift company and customer behavior. To prevent this migration of at least be prepared to follow it Thomke & von Hippel argues that the customer has to be involved in the development process; a method that is the foundation for semiconductor foundries. As on other markets, the semiconductor industry have a technological push that refers to when products are developed and sold on the market based on a new invention that is not derived from an explicit customer need. There is also a market pull present on the market where customer needs inspires companies to developments. Thomke & von Hippel have developed a tool for bridging this gap between a technological push and the market pull:

Develop a user friendly tool kit for customers. The tool kit should include a set of standard modules that the customer can easily combine to create complex solutions.

Increase the flexibility of your production processes. The manufacturing processes should be organized to respond to customers demands to a low cost.

Carefully select the first customer to use the tool kit. The best prospects are customers that have a strong need for developing customized products quickly and frequently.

Evolve your tool kit continually and rapidly to satisfy your leading-edge customers. Let the leading customers pull improvements of the tool kit since the leading customer's requests will set the standard for followers.

Adapt your business practices accordingly. Optimize the business model to allow customer integration on many levels of the company.

4.2 Resourced-based View

Since Barney presented the resource-based view in 1991, the areas of investigation based on this theory have broadened. Today the theory's application encompasses almost the entire strategic management area, which has resulted in extensive theoretical development and empirical testing. Hoskisson et al. (2000) denoted the resource-based view as one of the top three most insightful theories when investigating emerging markets.

4.2.1 Competitive Advantage

When Barney (1991) spearheaded earlier published articles (Barney 1986, 1989; Wenrerfelt, 1984), a new tool to look into sources of competitive advantage was developed; the Resourced-based view. *Firm resources* or just *resources* are "[…] strengths that companies can use to conceive of and implement their strategies" (Barney, 1991). The model strongly emphasizes the link between a company's internal characteristics and its performance; the set of resources determines whether a company will out-perform competitors and reach above average. To achieve this Amit and Schoemaker (1993) argues that it is important to transform *resources* into *capabilities*; ability to employ resources through the company's human capital.

In order to easily map a company's recourses, Barney categorizes resources into three distinctive groups (Barney, 1991). Note that access to financial funding is not normally defined as a resource, since this will have implications for the usage of the resourced-based view in this thesis.

> *Physical capital resources:* physical technology, plants and equipment, geographic position and access to raw material etc.
>
> *Human capital resources:* training, experience, judgment, intelligence, and relationship etc.
>
> *Organizational capital resources:* formal reporting structure, formal and informal planning, controlling and coordinating systems etc.

If resources are equally distributed and highly mobile among competing companies no company will gain a competitive advantage (Barney, 1991). Hence, a competitive advantage is based on heterogeneous and immobile resources. If a sole-owner of a unique resource is first to implement a strategy based on that resource, it is likely that the company achieves a competitive advantage. A first mover advantage often results in a cost or revenue benefit against other firms within the business. Such benefits lead to a resource position barrier, which consequence in a favorable position for the resource holder. Barriers can consist of consumer loyalty or technology lead etc. (Wernerfelt, 1984). Thus, it is important to examine a company's set of resources to find opportunities, not yet implemented by the competitors.

4.2.2 Valuable, Rare, Imitable and Organization

In order to find resources able to create a resource position barrier, Barney (1996) refined the resourced-based view with the more precise VRIO framework. By evaluating a resource in four stages, the question of *value*, the question of *rareness*, the question of *imitability* and the question of *organization*, links between the resource and a competitive advantage can be examined.

The Question of Value

A resource is valuable when it enables a company to implement strategies that improve its efficiency and effectiveness (Barney, 1991). In other words, a resource is *valuable* if it decreases costs or increases revenue for the resource holder. Hence, the holder of a *valuable* resource will gain a competitive parity against its competitors.

The Question of Rareness

If a *valuable* resource is easy to access it is likely to believe that many companies hold that resource. With such type of resources a company will not gain a competitive advantage, since all companies that hold these resources can create a capability out of it. Thus, Barney (1996) argues that a resource must be *rare*, to be used as a competitive advantage.

The Question of Imitability

Companies that hold a *valuable* and *rare* resource have a temporary competitive advantage, as long as the competitors are unable to either duplicate or substitute the resource. If a resource is costly or difficult to imitate, the resource holder gains a sustained competitive advantage. Duplication occurs when one company imitate a *valuable* and *rare* resource held by a competitor. Substitution takes place when a resource is replaced in favor for another, with the same strategic impact. There are at least two ways to obtain such resources, either though internal development or strategic alliances with another companies. (Barney, 1996) To determine which one out-performs the other, resource specific attributes is compared with cost and effectiveness in resource development. The authors will further discuss this subject during the chapters on strategic alliances and venture capital.

The Question of Organization

Barney (1996) states, that it is not enough to control *valuable*, *rare* and *non-imitable* resources. Unless they are well *organized*, a company will not get the benefits of a sustained competitive advantage; important resources can migrate and also be left unexplored. Well *organized* resources also help a company to concentrate on building the right future capabilities and also act as guidelines when developing new strategies.

4.3 Strategic Alliances

Strategic alliances have, during the last ten years, emerged as one of the central focal points of corporate strategy and competitive advantage. Today it is common to see alliances account for 20 to 50 percent of corporate value in terms of revenues, assets, incomes or market capitalization (Bamford, Gomes-Casseres & Robinson, 2003). There are numerous formal definitions of strategic alliances, but a commonly used definition is the one adopted by Doz & Hamel (1998) and Gulati (1998).

> *"Business relationships where partners with complementary human capital and physical capital resources come together for a specific business goal, remain independent, and equitably exchange or share resources beyond a simple fee-for-service relationship such as outsourcing."*

A strategic alliance can come in different forms; non-contractual agreements, contractual agreements, joint ventures, franchise ventures, and minority equity investments. Other forms of collaboration that, due to their permanent nature, are usually not considered to be strategic alliance is mergers and acquisitions. Since these potentially could be viable solutions to the purpose of this thesis, the authors will treat mergers and acquisition in the same way as other strategic alliances, see Figure 4.1.

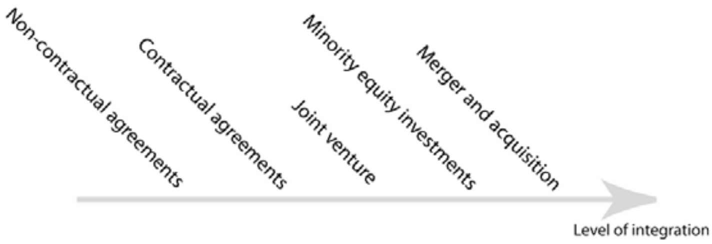


Figure 4.1 Different forms of strategic alliances and their level of integration between the involved companies (adopted from Doz & Hamel, 1998)

4.3.1 Reasons for Forming a Strategic Alliance

As in all corporate strategy decision, strategic alliances should add value to the companies involved. In order to be able to evaluate the studied objects' possibility to gain and provide value in a strategic alliance, two ways of describing value creation in strategic alliances are highlighted. The authors have chosen to combine both models, which give benefits to the categorization in the empirics.

Doz & Hammel (1998) chooses to categorize the value creating processes in three different main groups, denoted by numbers in the list below. Bamford et al. (2003) identifies five different value-adding activities, denoted by characters below.

1. *Co-specialization*. Deriving synergistic value by combining unique, and differentiated, previously separated resources. The resources should become substantially more valuable when combined. The importance of co-specialization is believed to increase as companies focus on a narrower range of core competencies.

   A. *Building new businesses*. Companies can decide to cooperate in order to pool technology or competencies to develop brand new products. Alliances can be useful when risks are high, skills are incomplete or speed is essential.

   B. *Access new markets*. Traditionally these strategic alliances have been focused on reaching new geographic markets. Recent trends show that companies collaborate to access new products and customer markets.

2. *Learning and internalization.* Intangible resources are not for sale in the open market and a way of obtaining these resources is to learn them from a partner in a strategic alliance. The skills learned from the partner can often be exploited beyond the boundaries of the strategic alliance and become all the more valuable.

   A. *Access skills and learning*. The same concept as the definition above.

3. *Co-option.* Incorporating a potential competitor in the alliance is an effective way of neutralizing the rivalry between the companies. Co-option could also be used in the sense of bringing firms with complementary goods into the alliance and thereby creating network economies in favor for the coalition.

   A. *Gaining scale.* Alike traditional mergers and acquisitions, alliances can be used to consolidate overlapping businesses and cut costs through economy of scale.

   B. *Improving supplier effectiveness.* Long-term relationship with preferred suppliers could shift risk and capital investments from the purchasing company to the supplier. The supplier gains value through better forecasts and constant demand.

Bamford et al. (2003) also emphasize the importance of creating an *advantage network* where a portfolio of alliances could be used to create value from all the above-mentioned elements.

4.3.2 Setting the Scope of the Strategic Alliance

When the purpose of the strategic alliance has been defined, the company has to consider what parts of their business that should be included in the strategic alliance. These issues are denoted as the scope of the strategic alliance. The scope of a strategic alliance has three dimensions: *strategic*, *economical* and *operational* scope. (Doz & Hammel, 1998)

The *strategic scope* determines the strategic alliance's outermost boundaries of cooperation, such as geographical markets or entire product categories. Allied companies on one market might be competitors on another, a constellation that commonly leads to mistrust and damages information sharing between the partners.

The range of activities that takes place within the partner companies on behalf of the strategic alliance defines *economic scope*. When setting the economic scope, attention should be paid to the conflicts and moral hazard that could rise. These conflicts are often dependent on the model chosen for transfer pricing and revenue share.

The *operational scope* of a strategic alliance is the activities that are performed jointly by the partners. Both minimization and maximization of this operational scope has its advantages, depending on situation. Minimizing leads to reduction of coordination and integration needs as well as reduction of the risk of unintended leak of technology or skills between the partners. Minimizing can be costly though; if later development calls for expansion of the scope, the prior distance and mistrust makes a swift change in operational scope difficult. A broader operational scope normally means a larger exchange surface and therefore facilitates joint learning.

4.3.3 Selecting an Appropriate Partner

Having defined how value should be added via a strategic alliance and the scope of it; the search for an appropriate partner begins. The search for a suitable partner should not be restricted to actors in the same industry, companies with different backgrounds and non-traditional competitors should be regarded in the screening process (Bamford et al., 2003)

Central in the choice of partner is the strategic fit between the companies. Strategic fit is defined by Jemison & Sitkin (1986) as:

> *"The degree to which the potential alliance partners augment or complement a partner's strategy and thus makes identifiable contributions to the financial and non-financial goals of the focal partner"*

The strategic fit describes how companies could create value together by sharing or exchanging critical resources. The questions that need to be addressed when evaluating strategic fit are numerous, as argued by Lewis (1990).

- How could a strategic alliance with a particular partner advance the overall strategy of the company? What objectives will be achieved that cannot be reached single-handed?
- What key resources are needed, and will they be available from the partner, when needed, and given priority?
- Is the partner the best alternative, now as well as in the future?
- Will the partner as well benefit from the alliance?
- Is there a risk that, by forming the alliance, the company's position is threatened? Is the alliance forming a new competitor?
- What could the alliance evolve to? Is expansion possible?
- Does the partner have problems that could affect the company? Are there factors they cannot control?

The accomplishment of the strategic task requires that the critical resources, that provide value to the alliance, are kept intact. An organizational fit that preserves the unique resources found with the partner is imperative. Organizational fit focuses on cultural behavioral norms and how differences in organizational cultures could cause conflicts in the alliance. As with strategic fit, some key questions could be identified. (Lewis, 1990; Jemison and Sitkin, 1987; Pablo, 1994)

- Are the decision makers, key personnel, and management style compatible?
- What company culture does the partner have in form of values, integrity, loyalty and attitude towards risk?
- What is the partners' reputation from prior alliances?

Nielsen (2002) suggests a separation between task-related and partner-related criteria when empirically investigating the most significant factors behind a company's choice of partner. His study, which is mainly focused on bilateral alliances, shows that the most important task-related factors are access to local markets, access to links to major suppliers/buyers, and access to distribution channels. The main partner-related factors identified are trust between management teams, relatedness of partner business, partner reputation, and the partner's financial status.

4.3.4 Strategic Alliances Involving Newcomers

The characteristics of a strategic alliance will be influenced by the involved partners' situation in the market. Doz & Hammel (1998) divides companies into *newcomers*, *followers* and *leaders*. Further, an upcoming *follower* is denoted a *challenger* while a *laggard* is loosing market shares to the leader.

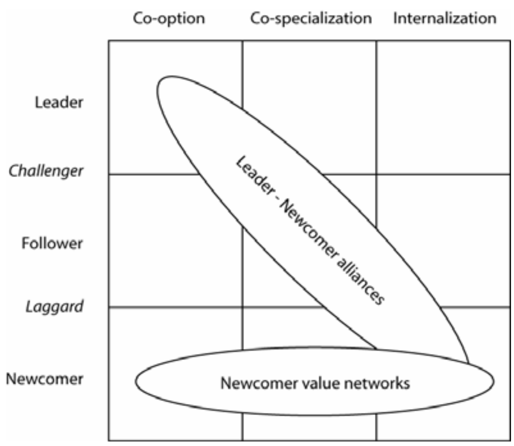


Figure 4.2 Strategic Alliances constituted of companies with different market positions adapted from Doz (1998).

As seen in Figure 4.2, the strategic alliances can be formed to create value from all the different categories mentioned in Chapter 4.3.1 and involving companies with different market positions. Since SMI is a typical newcomer, this chapter will focus on implications on strategic alliances where these kinds of companies are involved.

Newcomers often see a strategic alliance with a *leader* as a great opportunity to scale up their company and get access to the larger company's market and resources. However, newcomers are commonly intimidated by the size of the leading company and that theirs own technological development will suffer or be eroded by the larger company. The caution exercised when entering the strategic alliance often lead to failure to reach the expected creation of value. It is also common that *leaders* enter an alliance with a *newcomer* only to hedge their uncertainties regarding their future technology portfolio; should the technology become successful they will incorporate the smaller company, otherwise they will divest quickly.

A very common form of alliance constellation is between two or more *newcomers*. The main underlying reason is to bring different aspects of value creation together to form an *advantage network* with *challenger* potential. Such a network could benefit from *co-option*, *co-specialization* and *learning and internalization* concurrently. Newcomer alliances are often the most stable, since the allies typically share the same strategic ambitions and they enter the alliance with great motivation.

4.3.5 Exiting a Strategic Alliance

All alliances will eventually come to an end. The average *joint venture* has a lifetime of seven years and in almost 80 percent of the cases they end with a sale to one of the partners. (Bamford et al., 2003) Equity alliances typically last longer than non-equity alliances. High-tech partnerships without equity transfer are one of the least stable forms of strategic alliances.

Bamford et al. (2003) identifies a number of reasons for why an alliance is terminated, these reasons should be considered when writing the contracts surrounding the alliance. Acceptable reasons for exiting the partnership could be defined and an exit due to these reasons can be done without economic consequences for the partner.

One of the least painful exits for the involved companies is to terminate a strategic alliance when the strategic task for which the partnership was set up is completed. If the strategic alliance does not succeed in performing as well as intended, an exit is often preferred to keep trying. Large changes in the external environment will naturally impact the strategic alliance's ability to succeed and an exit might be the only viable solution. Changes in one or both of the parent companies can also have consequences for the alliance and a very common reason for an exit is that one of the parents does not fulfill its basic obligations to the strategic alliance. When the integration between the companies involved in the partnership is very low, the management of the strategic alliance can have the right to internally decide when the termination should be done.

4.4 Private Equity

Investors wishing to diverse their portfolio could do direct investments into small ventures. Private persons who do these kinds of direct investments are often referred to as business angels. However, the large information costs compared to the smallness of the invested value limits the number of viable ventures. To reduce the share of information cost and enabling greater diversification, venture capital companies accumulate investments from a large amount of capital owners to be invested in other companies.

4.4.1 Venture Captial ownership structure

Although the number of publicly traded venture capital companies is growing, the industry is still dominated by privately held limited partnerships. (Bilo et al. 2004). Limited partnerships are a company structure that allows foreign or domestic private individuals or institutions to invest in a venture capital fund that does not fall under the normal corporate tax-legislations. The fund is tax-transparent; the *limited partners* will be treated as were they direct shareholders in the portfolio company. The *limited partners* receive return on invested capital in direct proportion to their contribution and the growth of the *portfolio companies*.

In Germany, the limited partnership funds usually have one *general partner*: a limited liability company[12], which carries out the every-day management of the fund. The *general partner* normally makes no initial investment in the fund, and therefore has no explicit economic interest. The *general partner* is annually compensated with 1.5 to 2.5 percent of the funds subscribed equity. Some funds use a *management partner* to manage the funds' interests. The *management partner* makes an initial investment and then endows decision authority during the fund's life. Once the level of the carried interest is reached, the *management partner* typically receives 20 percent of the fund's net gain (Behrens & Weinan-Hären, 2004).

The portfolio companies are expected to create value for the venture capital fund, under supervision of the *general partner*. The ultimate goal for the *general partner* is to take the portfolio companies to an IPO[13], since this generally results in the largest returns for the *limited partners*. The complete picture of the venture capital fund and stakeholders is illustrated in Figure 4.3.

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[12] ger. Gesellschaft mit beschränkter Haftung (GmbH)
[13] Initial Public Offering. To quote a privatly held company on a public stock-exchange.

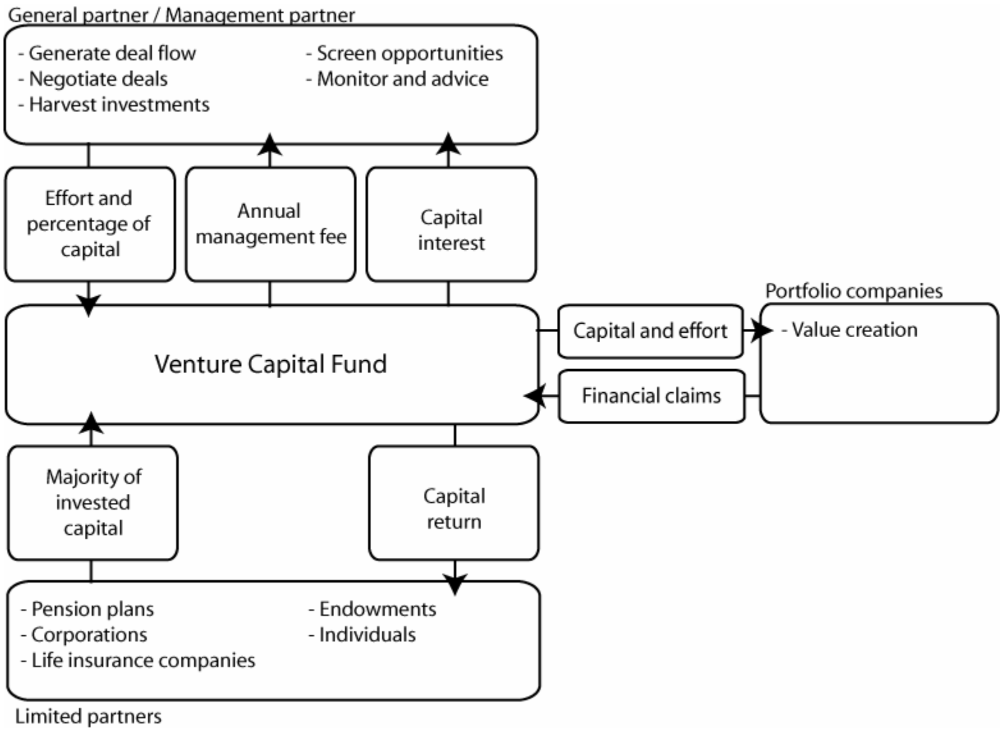

Figure 4.3 The structure of Venture Capital Funds adapted from SMIth & SMIth (2000).

4.4.2 Phases of venture capital investment

Depending on what phase of growth a company is situated in different form of financing is available and the capital will be used for different purposes. Isaksson (2000) has made a generally accepted classification of the financing phases; these phases can also be applied in the discussion on strategic alliances.

Early Stage Financing

Seed financing: capital supplied to an investor or entrepreneur in order to evaluate or test a concept before a company has been started.

Start-up financing: financing of a company for initial product development and marketing.

Expansion stage financing: financing of a company with products that have already reached the market.

Mature Stage Financing

Bridge financing: financing of a growth company that is expected to do an IPO soon.

Buy-out financing: financing of an acquisition or a buy-out of a company.

Turn-around financing: financing of a mature company in order to turn a negative trend.

Since the studied company is currently in the *expansion phase*, the emphasis of the theoretical discussion will be on investments in this particular phase. The *expansion stage financing* could be divided into two sub-categories, *second-stage financing* and *third stage financing*. *Second stage financing* is to companies in their early expansion phase, when manufacturing and sales are increasing and additional working capital is needed. The company has probably not yet reached break-even. *Third stage financing* is to companies in their late expansion phase, where sales and profits are increasing rapidly. The capital is typically used for expansions of manufacturing plants, marketing, and working capital as well as product improvements. (Isaksson, 2000)

4.4.3 Venture Capital Life-cycle

The venture capital business model consists of evaluating and selecting companies with high growth potential and then financing them with equity, grow them via management support and finally selling them at a higher valuation. The steps of the business plan are shown in Figure 4.4.

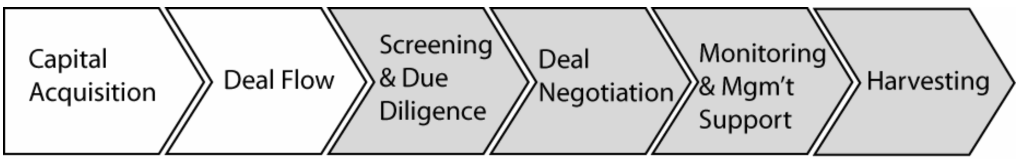

Figure 4.4 Steps of Venture Capital Business Plan adapted from SMIth & SMIth (2000).

The first step taken by the venture capital firm is the capital acquisition phase where the investment strategy is communicated in order to attract potential investors. When a sufficient amount of investor has been congregated, the fund is closed and the investors pay a first share of the committed capital to the fund. (Silver, 1985; SMIth & SMIth, 2000)

The second step for the venture capitalist is to create deal flow by gathering information about potential *portfolio companies* and by promoting the fund to entrepreneurs.

When potential *portfolio companies* have been identified these will be analyzed and screened. The companies' general fit in the funds investment strategy is evaluated and suitable ventures are compared to a number of explicit and implicit criteria. Finally, a formal due diligence is conducted on the remaining companies.

If there is a mutual interest between the venture capitalist and the entrepreneur, negotiations take place concerning the form of the investment and the contracts controlling the deal.

To maximize the return on investment the venture capitalist supports the entrepreneur, in which the fund has invested, with management expertise and contacts. The venture capital investments are often staged, so that multiple rounds of venture capital investments are needed to take the firm to the *harvesting* phase. The funded company has to reach stipulated milestones to get to the next stage and receive the new capital injection. (Gompers, 1995)

A limited partnership's lifespan is typical ten years, with the possibility to be prolonged if needed. (Bygrave & Timmons, 1992) To capitalize on the investment made by the fund, venture capitalists make an exit from the supported company. This is called the *harvesting* phase and implies the end of the fund's lifecycle.

The first two steps in Figure 4.4 only concerns internal aspects of a venture capital fund and will therefore be excluded. Instead, the last four steps, shaded in grey, will be further discussed.

Screening and Due Diligence

In order to obtain the maximum return on investments and reduce the risk of investing in portfolio companies that have to be liquidated prior to an IPO, venture capitalists spend a lot of resources on the due diligence. Investors in a venture capital fund signs an investment thesis, which acts as a guiding tool for the *general partner* in the screening process.

Kaplan & Strömberg (2000) presents an empirical study over criteria explicitly evaluated by venture capitalists during the screening process. According to this study the majority of the venture capitalists focus on the size and potential growth of the market on which the company is operating. Managements perceived quality and performance to date also has a large impact on the choice of *portfolio companies*. The experience and industry knowledge found with the management should be balanced with young and aggressive managers, preferably with prior experience of company start-ups. Following these factors, in order of significance, is the attractiveness of the company's business strategy and their competitive position in the marketplace. These could for example be evaluated in terms of novelty of the concept, focus of the strategy, intellectual properties held and first mover advantages.

The study also investigates the most important risks to evaluate before financing a venture. Quality of the management and the business strategy are the most significant; need of replacing the present management, lack of company building experience, little evidence of the feasibility of business model and lack of potential partners are common concerns.

Deal Negotiation

In a financing situation there is generally a conflict of interest between the *agent*, the entrepreneur that needs financing and the *principal*, the investor providing funding. The large academic literature on this issue has identified a number of ways to mitigate these conflicts. Due diligence plays a vital role as information collected before investment can protect the venture capitalist from bad entrepreneurs and unprofitable projects. The monitoring and management during the period of the collaboration will also give venture capitalists the possibility to prevent the entrepreneur from only acting in his own interests. Apart from these instruments, an extremely important way of preventing moral hazard is to negotiate and design contracts concerning the allocation of cash flow, control rights, exit clauses etc.

Monitoring and Management Support

The *general partner* or *managing partner* of a venture capital fund spends approximately 60 percent of his time managing and developing their investments (Gorman & Sahlman, 1989). There are two main reasons for why venture capitalists involve in their *portfolio companies*. The first has to do with any agency problems that have not been dealt with in the contracts and calls for monitoring the performance of the management to keep it in line with the *limited partners*' demand for high returns (Fama & Jensen, 1983). The second is based on the potential value added by the venture capitalists. With their market knowledge, business development experience and contacts in the industry, the *general partner* could contribute with recruitment of key personnel, strategic development, networks, operational issues and crisis handling. (Barney et al., 1996, Gorman & Sahlmann, 1989, Fried & Hisrich)

Hellmann & Puri (2000) show that companies that have been supported by venture capital are more likely to quickly bring their products to the market and to improve their human capital resources. Lerner (1995) argues that replacement of the CEO and changes of the board are likely to occur in a venture capital financed company.

Harvesting

At the end of the venture capital cycle the investors will harvest the return on their initial investments. This fact is well known for all involved parties when a venture capitalist enters a deal and the time and method for the exit is often stipulated in the contracts. (Lehtonen, 2000)

An exit can be made in five different ways according to Cumming & MacIntosh (2003)

> *Initial Public Offering (IPO).* The portfolio company is quoted on a public stock-exchange. Normally, the venture capital company does not sell their entire share of the stocks directly on quotation, but hold on to the shares for a couple of months or longer. The reason for this is to show the market that they have confidence in the company and to mitigate the information asymmetry between buyer and seller.
>
> *Trade sale or acquisition exit.* The entrepreneur and the venture capitalist sell their entire share to another company, usually operating in the same industrial branch. The limited number of potential buyers makes the valuation of the portfolio company more difficult.
>
> *Secondary sale.* Only the venture capitalists' shares are sold to a third party and the entrepreneur retains his shares in the company. This can be a way for a strategic investor to get benefits from the company's technology, without having to invest as much money as in a trade sale.
>
> *Buy-back.* The entrepreneur or the company buys back the stock from the venture capitalist.
>
> *Write-off.* This exit normally involves the failure of the entrepreneurial company. The venture capitalist can only claim money from their *senior preferred shares*.

IPO, buy-back and write-off could all be done partial or completely depending on the venture capitalists prediction of the future market development.

4.4.4 Business Angels

Business angel behavior is to a large extent very similar to that of venture capitalists. They are most commonly involved in seed or start-up phases due to the relative smallness of the invested capital. They also conduct extensive due diligence, but often have some personal or business relation to the supported company. This relation also implies that they rarely have the same demands on the return on investment.

4.4.5 Start-up Specific Impacts of Private Equity and Strategic Alliances

Technology-based start-up companies have been argued to normally have severe resource constraints and are therefore reliant on relationships with external partners. (Jarillo, 1989) For a company in the *expansion phase,* capital is commonly in short supply, and a collaboration that involves equity transfer from a larger strategic partner or a private equitant is desired. These collaborations do not come without implications, though.

The research on strategic alliances between start-ups and larger companies is inconsistent. Some studies report a positive impact on the early performance and valuation on IPO of the start-up company (Baum, Calabrese & Silverman, 2000; Stuart, Hoang & Hybels, 1999), whereas Alvarez and Barney (2001) shows that 80 percent of managers in start-ups felt unfairly exploited by the larger partner and that many companies went bankruptcy.

Start-up companies may face high obstacles when entering a partnership due to that; (1) they face high search costs in locating appropriate cooperation partners, (2) they may not want to engage in cooperative activity because they fear expropriation, (3) they are of unknown quality and so potential cooperative partners have difficulty evaluating them, and (4) they are not sufficiently developed to engage in cooperative relationships. (Hsu, 2004) Each of the above-mentioned areas will be discussed in turn together with theories on how an early venture capital investment could be able to overcome the obstacles.

The search cost, when looking for a suitable partner, is significantly higher in privately held companies. It is often a result from the managers' reluctance to broadcasting strategic directions to potential competitors, thereby making the search more difficult and costly. Venture capitalists can act as an intermediary and help the startup company with finding a suitable partner through their vast network of industrial contacts. The venture capitalist generally has a broader perspective, spanning over several industries and can thereby be more observant to potential threats in the business.

The fear for expropriation could be mitigated by a venture capital involvement through contractual expertise and also by providing a partner monitored by the venture capitalist. Also companies not governed by the venture capitalist might put their chances for future funding on stake, should they expropriate a company that venture capital supports.

The unknown quality of the startup company is likely to have smaller impact on the partner search if they are funded by venture capital. The extensive due diligence conducted by a *general partner* vouch for a company with stable financial situation and high predicted growth.

As shown by Hellman & Puri (2002) venture capitalists have a great impact on reducing the time to commercialization and on the development of the *portfolio companies*. This would also reduce the time until a company becomes attractive to potential partners.

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5 Scenarios

This chapter describes the background, development and results of a scenario-based questionnaire distributed among the management group of SMI. The scenarios are results from theoretical findings presented in Chapter 4 and will help to focus the empirical studies in Chapter 6.

5.1 Background

Since the late 90's the MEMS market has been one of the industries with the highest anticipated growth potential. (Eloy, 2004a) The market has indeed developed, but mainly in a small number of niches and companies; the overall expectations have not been fulfilled. Consequently, many MEMS companies have been forced to close their business and some niches have come to a complete standstill. Others have reached a commercial break-trough and are established in the MEMS market. The downturn has been a severe blow for small and mid-size MEMS companies and consolidation in the market is common.

To be able to propose a suitable funding strategy for a small MEMS company like SMI, the authors find it vital to identify both internal and external constraints and the management's future ambitions with the company. A discussion about strategic alliances and private equity would be pointless without considering the complicated context in which the company operates. To limit the number of studied parameters in the empirical studies, the management group is asked to reflect on four different, by the authors fabricated, scenarios of the present and future situation.

5.2 Setting-up the Scenarios

> *" The process of building scenarios starts […] looking for driving forces, the forces that influence the outcome of events."* (Schwartz 1999)

Four possible constraints were adopted as the foundation for the different scenarios: a market constraint, a financial constraint, a technology constraint and an internal constraint. The constraints were then mapped against findings that were identified during the theoretical studies and orientation interviews. The findings and constraints seen in Appendix 1 constitute a basis for developing symptoms that would be possible to find on the market. The symptoms described in the scenarios were mainly derived from the authors' subjective opinions and perceptions of the market.

Each scenario presents an external picture of the market, an internal picture of SMI along with a best and a worst-case future scenario. A number of questions are asked after each picture, concerning the accuracy of the scenario and the resources expected to play the most important role in the particular situation.

The discussion about resources is important since this study is based on the assumption that resources held by the company will play an important role in overcoming both external and internal symptoms identified. To strengthen some resources, either through strategic alliances or private equity, could also have impact on the underlying root-causes to the symptoms. To identify main categories of resources, the respondents are asked to rank the most important resources for the environment described in the scenario. In addition, answer whether SMI currently are in control of these resources. The most favored main categories will then have to be deeper investigated to find more concrete subgroups. Held resources give an image of SMI's strategic position and core competencies whereas the lacking resources can help to answer the question how a capital injection or a strategic alliance should be used. The set of resources is given by the authors, but is derived from Barney's (1991) categories.

Physical Capital Resources	Human Capital Resources	Organizational Capital Resources
Access to financial slack	Close relation with key customers	Broad customer portfolio
Easy access to packaging and testing	Excellent manufacturing process knowledge	Clear vision, mission and strategy
Financially strong stakeholders	Excellent marketing and sales knowledge	Dynamic and inventive organization
In-house production plant	MEMS design and development skills	Lean and cost effective organization
Strong protection form IP	Strong management group	Shareholders with good reputation
	Value chain coordination skills	

Table 5.1 Classification of resources appearing in the scenarios, according to Barney's categories.

5.2.1 Market Constraint

The scenario *Waiting for the killer application* suggests that the majority of the actors on the market are searching for a high-volume product that can bring continuous profits, finance further development and show the potential of MEMS to other industries. A high-volume product is especially important for a company with manufacturing as core activity, since degree of utilization and batch sizes greatly affects profits.

5.2.2 Financial Constraint

The scenario *Catch 22 – Price vs. Volume Dilemma* suggests that the main reason for the foundry-markets relative standstill is the lack of financial slack. The companies are locked in a situation where the products are too expensive for the customers to request in any larger volumes. Cost cutting and price reduction is virtually impossible due to the small volumes and it is therefore hard to reduce prices to drive up volumes. Foundry companies that have access to financial slack could use it to build their own market through reduced prices in order to gain volumes and future profits.

5.2.3 Technological Constraint

The scenario *MEMS – A technology, not yet a product* suggests that the technological focus in the market has made the products customer-unfriendly. Apart from some high-tech companies, the potential customers have very limited knowledge in MEMS and are not interested in buying MEMS specifically, but to buy technical solutions to problems. The lack of coordination in the value chain makes standardization difficult and every new solution calls for extensive efforts in design, packaging and testing.

5.2.4 Internal Constraint

The scenario *SMI – Dropped off in the middle of nowhere* suggests that the overall market situation does not pose a problem but SMI's business model is extremely hard to make profitable. The current managers at SMI did not explicitly choose their business model, due to the company's prior history. The foundry model has shown to be a successful strategy in the semiconductor industry, but differences in level of standardization, product volumes and market penetration might make it extremely difficult to make profit out of a pure MEMS-foundry.

5.3 Participants

Initially the scenarios were distributed to the entire management group of SMI, in total nine persons. The study was then extended to include three PHILIPS managers, with knowledge about SMI and the MEMS business.

Internal:
Peter Draheim, Chief Executive Officer
Wolfgang Weggen, Chief Financial Officer SMI and Philips Semiconductors GmbH
Günther Kowalski, Chief Technical Officer
Bernd Schünemann, Business Development Manager
Georg Menges, Marketing and Logistics Manager
Thilo von Freyhold, *Sales Manager*
Hans-Ulrich Schröder, *Technology Manager*
Björn Tesch, Chief Operation Officer
Susanne Platzbecker, *Controller*

External:
Andreas Brenner, F&A, Philips Switzerland
Hartmut Frerichs, Product Manager, Philips Car Monitoring Systems
Mr. X

5.4 Results

Eleven of the twelve participants returned the questionnaire. The authors compiled the replies from the scenarios in order to get an overview of answers and visualize the results with charts.

5.4.1 The Internal and External Picture of SMI

The authors have tried to keep the constraints separated in the four scenarios to avoid overlaps between them. However, the fast development in the market might cause problems in aspects of time for the different scenarios. It is possible or even likely to believe that one scenario can be accurate at this moment and then be followed by another scenario. To prevent this and pick up tendencies, the questionnaire included both questions on the present and the future situation.

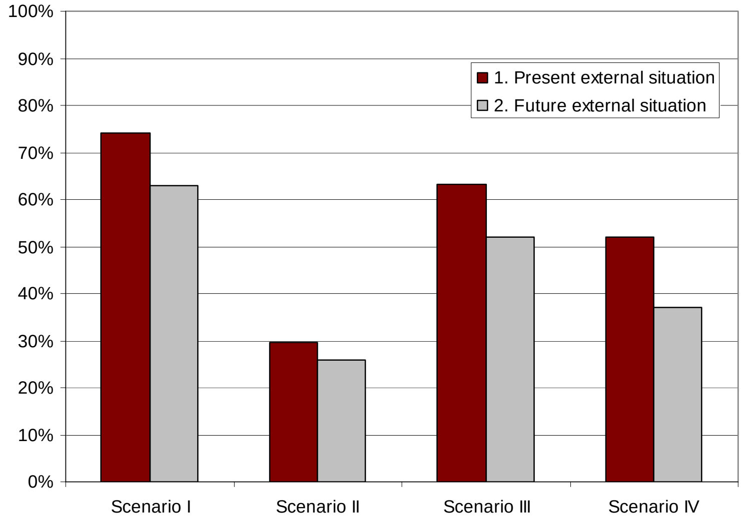


Figure 5.1 The present and future external situation.

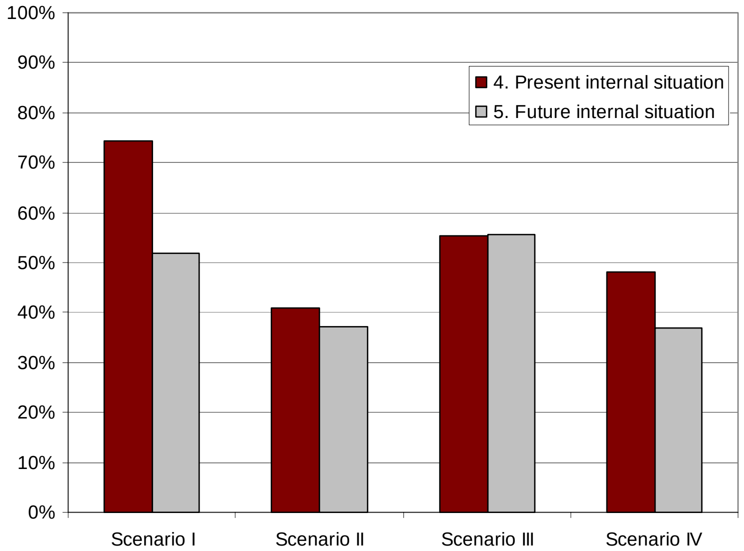


Figure 5.2 The present and future internal situation.

Although widely spread, a tendency can be seen that Scenario I and III are the most representative for the managements opinion. Scenario I and III have the uppermost level of agreement on both external and internal situation, see Figure 5.1 and 5.2. They are also, in the summarizing questions, regarded as the most accurate with four respectively three votes. Furthermore these scenarios have the largest amount of ‘completely agree’ and ‘mostly agree’. Based on these facts, the study will from now on proceed with these two scenarios in parallel, but will incorporate some specific symptoms from the other two.

Due to the fact that the scenarios are derived from four different constraints and that each scenario just adjust one constraint at a time, a situation that actually is a mix between constraints will favor more than one scenario. The authors believe that keeping Scenario I and III throughout the study will make it possible to collect findings and knowledge from both of them. This will give multitude to the study and make it more accurate over time. Keeping them separated and not create a mix between them ensures that patterns can be fixed to a specific constraint.

In all scenarios, the question about future external situation reaches a lower level of agreement than the present external situation. For obvious reasons, it is harder to predict and agree on a future situation and therefore the lower agreement was expected. Regarding the internal situation, Scenario I looses a larger relative share of supports when looking to the future situation than Scenario III, which have constant values. This could be interpreted as a delay in time between the first and the third scenario, where Scenario I is a good image of the current internal state but that the company might find them selves in the situation described in Scenario III.

5.4.2 Resources

Close relations with key customers, excellent marketing and sales knowledge, MEMS design and development skills are considered as important resources in almost every scenario, see Appendix 3. The resources mentioned in Scenario I and III are equal, except that the experienced need of a clear vision, mission and strategy in Scenario I is replaced by excellent manufacturing and process knowledge in Scenario III. Noticeable is that, five of the six key resources are regarded as Human Capital Resources in Barney’s classification as seen in Table 5.1. Theory in private equity and strategic alliances strongly emphasizes the importance of a clear vision, mission and strategy to succeed in obtaining them. However, weaknesses in this area cannot be influenced by either a strategic alliance or private equity and will therefore be excluded in the empirics.

Scenario I	Scenario III
Close relation with key customers	Excellent marketing and sales knowledge
Excellent marketing and sales knowledge	Close relation with key customers
Clear vision, mission and strategy	MEMS design and development skills
Value chain coordination skills	Value chain coordination skills
MEMS design and development skills	Excellent manufacturing process knowledge

Table 5.2 Key resources with the highest ranking in Scenario I and III

Obtaining a specific resource is committed to a certain strategic risk; if the resource is dedicated to solve a specific problem and that problem does not occur, the investment in the resource has been in vain. Consequently, resources that are considered important in more than one scenario can be associated with a lower strategic risk than resources linked to just one scenario and these resources should be given larger relevance. Resources distinctly identified in just one scenario often depend on the close relationship between the resource and the environment presented in the scenario, e.g. access to financial slack in Scenario II.

One of the main issues of this thesis is to examine the relation between lacking resources and how to acquire them. The given key resources will play an important role in SMI's further development. However, SMI is lacking vital resources according to the replies of the question concerning whether the company is currently in control of them. Out of the eleven participants in the questionnaire only three persons defined specific missing resources. From those responding, the following deficits were identified in Scenario I and III.

Scenario I	Scenario III
Clear vison, mission and strategy	Broad customer portfolio
Close relation with key customers	Close relation with key customers
Excellent marketing and sales knowledge	Marketing and sales knowledge
Financially strong stakeholders	
In-house production plant	
MEMS design and development skills	
Strong protection from IP	

Table 5.3 Resources stated as not currently in control by SMI of which four is seen as key resources

Disagreement on the above mentioned resource deficits could be seen among the three respondents; some resources were explicitly mentioned as lacking by one manager but seen as controlled by others. Those who have not replied to the question concerning internally controlled resources will be approached with the question during the interviews. *Close relation with key customers*, *excellent marketing and sales knowledge* and *MEMS design and development skills* are also regarded as key resources according to Table 5.2; these will be of great interest for the empiric studies. *Clear vision, mission and strategy* appears on the list of lacking resources but, as stated above, this is not an issue that can be addressed by private equity or strategic alliances. Furthermore, it could be an expression of an internal lack of communication of the strategy and not a lack of a business plan that will attract partners.

5.4.3 Summarizing questions

The summarizing questions were added for two reasons; the respondent is able to review the scenarios and clearly define which scenario he agreed the most with. Additional comments to the scenarios could also be provided in this section. Second, the authors are able to evaluate if the respondent has identified the same constraints as the scenarios were derived from. The most accurate scenario was, according to the summarizing questions, Scenario I and III and the most potent risk in these scenarios were the financial and market risk for Scenario I and the strategic risk for Scenario III. The discrepancy between the constraints and the identified risks could be a symptom of the difficulties to clarify causality. Financial risk could be derived from failure in the market and strategic risk could be dependent on how well the technology is adapted to allow a foundry business model.

A few additional comments were enclosed and concerned the necessity of having a strong management group no matter what situation a company faces and that a manager

> *"…also judge the financial risk for all scenarios as the most potent. The period of time needed to build up customer relationships / intimacy needed for business development as well as the financial injection needed for a fast ramp-up after the appearance of a killer app is consuming financial resources."*

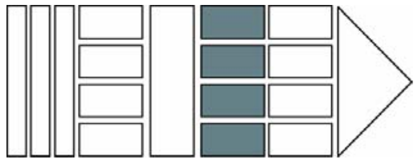
Another interviewee questions the method of using scenarios and stating that,

> *"The questionnaire forces you to think in these predefined scenarios without leaving room for new thoughts."*

This statement is a valid criticism against a scenario based study, but considering the limited time for the study and the need to focus the report in an early stage, the authors believe that scenarios can be a valuable method to apply. Additional comments and thoughts have been acquired from interviews with the participants in the questionnaire.

6 Empirics

This chapter includes the empirics found during the study. First SMI's position in the MEMS market is presented followed by findings focused on the key resources found in the scenarios. The private equity situation in Germany and strategic alliances in the MEMS market is also presented.



6.1 SMI in the MEMS Industry

6.1.1 Mission

SMI's main mission is to be a service provider for Microsystems technology. They also aim to be an innovation partner for silicon processing and wafer level packaging. Finally, SMI will act as a professional foundry service and offer production on an industrial scale (SMI, 2004c).

The two scenarios emphasize different statements in the above-mentioned mission. Scenario I focuses on SMI as a foundry for large volume of MEMS applications while Scenario III under-lines the coordination services provided. The evolution of the mission has been described during the interviews; when SMI chose the initial business model as a pure foundry it showed that the market was overestimated. It was believed that there would be an accumulated demand for a MEMS foundry in the market and that customers would initiate the contact with SMI. This assumption was false and the role of service provider was incorporated in SMI's mission. The importance of the coordination service divides the management team. According to interviews, it is either seen as a prerequisite, now and in the future, to be active on the foundry market or seen as a catalyst for developing the foundry culture.

6.1.2 Business Model

SMI is a service provider for MEMS manufacturing. Their core activities are to be a foundry for MEMS products and provide services to facilitate for customers to integrate MEMS in their products. The value chain from SMI's point-of-view is presented in Figure 6.1 and it also high-light these in-house processes. SMI uses their large industrial network to provide customers with competency from all the parts in the value chain. To remain credible as a foundry, SMI will never be the owner of products, regardless if they are designed and developed internally, since they then could be considered as competitors to their customers (SMI, 2004a). In order to get the possibility to put manufacturing processes to a test, train the operators and get positive cash flow, SMI is currently running manufacturing projects in wafer level packaging[14].

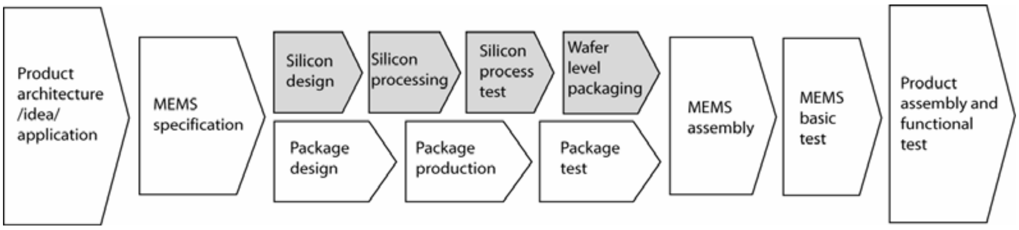


Figure 6.1 The MEMS value chain from SMI's point-of-view. SMI's current activities shaded. (SMI, 2004c)

SMI differs from most other foundries in that they have no in-house production plant. This asset-light start-up strategy is intended to keep costs at an absolute minimum; however a foundry without an in-house fab is not a long-term sustainable business model. Customers have to be convinced that the foundry masters the manufacturing processes internally and that they add value to the end product. However, investments in an internal fab will only be made when customer demand for larger volumes has been established. This strategy makes the investment plan hard to predict. To this date, investments of about € 1 million have been made to expand the production facility in the Fraunhofer ISIT. The next step will be to invest approximately € 2 million in another capacity expansion of the Fraunhofer ISIT fab. According to the business plan, a conversion to 8" wafers will be made during 2006 and a complementary in-house production plant will be installed in the ground floor of SMI's office building. The transition to 8" wafers is important since the foundry uses pre-processed wafers that already have been prepared with IC to construct the MEMS parts on. The majority of the IC-manufacturers only use 8" processes and the access to inexpensive IC wafers are highly dependent on the transition to this larger size. Development of new equipment is also focused on 8" techniques. Investments are

[14] Wafer level packaging is a technique where an IC is encapsulated before singulation of the chips. This is more cost effective and the finalproduct will be smaller than with ordinary packaging techniques. The technique is also believed to play an important role in MEMS packaging.

predicted to amount to € 12 million. Given a growing demand, the already started main fab will be completed during 2008. (SMI, 2004b)

6.1.3 Organization

SMI consists of about 30 employees, with focus on a strong engineering development team and a management group with large experience from the semiconductor industry. The engineers typically hold a PhD in silicon related physics and the managers have been recruited from high corporate levels in Philips. Recent employments have been made from other MEMS start-up companies to get more experience from entrepreneurial issues.

The market constraint that Scenario I was based on is evident from interviews with the managers in favor of that scenario; they argues that there is to much organizational focus on technicians and would like to grow the marketing and sales department to be able to initiate orders from a larger range of customers. When a customer base is established, engineers with specific competency in MEMS should be hired to complete the projects. Scenario III supporters state that a good technological foundation is vital and that technological land winnings will be needed to lower prices and enhance performance and thereby attract customers.

6.1.4 Entry Barriers

The entry barriers in the foundry business have traditionally been seen as constituted of the large investments needed to construct a fab. SMI has however, showed that a foundry could be started and attract customer even without an in-house fab. The extended supply chain focus in many industries has lead to a large entry barrier in the markets addressed by SMI; it is extremely difficult for a small company to act as a supplier to large players. SMI has the advantage of being owned by Philips and therefore has a large company as shareholder, qualifying them to initiate orders from leading customers and the marketing manager argues:

> *"A small company will never be able to deliver parts to for example Nokia, no matter if they have very good ideas for a solution"*

The protection from intellectual property and the manufacturing knowledge can also protect the business model, but these factors are not usually considered as long-term protections in a high-tech industry, especially in a market situation where dominant technologies have not yet been settled.

6.1.5 Market Situation

The market situation is complex; the large break-through for MEMS has been awaited for a long time, but only been seen in a limited number of applications. The once large hope for what seemed to be an incredible opportunity in the optical network market is fading rapidly, leaving overcapacity in manufacturing plants and revealing risks in the business for investors. Never the less, managers and analysts initiated in the business are convinced that the technology will succeed and new business opportunities will see the daylight. According to the interviews, the key question is when, how and in what pace the foundry culture will develop. Certain managers are of the opinion that there is currently no major hindrance for a foundry to be successful; it is only a question of time. Development of products, profiling of a company's brand and building up customer relations takes time but will be solved. Other managers see present obstacles in the market and argue that SMI will have to actively build its own market.

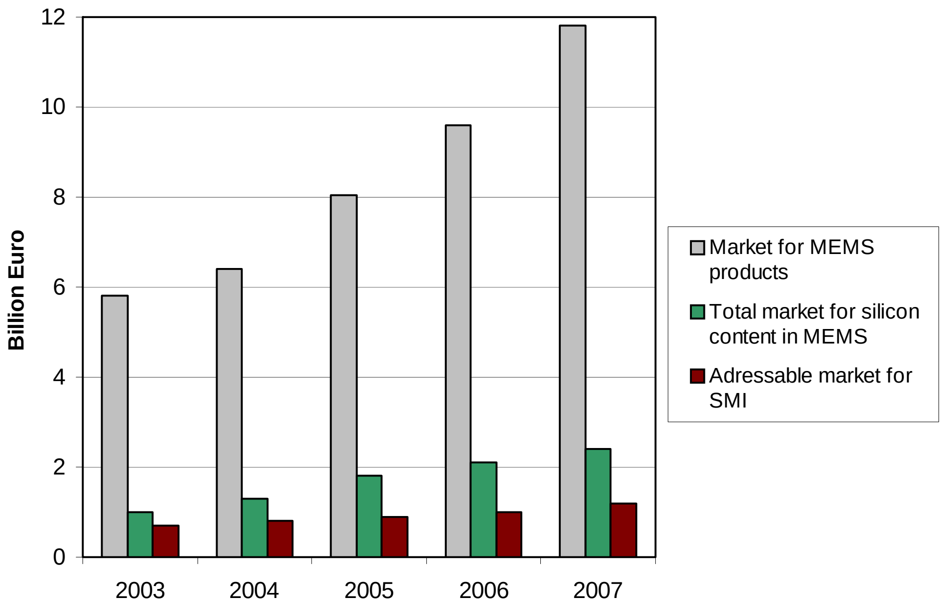


Chart 6.1 Potential marktet for SMI foundry service (SMI, 2004)

The complexity of the market is also shown in the large range of outcomes from different market analysis. The forecasts for the worldwide turnover for 2007 vary from € 12 billion to € 80 billion. The silicon manufacturing part is believed to represent around 20 percent of the value added in MEMS. Even with the more conservative figures as a basis for future income and with a market penetration of 5 percent, SMI would have a turnover of around € 120 million in 2007, se Chart 6.1. (SMI, 2004)

MEMS are forecasted to enter a wide range of industrial segments in the near future, with communication and medical as the leading markets. The total share of these and other attractive markets in 2007 are presented in Chart 6.2.

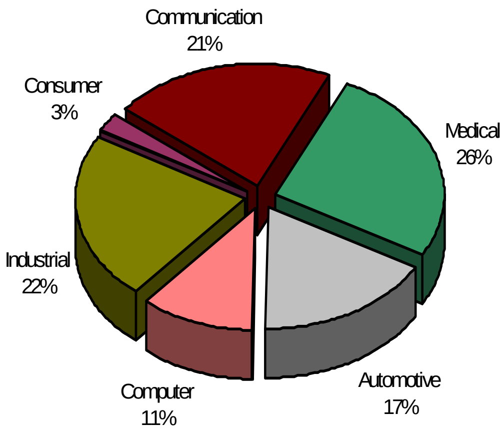


Chart 6.2 MEMS Market 2007, total € 11,7 billion (SMI, 2004)

6.1.6 Products

Due to the high fixed costs in MEMS manufacturing, the degree of utilization of the manufacturing facility is, to a large extent, the basis for the financial results. A high-volume application with a constant demand and reasonable margins would provide a foundry with an economic respite. In addition, it could also give the newly started foundry a possibility to put their manufacturing processes to a test and to prove their capabilities to other potential customers. These kinds of killer applications are agreed among the management of SMI to be a desirable way to scale up the company and make it profitable.

Whether and how a killer application could be found and what to do in the mean time is however a source of disagreement. The managers in favor of Scenario I believes that there must be an active marketing and sales organization that, in close collaboration with potential customers, identifies needs that could be covered more efficiently and cheaper by a MEMS based solution. The managers in favor of Scenario III are more restrictive and believe that a killer application is found by accident, not through an active search. They state that a killer application is likely to reach high volumes in terms of units, but maybe not in terms of wafers and thereby not fill up a significant part of the production facility. Instead they believe that the company should focus on technological developments that will enable the foundry to be active with a larger range of customers and eventually there will be a large enough accumulated demand to make a foundry profitable.

The driver behind the rapid growth in automotive MEMS has been the increasing demand for passenger safety. Accelerometers for setting off airbags, tire air pressure sensors and ESP[15] systems have all been realized with MEMS as safety increasing measures. The market drivers in the mobile communication are not as powerful; to large extent cell phone manufacturers or service providers have to create customer needs. Potential killer applications in this market could be 3D-compasses for GPS features, tilt sensors for cursor movement and RF switches to decrease the size of the tranSMItter system in cell phones. The demand for these applications is not believed to grow until the systems could be produced to a lower cost and the service providers release value adding services that use these extra features. The shift of market drivers in the mobile industry, from mobile phone manufacturers towards service providers has made the technological road mapping and customer identification more complex.

Another market that SMI is glancing towards is the medical application market. Blood pressure sensors and some lab-on-chip solutions are systems that have already reached commercial break-through. With an aging population and higher demand for medical treatment, patients treating them selves from home and more flexible medical care will be needed. Consequently, the demand for reliant and inexpensive medical systems will grow and the medical MEMS market with it.

6.2 Resources

The two scenarios chosen gave an image of the key resources needed to resolve the future problems and grow in the market. Some resources are seen as important independent of the situation SMI will face in the future and can therefore be perceived as more important and committed to smaller risks. In this chapter the five

[15] Electronic Stability Program

most important resources are presented along with the managements' thoughts on them and different company or market-specific issues connected to them.

6.2.1 Close Relations with Key Customers

Every company is in need of customers, but how to approach, select and make business with them can for sure be very different. As mentioned above, the customer relation among the one in favor of Scenario I is diverse from those in favor of Scenario III, which also reflects their expectation on a key customer. A key customer can either be a customer with a high demand for silicon structures or a customer acting as a doorkeeper to a new industry. A high volume customer creates an opportunity to get a high utilization level without large set-up costs. In addition, such a customer could facilitate the approaching of other customers by stating a successful example.

SMI faces the challenge of working with customers who differ largely in their initial MEMS knowledge and has made the following categorization of their customer base:

1. MEMS providers with only an extremely limited silicon manufacturing capacity. The large investments needed to build up internal manufacturing capacity make it impossible for small and medium sized companies to produce in-house. The function as an aggregator of production volumes makes the foundry attractive for these companies' needs. The foundry model also has the advantage that it, unlike many of the large semiconductor manufacturers, does not sell any own products and the competitive situation between the foundry and the MEMS producer will be easier to handle.
2. MEMS system manufacturers with their own productions facilities are likely, as volumes augments, to seek second sourcing for the silicon parts. A flexible contract with a foundry is believed to be an attractive alternative for them.
3. High-tech companies with no internal knowledge in MEMS, but with products that could be realized cheaper and with higher performance could benefit from SMI's extensive know-how in silicon manufacturing, as well as their role as integrator and project managers.

SMI's management team concludes throughout the interviews that depth is much more vital than width when it comes to customer relations. Although, the marketing unit argues that a combination will contribute the most to the success of SMI, Scenario III advocates prefer depth. They claim that SMI is too small to handle customer needs from companies in diverse industries. The automotive and mobile communication industry for example has completely different technological roadmaps and does not face the same obstacles in their markets. The automotive industry has extremely high demands on quality and reliability, whereas the mobile communication industry focuses on cost cutting and short development cycle times. To be active in these diverse fields, a company has to have the engineering expertise and manufacturing processes entirely devoted to the specific industries. SMI has not yet reached a size where this is manageable.

All interviewed managers affirm the advantages of having a close relation with a customer. Customers have technology know-how to realize products with standard techniques and SMI has competence in translating these products into silicon structures. Both competencies have to be combined in MEMS development and therefore, a close relationship is a prerequisite. The CEO states:

> *"We have limited knowledge in acoustics but can, together with the customer, develop silicon microphones thanks to our MEMS knowledge"*

A slight difference in the characterization of closeness distinguishes Scenario I and III supporters; the first emphasizes customer pull of killer applications whereas the latter believes that long-term joint development of technological roadmaps will accelerate the market penetration of MEMS. These discrepancies will have an impact on the scope of a partnership and which kind of customers that will be the most suitable for a cooperation. A partnership aimed to result in a strong customer pull requires a large exchange basis to be able to pick up needs and ideas for new products. A partner close to the end-customer is also important, since the effects of market pull will be stronger and the MEMS knowledge is likely to be smaller and thereby a larger amount of unexplored opportunities to capitalize on. A coordination of technological roadmaps could be done with any kind of partner and need a smaller exchange basis, consisting of mainly technical development plans.

Present Key Customers

SMI has been involved in a series of customer projects; however the last year's economical downturn forced several customers out of the projects. The key customers today are different divisions within the Philips group. Nokia has recently certified SMI's internal processes and SMI is thereby ready to supply a large mobile company with MEMS. The planned expansion into the medical sector as of 2005 will open up the possibility for cooperation with Philips medical systems as well as new external customers.

6.2.2 Excellent Marketing and Sales Knowledge

Marketing and sales knowledge is ranked as an important resource that SMI has to develop to be able to stay in business. The MEMS industry has been characterized by a technological push and the management agrees on the fact that a company has to focus on customer needs to be competitive. One way to bridge the gap between technology and customers would, according to marketing and sales managers, be to employ application managers. They would be sales engineers that could work closely with a customer and also have the technical competency to judge whether a MEMS based solution would be feasible for the customer.

The novelty and complexity of the MEMS technology makes it hard to increase customer awareness of the products offered and the potentials with them. MEMS also have the disadvantage of being a spin-off technology to the semiconductor industry, an industry where few customers have an explicit internal knowledge and research. Being more specialized for individual customer needs than the IC, MEMS puts larger demand on customer involvement in early development phases.

This double role as a manufacturer and service provider is also important since SMI is involved with customers with very different knowledge in MEMS. To be able to sell foundry services to customers without internal knowledge, SMI attempts to facilitate the transition to silicon-based solutions by providing development, project management and initiate contacts within their industrial network.

To further enhance customer awareness the two scenarios suggests different possible paths to follow. Scenario I advocates argues that the submerging of a killer application would show the potential of the technology to a wider range of customers letting SMI attract new customers with the seed of a new killer application. Scenario III supporters emphasizes the need for the whole industry to work towards more consumer friendly products as a way of facilitating the use of MEMS instead of traditional solutions. Hence, they are more focused on SMI’s role as an integrator and facilitator in the value chain and for a wide range of customers.

6.2.3 MEMS Design and Development Skills

The customers rarely have an exact blueprint of the product they would want manufactured, more often the input is only a principal idea or a general need. To fulfill these customers' needs, the design and development skills are considered important. The MEMS industry is a new business and set to solve old problems with new technologies. This in combination with the uncertainty and low awareness that characterizes the customers makes it important to make products right first time and is argued by the Business Development Manager.

> *"The customer's suspiciousness to this new technology means that you will not get a second chance."*

The large success of the semiconductor industry was highly dependent on the emerging of the CMOS[16] standard that allowed designers and customers to choose between standard chip structures and combine them to new products. The customers only need to understand the interface signals. The MEMS industry is slowly starting to standardize designs and processes, mostly driven by large companies like Bosch or by MEMS collaboration programs. There are obstacles to the standardization though; the small volumes reduce incitements for standardization research at the individual company and the small volumes also makes second sourcing unprofitable for the customers and standardization exchange between different suppliers is not necessary. The CTO of SMI believes that standardization will be driven by larger volumes and will follow an evolutionary pattern where the best techniques and processes will survive and set standards for the rest of the industry.

6.2.4 Value Chain Coordination Skills

As a service provider for MEMS solutions SMI's management states that value chain coordination skills are important for the success of the company. To complete a functioning MEMS solution, a lot of different parts in the value chain have to be brought together and integrated. This coordination calls for a strong network of companies from different value chain areas, supplying the service provider with expertise in packaging, testing, design etc. A broad partnership portfolio with well-known suppliers also helps the company strengthen its brand.

[16] Complementary Metal Oxide on Silicon. A widely used chip technology

Engineers with the ability to see the whole system perspective are also a necessity for managing the integration. These da Vinci-like engineers should preferably have knowledge from all of the wide range of scientific fields involved in the making of MEMS. Some managers state that engineers experienced in undertaking MEMS projects in a commercial environment is a rare resource and that it will take time before the educational system has caught up with the increasing demand. Most of the technological universities in Germany have launched educational programs to school MEMS engineers but research institutes, doctoral studies and university spin-offs consumes a lot of the educated engineers. The novelty of the technology also implies shortage in project management experience with the engineers. SMI has been able to attract a number of engineers with experience in the industrialization and commercialization of MEMS; this is argued by the management to be a competitive advantage for SMI that possible entrants will have difficulties to overcome.

6.2.5 Excellent Manufacturing Process Knowledge

Due to the experienced engineers and managers, SMI concludes that they possess excellent manufacturing process knowledge internally, a fact that separates them from many competitors. Over the last couple of years, a lot of start-up companies in the MEMS business have gone out of business due to heavy investments in fabs without a customer base to fill them. SMI realized that a flexible process is a prerequisite to cut costs in order to make MEMS solutions attractive for a larger number of companies. Although microscopic, MEMS are in general much larger than standard IC and therefore investments in the most up to date equipment are not necessary. With their process knowledge, SMI has had the ability to negotiate with the Fraunhofer ISIT to get a flexible manufacturing contract. In the future, they believe that they will be able to instruct equipment manufacturers how to reduce the features of the machines to a level suited for MEMS production and thereby allowing smaller investments. MEMS processes has not reached the same level of industrialization as the semiconductor industry and an effective foundry can not be acquired only by investing in equipment but has to be developed by personnel that understands the processes and the differences to the semiconductor industry.

MEMS process technology also differs from IC processes in the possibility to create generic processes; it is still struggling with the law that has been a difficult obstacle in the business for a long time: one product, one process. A foundry has an own unique set of modules that can be combined to build up process-steps or whole processes. Development of modules is important if the foundry wishes to reach a higher degree of flexibility but every new module is often linked to an investment in equipment and sometimes even new machine operators. Due to the customer-specific solutions provided by MEMS, the possibility to re-use the same combination of modules for a larger number of products is still limited and new processes have to be arranged for every new customer. This has impact on the development times and degree of utilization in the fab.

Excellent manufacturing process knowledge is considered as a key resource in Scenario III where a flexible foundry will be essential to accumulate high volumes from a large variety of products. A killer application would reduce the demand for flexibility since this could be done in a defined process. Supporters of Scenario III are not convinced that it will be possible to find an application that has a high enough wafer demand to dedicate a process for a long period of time. Scenario I advocates agrees to a certain extent, stating that SMI's focus on the mobile communication market implies that every single chip will be extremely small and therefore the demand on wafer level will not fill up large parts of the fab. If SMI should initiate orders from a different market, where systems are larger and thereby fewer per wafer, dedicated processes would be profitable and other resources will be more important.

6.3 Strategic Alliances

Strategic alliances and other collaborative agreements have started to crisscross the MEMS industry. The downturn and overcapacity in the market as well as the complexity of the products have driven these consolidation trends. Different actors have chosen different models of value creation and strategic scope.

6.3.1 Value Creation in MEMS Alliances

The market is still too young to show any obvious signs of co-option alliances that concern the foundry model, since the competitive positions are hard to identify. In other areas of the industry, co-option alliances have been seen as a way of reducing the risk of technological substitution; companies with products that could be replaced by MEMS technologies form alliances or acquire actors that are threatening their position. Alliances involving co-specialization or learning and internalization are more common.

Co-specialization Alliances

The large number of complex development and manufacturing processes has made co-specialization alliances an important strategic tool to generate complete systems from ideas. Most of the co-specialization alliances in the MEMS market consist of companies arranged in network structure, with a system integrator in the nodal position. Companies with deep knowledge in manufacturing, testing and packaging are connected to the nodal company, through which customer contacts are directed.

Co-specialization to access new businesses can also be created to join separated areas of technology to develop new products. For example, a development of a silicon based microphone involves extensive knowledge in both acoustics, often provided by a company specialized in ordinary microphones, and in silicon structures and micro-scale physics, a knowledge found within a MEMS company like SMI. This alliance does not contribute to the actual transfer of knowledge, since none of the companies has an explicit interest in learning the partner’s technologies. Bringing the specialized and complementary knowledge together to access completely new businesses creates the value.

Access to new markets is another reason for forming a co-specialization alliance. Due to the fact that the MEMS industry is mainly focused on accessing markets dominated by a handful of large players, small MEMS businesses are in need of large companies’ credibility and sales channels to enter these markets. Large companies, on the other hand, need access to up-coming MEMS products and technologies to make an entry in the growing market. These alliances are usually created between OEM suppliers for the automotive, communication and life science markets and small university or research institute spin-offs. SMI’s close relation to Philips could be attractive for partners looking for this kind of market access.

Learning and Internalization Alliances

Many semiconductor companies glance towards the MEMS industry and have either started subsidiaries active in the market, like Philips did with SMI, or formed alliances with small MEMS start-ups. The main reason for the semiconductor company is to have a feeler present in the MEMS business to be able to pick up trends and developments in the market and thereby be able to make a faster full entry if the market starts to grow rapidly. The smaller company can, a part from a lot of the co-specialization benefits mentioned above, get access to the semiconductor company’s experience and IP portfolio.

A lot of the development of the MEMS technology comes from universities or research institutes like the Fraunhofer. MEMS companies with limited resources devoted to research and development can benefit from forming partnership with theses kind of institutes. The institutes can benefit from the company's capability to commercialize the developed products.

As mentioned earlier, customer awareness of MEMS is in general very low and a key success factor for the technology is to improve the customers' knowledge. Strategic alliances between a MEMS company and a customer often aim to identify opportunities to replace system components with MEMS technology. The closer the customer is situated to the end-user, the more limited is in general their knowledge about MEMS and one of the interviewed Philips sources states that the most effective way to increase customer awareness and create a larger demand for MEMS is to form a strategic alliance with a leading customer, supplying end-users directly.

6.3.2 The Strategic Scope of MEMS Alliances

As external observers of the industry, it is not possible to evaluate the operational and economical scope of the alliances seen on the market, since most of the companies are not publicly quoted and thereby extremely reluctant to disclose any financial information.

The strategic scope could, based on the theory, be reviewed on an industry level. The most common structures identified shows that companies are starting in different ends of the industry and moving towards a middle position. Either newly started system manufacturers partner up with companies from all parts of the value chain to be able to provide complete solutions to their customers or large semiconductor companies entering the MEMS business teaming up with smaller companies in the MEMS market to get access to specific knowledge. Differences can also be seen in the choice between a market scope and a product scope. Some alliances has focused on producing one sort of products to a number of different markets while other alliances have focused on a small number of markets but tries to supply them with a large number of different products.

6.3.3 Present Key Partners

The key partner today is the Fraunhofer ISIT, which provides design services, manufacturing development and manufacturing facilities. The Fraunhofer Institute is a contractual research institute that undertakes applied research for both the private and the public sector. With around 12,700 employees from different scientific backgrounds, the institute is a very strong force in Germany's industrial environment. Located in Itzehoe, on the same premises as SMI, the Fraunhofer ISIT is the business unit focused on silicon technologies, with a strong knowledge in MEMS design. SMI has a comprehensive cooperation agreement with the Fraunhofer Institute letting them take part of innovations and developments made at the institute.

SMI also have collaboration and projects going on with packaging and testing companies to enhance the role as a service provider and to realize working solutions.

6.3.4 The Relation with Philips

SMI is founded and completely owned by Philips but are working as a very independent company and the relation with Philips have a lot of characteristics in common with a strategic alliance. The internal demand for MEMS solutions in Philips' products is believed to grow in the near future, but the company does not have a strategy for their future supply of MEMS. Philips divisions are responsible for their own sourcing and entitled to source both internally and externally and it is therefore not evident that they will choose SMI as their provider. Philips considers SMI as an opportunity to withhold a presence in the MEMS technology while waiting for a decision concerning their future MEMS strategy. A full internal entry could later on be made either through a buy-back of SMI or by setting up a whole new business unit. Buy-backs are however quite rare in Philips and most of the external ventures has ended in either liquidation or IPO. SMI is not seen as a strategic asset at the moment but Philips considers the company as an enabler to get access to the Fraunhofer Institute.

Philips is active in different fields of the automotive market and is planning on restructuring the company to be more focused on this market. Such a focused entry would increase the internal demand for MEMS. The main presence in the medical market is in large medical x-ray cameras and similar products, not in personal healthcare. Should Philips enter the growing personal healthcare market, the demand for MEMS within the company would increase since it is a prospected future mass-market for MEMS.

SMI is currently undertaking projects with diverse parts of Philips, for instance to develop silicon microphones that would be smaller, cheaper and more efficient than standard solutions.

6.4 Private Equity

The managers' perception of private equity is that the company is not mature enough to be attractive to venture capitalists. However, tendencies can be seen that venture capital is returning to the marketplace and that investments in MEMS companies are popular for venture capital funds.

6.4.1 Venture Capital Market in Germany

The Venture Capital market in Germany is growing and investments have already in the third quarter 2004 exceeded the total amount of investments in 2003. It is still significantly lower than during the dot-com era in 2000, but figures on fundraising indicates a strong future access to venture capital for companies in Germany, see Chart 6.3. The majority of the capital is invested in start-up or expansion companies. The regional differences concerning invested capital are large, with Bavaria as the largest receiver for funding and Schleswig-Holstein, where SMI is situated, among the smallest.

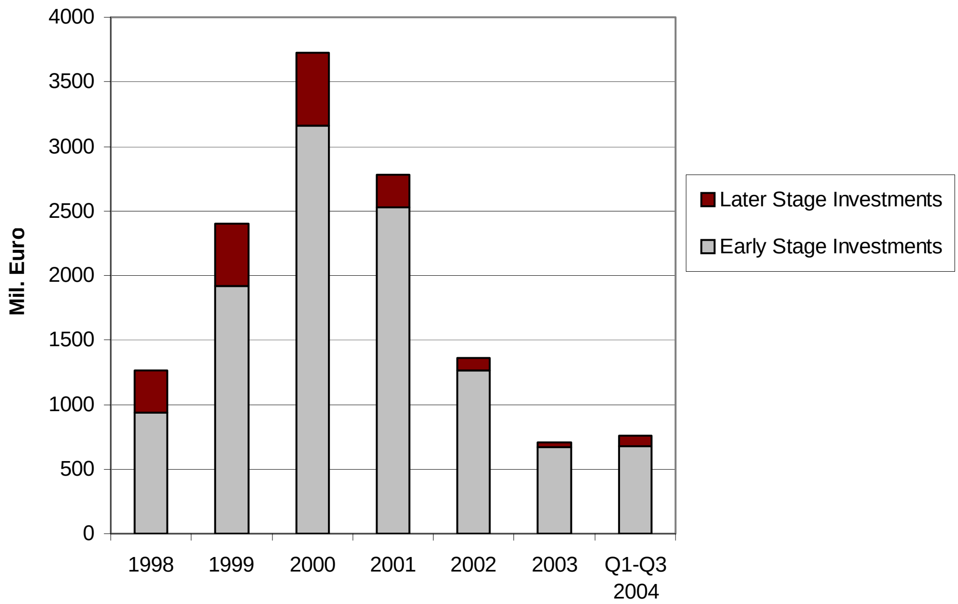


Chart 6.3 Venture capital market in Germany (BVK, 2004)

The most attractive industrial sector for venture capitalists has, during 2004, been the healthcare industry that received 16.7 percent of the total funding. The semiconductor industry was one of the least attractive industries with a mere 0.3 percent of the total investments. Due to the industry-crossing nature of the MEMS products, it is hard to judge where it belongs in this rough categorization but substantial investments in MEMS related companies have been done across Europe during 2004 and there is no evidence pointing towards a different situation in Germany.

The most common exit in Germany during 2003 was write-off of the portfolio company, which accounted for 40.2 percent of the total number of exits. No new IPO were made during 2003, although IPO made during 2002 still gave capital return to the venture capitalists. (Bundesverband Deutscher Kapitalbeteiligungsgesellschaften, 2004)

6.4.2 Experiences from venture capital in the MEMS market

One of SMI's managers, with prior experience from a venture capital funded MEMS start-up company explains:

The main interest for venture capitalists is to get return on their investment and they therefore seldom enter a venture without expecting double or triple returns after a period of three to four years. The key factors to get venture capital are to have a strong and aggressive business plan based on a very clear vision. It should include a detailed roadmap with milestones and financial targets. The management in the company should also be able to show the venture capitalists that they, by devoting their talent and energy in the company, will succeed to grow the business. A lot of start-up companies have most of their key assets bound to a few specific persons and the ideas contributed by these persons. It is likely that the company will go out of business if these key-personnel should leave the company in an early face. To mitigate this risk, venture capitalists often demand that these persons are tightly financially bound to the company, by a large private investment in shares or some other solution.

Venture Capital investments are almost invariably committed to some staging-model, but the form of the staging can vary. The targets for reaching subsequent stages are typically contingent on sales, revenues, released product or patents. According to the interviewed manager's experience, the first milestone is typically about a year after the initial investments and the following ones every half year.

Staging does not have to mean that additional investments in the company is made, it can also be contracts controlling the amount of shares held by the venture capitalists.

Failing to reach a target, the funded company has to release more shares to the venture capitalist. It is, however very uncommon that the venture capitalists would want to control 50 percent or more of the company due to the agency problem.

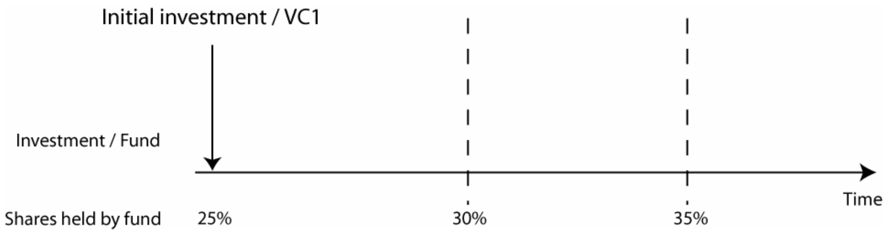


Figure 6.2 Staging through changes in shares held by venture capital fund

Another arrangement is to have no contractual bindings with the venture capitalist and both the company and the fund can choose whether a continued collaboration is desirable.

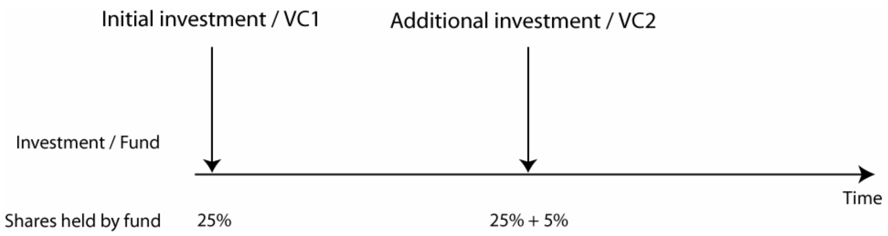


Figure 6.3 Staging without contractual bindings

The third general model is to initially receive a part of the funding and, depending on the level of target fulfillment, additional funding later on.

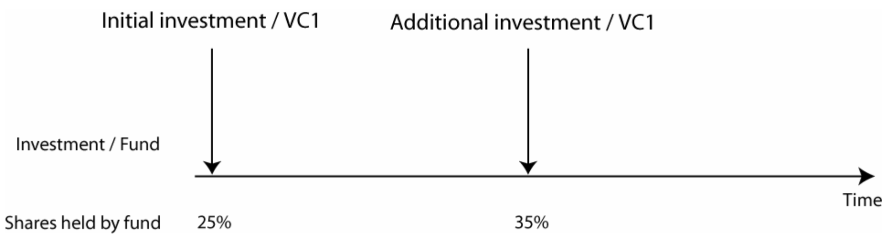


Figure 6.4 Staging with contractual bindings

According to the interviewed manager, the venture capitalist did not contribute with any useful additional resources, besides the actual capital injection. The company was helped with some accounting and business administration issues, but not with customer contacts or strategic partners.

The exit procedures have changed since the MOEMS market crashed; prior to the downturn, IPO was in focus for every investor but very few MEMS companies grew sufficiently to make an IPO a viable exit. More common is that a larger strategic partner acquires the company, a procedure that is easier if the company is partly owned by a venture capitalist than if it is partly owned by another strategic partner.

6.4.3 Business Angels in Germany

The significance of business angels has grown in Germany over the last couple of years. The financial status of a number of individuals has increased largely and enabled them to do substantial investments in start-up companies. A single business angle rarely invests the amount of equity that would be needed to get a majority share in SMI; 75 percent of the investments in Germany are below € 500,000. Investors are typically involved in between one and five different companies, mainly in the seed or start-up phase.

The most important factors when conducting a due diligence is the impression of the entrepreneur or management team followed by the products offered by the company and the market's potential growth. Most of the business angels carry out the due diligence themselves. The business angel commonly has a prior connection to the company, either through a personal contact or a business acquaintance and is generally active in the monitoring process with several days per month committed to the development of the company.

A large number of business angels also have experience from investing in venture capital funds. (Peters & Stedler, 2002)

6.5 Moving into the analysis

This chapter has outlined an image of SMI's position in the market and how a set of key resources will impact the future success of the company. These key resources have then been further dissected to obtain a lower level of abstraction. To obtain and strengthen these resources, while fulfilling Philip's demand on lower ownership share, the choice stands between private equity and strategic alliances. The authors have tried to summarize the issues from the empirics that will have the largest significance for the analysis in Figure 6.5.

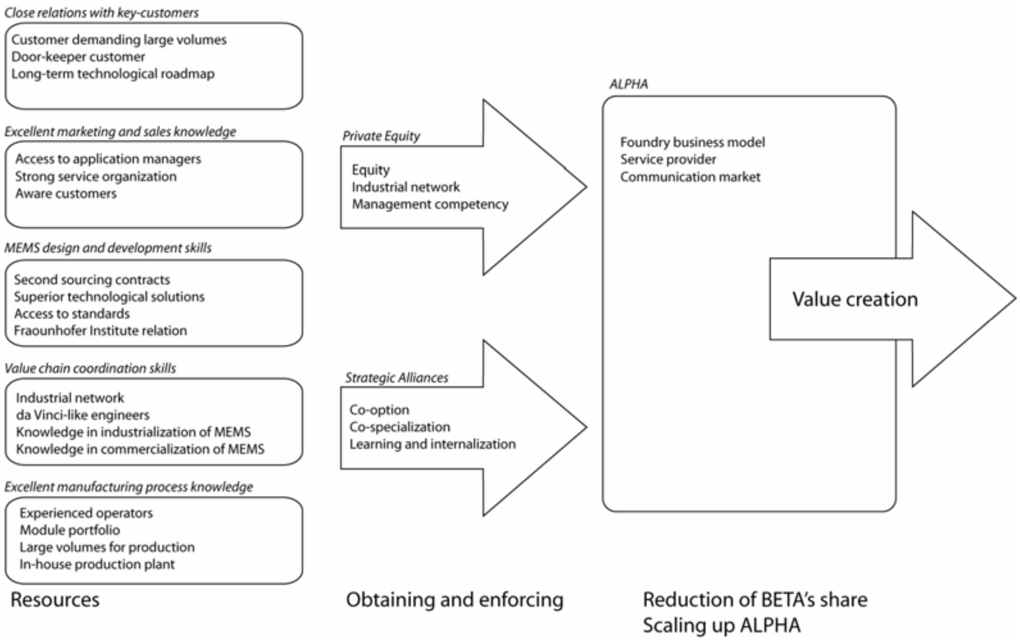
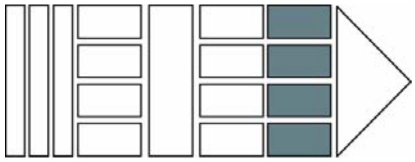


Figure 6.5 Summary of the most important issues from the empiric chapter.

7 Analysis

This chapter contains the analysis of the thesis. The subchapters from the empirics are kept in order to guide the reader and important connections to the theory are made through out the analysis. Findings in the analysis will act as foundation for the conclusion chapter where the authors' recommendations will be made.



7.1 SMI in the MEMS Market

7.1.1 The MEMS Market

As stated before, the market situation is highly complex and to make estimations of the future market for foundries is extremely difficult. The empirics have showed that the market analysis reports often are exaggeratedly positive and have been presenting the same near-future estimates every year, but they have yet to be realized. The market is believed to grow, but the boom that the semiconductor industry has experienced seems quite distant. The reasons for this belief includes that MEMS does not enjoy the same *network effect* as the IC business does; when a new semiconductor product family is presented, other chip-structures also requires updating. For MEMS these effects have been small and MEMS rarely requires other MEMS applications in order to work. The MEMS industry is also struggling with the issue that, due to the very fast downscaling of IC, their products have to be almost as small as standard chips but the volumes are still very small. The semiconductor industry, on the other hand, has had the advantage of going from large chips in small volumes to small chips in very large volumes. These issues make it unrealistic to believe in MEMS as an equally fast growing market as the semiconductor market has been. Thereby it will be difficult to adopt the same manufacturing and marketing strategies as the semiconductor market has been using.

The consolidation trends are likely to be an effect of, among other factors, overcapacity in the production facilities due to the large investments made in fabs during the opto-MEMS boom. Consolidation is likely to continue as the value chain positions become established and larger players enter the market. Nevertheless, the market is still believed to stay quite fragmented with a lot of niche companies unaffected by the consolidations.

The industrial structure is likely to change a great deal in the future; the positions in the value chain will settle and companies will specialize. The trend that can be seen at the market today is that more and more actors emphasizes on the services they provide. Many companies try facilitating for system customers to buy products by helping them with integration and industrial networks. This results in an industry with a value chain where there is no clear position where customers enter and this might harm the industry as a whole. This uncertainty is likely to disappear when the first large orders are obtained and the companies getting this contract will later have a position as preferred suppliers to the system customers and other companies will source these companies. Due to the entry barriers consisting of the size and credibility of the company, the customers are likely to be directed through a large actor.

Even though there are large obstacles to overcome to expand the market, the overall assessment of it is positive. Technologies as Internet telecommunication and video tranSMIssions with high demands for optical fiber network capacity have the potential to result in a return of the opto-MEMS market. The market for self-treatment medical appliances will also grow with the world’s aging population. The medical market is highly controlled by governmental regulations and decisions in favor of MEMS solutions would be an extremely strong injection for the market development. A major breakthrough on any of these markets will have effects on other industries and carry MEMS technology to a position as an extremely important industry.

7.1.2 The Foundry Market

The foundry market for MEMS products is still harsh and the conditions for operating on it are nowhere near the conditions on the IC foundry market. The lack of standardization and the relatively small volumes demanded prevents the companies that are active on the market from doing substantial investments in development of the business. Nevertheless, new companies with the foundry business model as a foundation are started and the competition gets even fiercer. SMI has a very large advantage against its competitors in that they have followed an asset-light strategy and is one of the few companies that will have the possibility to sell products at a reasonable price from the beginning. Other companies are dependent on high volumes to be able to spread their fixed costs and their high burn-rate will make it imperative for them to quickly find a killer application or many customers. Due to the lack of standardization and the technical difficulties to be present on more than one market, it is highly important that a company makes a good initial choice of market.

At the moment, no foundry has been able to come up with manufacturing processes that are flexible enough to let them take on any project given to them. The lack of manufacturing flexibility constitutes a large obstacle for the MEMS foundry market and flexibility has to be improved if the market should be profitable. Flexibility could come in different shapes though; a foundry that are able to use relatively static manufacturing processes to realize products that, with small adjustments, can be sold on a number of different markets will have a strong position in a future market.

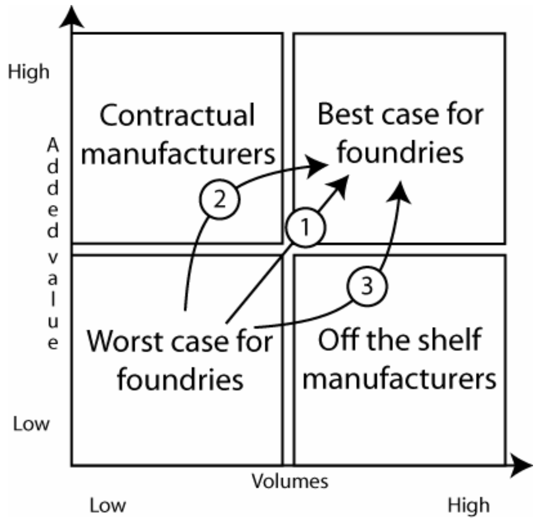


Figure 7.1 Actors on the MEMS manufacturing market and their position in view of added customer value and manufacturing volumes. The arrows illustrate possible movements in the matrix and the numbering follows the table below.

In the empirics the authors identified SMI's business model as an open foundry model; one of three in the main category for MEMS manufacturers. The other two are contractual and off-the-shelf manufacturers. In an attempt to arrange these business models in added value and volume the authors have created a matrix, Figure 7.1. Contractual manufactures provide high added value for their customers but on the other hand these products are often highly specialized and therefore give low volumes for the manufacturer. Off-the-shelf manufacturers produce high volume products often without protection from IP and with low degree of specialization. Hence the products give low added value for the customers and are often used in standard products for the consumer or industry market.

This categorization gives the open foundry manufactures two possible business models, low volume-low added value or high volume - high added value. The business model low volume - low added value is obviously unattractive in the long-run but can be feasible for an entrance in the MEMS manufacturing business. The collected empirics give that many open foundries are stuck in the down-left box, both from lock-in effects from players in the other boxes and difficulties in their own market, as described above. The top-right box is certainly the most attractive business model for MEMS manufacturers, but to be able to stay there in the long-run foundries have to continuously add new killer applications to their product portfolio. Since, every killer application will eventually become an off-the-shelf product and therefore become unattractive for a foundry to manufacture. Killer applications with decreasing volumes or high demand for improvements are likely to be produced by contractual manufacturers instead of open foundries.

For open foundries like SMI it is essential to get products in the top-right box. The authors have identified three possible paths to get products there.

1. *Killer applications*, in this thesis defined as applications with high added value and high volumes, enable companies to move products diagonal though the matrix. The empirics give that killer applications have given a number of foundries a successful launch, but also that killer applications often occurs by chance. SMI or other open foundries can therefore not have a business model that is dependent on the emerging of a killer application.
2. *Pull or move products from or via the contractual manufacturers.* If SMI is able to identify products with high added value and potential of becoming high volume products, through moving them into new markets, SMI is capable to compete with the contractual manufacturers. Another possibility is to develop products together with one customer to create value and then use the gained skills for helping these products to reach new markets. Both these methods can be said to use the box of the contractual manufactures for reaching the top-right box.

   For SMI there are two limitations for these actions, first, SMI does not own any products and second, empirics have shown that it is complicated for a small company to operate in different market at the same time. To overcome the first limitation SMI either has to help their customers to find new potential markets for their products or SMI has to identify customers for which they can add value by using their gained manufacturing knowledge for new customers. Both these actions can give SMI the possibility to get volume out of high added value products.

3. *Pull or move products from or via the off-the-shelf manufacturers.* The lock-in effects from the off-the-shelf manufacturers are larger than among the contractual manufacturers, because of the size and strength of the off-the-shelf manufacturers. The off-the-shelf manufacturers are experts on high volume production and their products are price sensitive. SMI's only opportunity to pull products from this box is to become a second source to an off-the-shelf manufacturer; a feasible action for a foundry with high flexibility. To move products through the down-right box is absolutely unlikely for SMI to accomplish, because a foundry is never competitive compared to an off-the-shelf manufacturer when it comes to volume production.

Consequently, the matrix has identified three alternatives for open foundries to get products from the down-left box to top-right box. First, find a killer application which enables a fast move diagonal in the matrix. Second, provide value adding activities to their customers' products in order to move them upwards in the matrix and then find new markets to raise volumes. The final is to provide off-the-shelf manufacturers with second source capabilities. Which one to focus on is strongly linked to the set of resources SMI is in control of and consequently the authors will return to this discussion in Chapter 7.2.

7.1.3 Business Model

SMI's mission incorporates three main value adding activities – *service, innovation* and *manufacturing*. The *service* role consists of using the industrial network at hand and facilitating the development and design of MEMS applications. The *innovation* role is development of products and processes and constitutes the interface between a customer need and the *manufacturing* of the actual silicon structure.

The interaction between the different roles and how customers should be approached can be seen from different perspectives and two possible business models have been derived. The two business models reflect the two different scenarios chosen in

Chapter 4, the model in Figure 7.2 is in line with the large volume manufacturing focus of Scenario I while the one in Figure 7.3 is close to the technology and coordination needs of Scenario III.

The first business model proposed is seen in Figure 7.2 and treats manufacturing as the core activity of the company. Customers only enter via the service channel and innovation is focused on supplying the fab with manufacturing volumes. The final product is always a manufactured unit and when the market takes off and other actors enter the service and innovation segments, SMI will focus the main part of their resources on manufacturing and thereby becoming a pure open foundry.

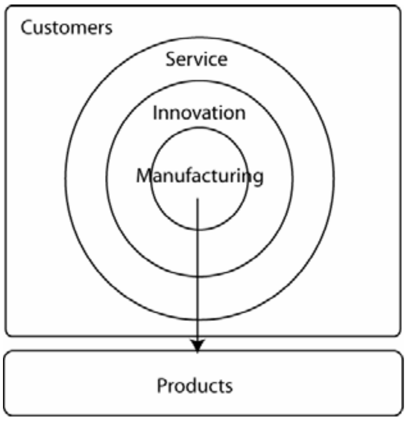


Figure 7.2 Business model with manufacturing as core activity.

The empirics have shown that SMI is fairly close to this business model today but the *service* and *innovation* parts have only been involved in a few projects that have not yet lead to *manufacturing*. Lack of customers that are attracted to the company is a symptom of a *service* unit that is not sufficiently developed and *innovation* has mainly been involved in internal projects with Philips. The strategic risks with this business model are mainly that the price pressure in this segment can become very much stronger and that manufacturing could become more loosely linked to *service* and *innovation* resulting in off-shoring to low-cost countries.

In Figure 7.3 the three activities are seen as independent and all seen as core-activities for SMI. Even though the projects are driven from *services* through *innovation* to *manufacturing*, customers are supposed to be able to enter in any stage of the chain depending on their needs. Customers should also be able to exit the chain at any stage and SMI's final product does thereby not have to be a manufactured unit.

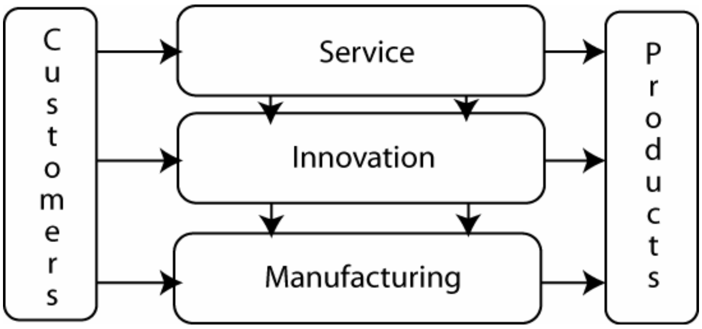


Figure 7.3 Business model with independent activities

A choice of this business model is further from the present situation and would force SMI to strongly develop *service* and *innovation*. The strategic risk in this model is mainly a result of the complexity of the model, SMI will have to master the different activities and also make them work very efficiently together.

The differences between the two approaches are large and the choice between them will have a major impact on the company's future development. The choice is mainly focus versus market size. The first model will be able to be more focused internally and externally whereas the latter will let SMI respond to a larger amount of customer needs. An exposure to different customer needs is of great importance when operating on an uncertain and emerging market. Addressing a larger amount of customer needs however also implies that SMI will face competition from companies with focus on one or more of the activities and will have to be a leading company in all the three areas. Deploying manufacturing as the core activity means that externalization of the other areas are easier than if they are all integrated in the company's core business.

7.1.4 Choice of Product Portfolio

SMI has focused its initial marketing efforts toward the communication sector, a choice of customers that does not come without problems. MEMS applications are believed to add features to mobile phones that will give value to customers and enable the service providers to launch services that will completely change the way consumers use their mobile phones. However, mobile phones are getting smaller and simultaneously filled with more content. The small size as such is not the main obstacle for MEMS solutions, but for a foundry small size implies a small number of wafers to be produced. The prices of mobile phones keep declining and consumers are price-sensitive, as a result the price per chip has to be reduced dramatically from today's levels. A foundry focusing on the mobile market ergo faces the risk to get stuck in the low-volume low-margins dilemma dealt with above. To avoid this position the foundry has to accumulate volumes by having a broad product portfolio that covers all kinds of MEMS, suitable for a mobile platform. Microphones, tilt-sensors, 3D-compasses and some other applications believed to be found in tomorrow's mobile phones have the potential of being some of the first industry-crossing MEMS killer applications. A silicon microphone could replace the standard microphone in any audio device found on the market today and thereby augmenting the volumes and eventually make it an off-the-shelf product.

With the credibility of having Philips as a large stakeholder, SMI could become an attractive supplier or second source for one of the large mobile phone manufacturers and thereby having the possibility to develop modules and processes suitable for producing these applications.

The choice made to approach the communications market is not excluding an entry on other markets. The medical market, that SMI is glancing towards, is not as price-sensitive as the communications market and the volumes are believed to rise over the forthcoming period of time. However, the quality demands in the medical applications market is extremely high and a company that has not showed their abilities in manufacturing and quality processes is not likely to succeed in getting orders.

The automotive market is a market with producers that already are very aware of the advantages with MEMS and SMI would therefore not have to invest as much effort to improve customer awareness as in other markets. Still, the competition in the automotive market along with the high quality demands make an entry on the market difficult, unless having a collaboration with a company already present as a supplier to the automotive market.

7.1.5 Market Pull versus Technology Push

A company could use a technology push and develop new solutions that they think will solve customers need or choose to pay attention to the needs that really exists on the market and focus their research to try to solve these specific problems. The two approaches both have advantages and draw-backs that normally make it hard to find the perfect mix between them. Since the general idea for a foundry is that it does not own or develop own products, SMI will be dependent on a strong market pull. The ideal situation would be to be approached with ideas, concepts or complete blue-prints from customers that then could be transformed to silicon structures. In order for this to work, customers have to be aware of the potential of the MEMS technology and of SMI as a competency within this industry. This is currently not the case and SMI is situated in a difficult position where the technological push has to be transferred to a market pull.

The technological push has however not been able to open the customer's eyes for this new technology and SMI's sales force will have to act as a middle-hand, identifying customer need and helping them to realize when a MEMS solution is appropriate. Concurrently, SMI will have to continue to develop their technologies to answer to identified customer needs and to generalize solutions to different environments and different industries. SMI already has the engineering force needed to be involved in development projects and push technologies to more than one market and is therefore now in need of a sales force that has the ability to guide the customers and identify new business opportunities.

The question of technological push versus market pull is closely linked to the company's position in the value chain, the further away from the end customer the harder it will be to recognize their needs. SMI has chosen a position that is relatively close to the end-users of the systems and considering that the company will need to put a lot of efforts on dealing with issues concerning the present position, an expansion in any direction would not lead to improved performance of SMI.

7.2 Vital Resources for Competitive Advantage

As argued in Chapter 5.4.2 all the most important resources are, in this rough classification, *human capital resources*. For a start-up company with production facilities in place this is not an unexpected result. Since the main part of the *physical capital resources* have been developed in the semiconductor industry, they are not difficult for a company to acquire and will thereby not give a company a competitive advantage. The novelty of the industry makes the benefits of *organizational capital resources* less important, when the market has settled and competition increases these resources will be increasingly important. Two *organizational capital resources* that strongly influence SMI's position in the market are further discussed in Chapter 7.2.6.

How the most important resources will support the value creation in the company depends on what business model the company chooses to pursue. The first business model, seen in Figure 7.4, treats manufacturing as the core activity and manufacturing and process skills will therefore be the foundation for the business made. Other resources are formed in a *resource pyramid* where customer projects will be driven by the resources from the first to the fifth resource. All resources will have to be strengthened, but only treated as facilitators for the core activity. It is however imperative that the strong links between *service, integration* and *manufacturing* are kept, otherwise SMI's strategic position is seriously threatened.

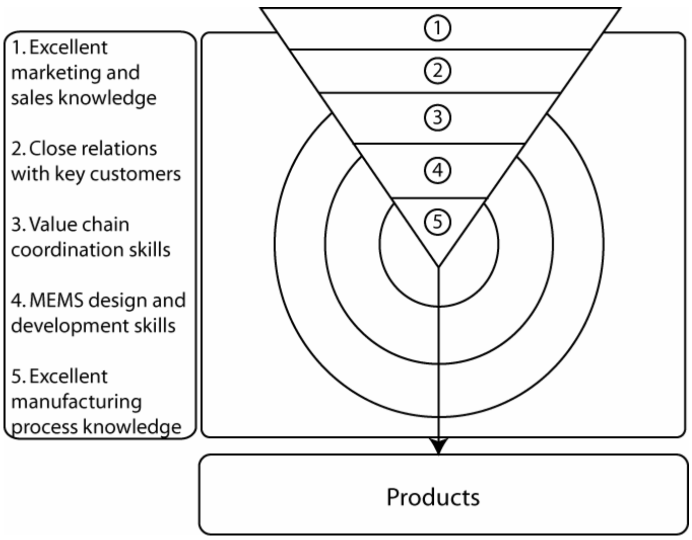


Figure 7.4 Linkage between the resource pyramid and the business model with manufacturing as core activity presented in Figure 7.2.

As seen in Figure 7.5, the third to fifth resource will be the foundation for the core businesses in the second business model. This makes them equally important and they will have to be focused on simultaneously and thought of as long-term business processes. The first and second resources are facilitators for attracting customers in to one of the activities.

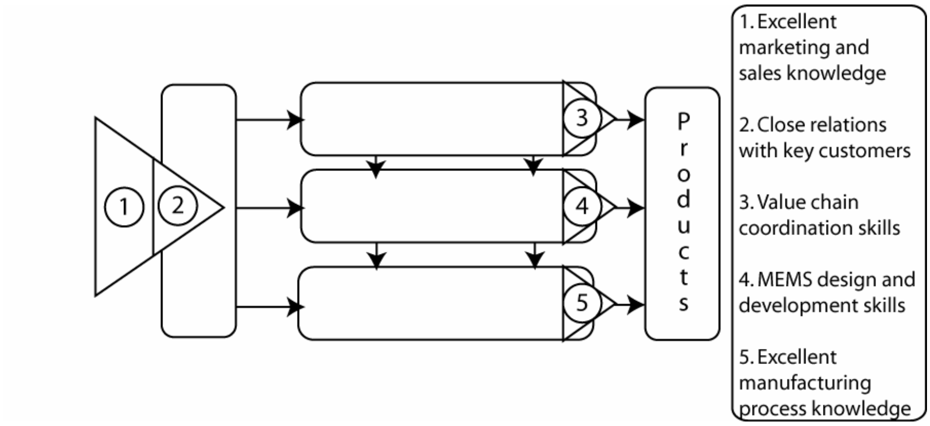


Figure 7.5 Linkage between resources and business model with independent activities presented in Figure 7.3.

In both models, the marketing and sales skills and the relations with key customers are essential to get customers into the system. The customers will be offered different products in the two models and will have to be approached differently.

7.2.1 Close Relations with Key Customers

SMI is currently in need of profiling the company on a customer market and they need to obtain volumes in order to gain and prove manufacturing knowledge. To do this, a customer with a strong position in the industry must be addressed by SMI. The company should have enough resources to be able to provide expertise in areas that combined with SMI's knowledge in silicon structures can constitute fruitful development projects. The efforts needed to develop a working MEMS application makes it impossible for a company of SMI's size to undertake projects with a large number of customers. Still, the uncertainty of the market makes a too narrow customer portfolio associated with large risks and a well-balanced portfolio consisting of both development projects and pure manufacturing is crucial for SMI. Concerning the choice of market, discussed in Chapter 7.1.4, the authors believe that SMI should focus on one market since close relation with key customers will be easier to obtain with this focused approach. The markets are not by any means saturated by MEMS-products and business opportunities will be found.

There are different categories of customers that could be possible to attract to SMI. As seen in Figure 7.6, the customers could have both service needs and manufacturing needs. Companies with large service needs but small manufacturing needs are likely to be niche players that enters the MEMS market and need help with translating ideas into silicon structures that will not initially reach a high volume market. To provide second sourcing or supplying MEMS system manufacturers with silicon structures will not call for large efforts in terms of services, but the manufactured volumes could be high. The most profitable customer to attract would be a large company that have lacking knowledge in MEMS and therefore wishes to be provided with services and also will reach a high volume market. For these customers, SMI would add a lot of value and could consequently benefit from large margins on the products. A customer from this segment would also help SMI to promote their capabilities as both a service provider and a manufacturer.

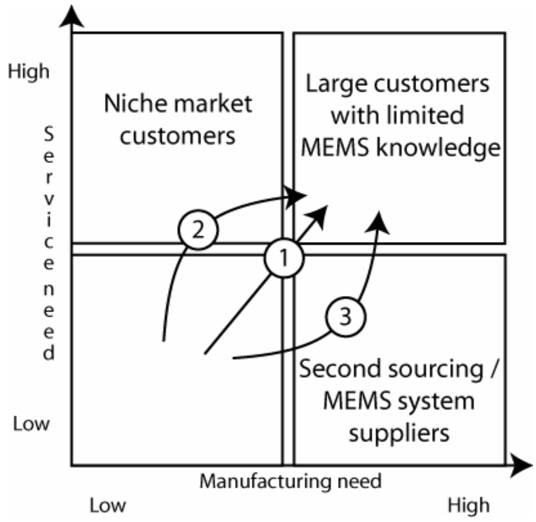


Figure 7.6 Potential customer segments for SMI, categorize by service and manufacturing needs. Arrows symbolize possible movements in the matrix and follows the numbering in table below.

The methods for attracting customers from the different segments and moving them to the profitable top-right box are diverse and put different demands on SMI. The paths according to Figure 7.6 are described as:

1. *Attracting killer customers directly*. SMI has the rare resource of having support by Philips and close relations to the Fraunhofer Institute which gives them the possibility to follow this path. Many other foundries will find it extremely hard to enter this segment directly. Even with the mother company's support, SMI will have to take full advantage of their experienced management team and industrial network to access these customers. Attracting customers from this segment will take up a lot of the sales and engineering unit's time. Due to the time-consuming process of getting these customers, SMI should focus their resources on a very limited number of

customers from this segment. Many large customers are also likely to be reluctant to collaboration with the same supplier as their competitors have and focus is essential.

2. *Attracting niche players and raising their manufactured volumes.* Low volume niche players are likely to be easier to attract than the large killer customers. The low volumes will however not fill up the fab and SMI will be dependent on a successful commercialization of the products in order to get the capital invested in the development back. The ability to undertake cost-efficient and fast development projects will be a key competency to get contracts from this segment. The commercialization of the products will not always be successful and hence it is important that SMI spreads the risks by conducting business with a number of companies concurrently.

3. *Supply MEMS system manufacturers or act as second sources.* Without having proved the manufacturing capabilities, customers from this segment will be difficult to approach. The credibility from the Fraunhofer Institute could help, but they have no experience in large volume manufacturing. A customer from this segment will also not be easily moved to the top-right box, since they already have internal knowledge in MEMS and the service needs are likely to continue to be low. A customer from this segment could be beneficial for getting a positive cash-flow that could be used to develop relationships with customers from other segments. The low service needs enables SMI to take on customers from this segment as soon as they have free production capacity.

Due to the highly random emerging of killer applications, the focus should not initially be to find a killer application but to find a killer customer. The ideal customer would be a large company that encompasses all the above mentioned categories. The sales efforts put in to the customer will then result in upcoming niche products, development projects for large volume application and second sourcing of present applications. This killer customer should preferably develop systems that potentially could include a number of different MEMS applications. Having such a customer from would give SMI access to both a new industry and to new technologies and give them more credibility as an open foundry and thereby be a highly *valuable* resource.

Having a close relationship with a killer customer is a *rare* resource on the MEMS market since only a few of the large customers have an explicit strategy for MEMS and the suppliers are too small to be attractive to the large actors. Over time, the resource certainly is *imitable*; every large company will have a preferred MEMS partner if the technology becomes successful. The resource can however lead to a temporary competitive advantage and is thereby very attractive for SMI. The scope of the relationship with a killer customer will decide whether the resource will be *organized* and if the foundry can capitalize on it.

The ability to have a balanced customer portfolio, with customers from all the different segments, is easier if choosing the business model with independent activities. The option to only sell services or only manufacturing increases the addressed market's size.

7.2.2 Excellent Marketing and Sales Knowledge

Customers will have to be approached by a strong marketing and sales department. The sales process will not be an ordinary straight forward sale. Instead it will be a process where SMI promotes them selves as an expertise rather than their products. What product that will be the outcome of the collaboration will only be evident after discussions with the customer. To be able to make a contribution in these discussions, application managers have to be familiar with the technological constraints and possibilities present but also have strong capabilities regarding the understanding of the customers' products and where SMI could add value to them.

This resource is extremely important to gap the current void between the technological push and the market pull and is mainly strengthened by having more employees with sales and marketing tasks. Although *valuable*, the resource can not be said to create a sustainable competitive advantage, since all company is likely to obtain it. The resource is more of a qualifier to even be present on the market and an enabler for the company to capitalize on other resources and hence very important to acquire.

Customer awareness could be increased if a killer application emerges on the market and changes the performance of a category of products. A killer application is more likely to appear if the customer awareness is large and SMI will therefore have to work actively to increase it. Informing companies about the potentials and benefits of using MEMS will be one of the main tasks for a sales and marketing unit. Any efforts to augment customer awareness of MEMS will also benefit SMI's competitors. Stronger positions for other actors in the market will help drive the interest and the industry will have to join forces to promote the technology and not worry about competitive positions in this initial phase.

The sales unit will have to approach customers with different products depending on which business model that is chosen. It will be easier to focus when mainly selling manufacturing capability whereas they will have more customers to approach when selling project management and other service and innovation products. From sales point of view, the ability to offer a strong service organization to their customers is important in both models.

7.2.3 MEMS Design and Development Skills

MEMS design and development skills are tightly linked to human capital resources; engineers with the knowledge of MEMS development are essential for a foundry. These kinds of engineers are today a *rare* resource that is hard to *substitute* and could thereby, if they are *organized* to enforce the strategy, give the company a competitive advantage. With a growing interest from universities in educating MEMS engineers, it is not likely to believe that it will be a sustainable competitive advantage to possess this resource.

Being a core activity in one business model and very closely linked to the core business in the other one, this resource is *valuable* for SMI to possess no matter which business model that is chosen.

With their early entry on the foundry market, SMI has the possibility to be a part of the evolution of standards. In order to be so, the technological developments have to be superior to those made by other foundries. Market penetration of the solutions is also important if the technologies should become standards. Large customers could be one way to mission the technologies to the market. Another way would be to collaborate with other strong actors at the MEMS market and thereby be part of a forceful coalition that would have large impact on the industry as whole. The third way would be to acquire second source contracts that will allow technical standards to migrate between the different sources and thereby successively setting standards.

7.2.4 Value Chain Coordination Skills

If choosing the business model with *service, innovation* and *manufacturing* as core businesses, value chain coordination skills can no longer be regarded as only important as a facilitator for getting contracts. This resource is then a part of the core business and has to be developed accordingly. Skilled engineers are a necessity for getting the birds-view look on the value chain to be able to understand the difficulties in every part. These da Vinci-like engineers are likely to be *rare* and difficult to *imitate* for a long period of time. A way of acquiring this resource would be to let already skilled engineers work in development projects with other actors in the value chain.

If the other business model is chosen, it is not necessary to have this resource internally. An alliance with a system integrator will give SMI the opportunity to focus solely on manufacturing issues and customers in need of coordination are directed to the partner. The MEMS commercialization and industrialization knowledge will be vital in both models and can only be fully developed and proved by taking on MEMS-projects.

7.2.5 Excellent Manufacturing Process Knowledge

Due to the managements' experience from the semiconductor industry and the collaboration with the Fraunhofer Institute, SMI has good knowledge in MEMS manufacturing processes. To this date they have no experience in large volume manufacturing of MEMS and the only way of obtaining this is to reach a larger customer base. High-volume manufacturing experience would give SMI a resource that at the moment is quite *rare* but the threat of imitation is significant; a lot of the knowledge is transferable from the semiconductor industry and any entry from a large semiconductor company would soon reduce the competitive advantage. The same discussion is applicable for the operators; any company that gets high-volume contracts will have the opportunity to develop their operators.

The development of modules is closely linked to the approach to technological push versus market pull. Either SMI decides to develop modules that they believe will be successful for attracting different customers or they let some large customers guide the development of modules. The benefit of the first option is that SMI will have a set of modules suitable for a large number of customers. The benefit of the latter is that they can be sure that the developed modules will be suitable for the large customers.

Focusing on the mobile communications market also forces SMI to have a very cost effective fab and companies that can retain their flexibility without having higher prices are the ones that will succeed on the MEMS foundry market. New process equipments are currently being developed by machine producers that aim at enabling a new approach to manufacturing of both MEMS and semiconductors. The machinery is said to largely reduce the investments needed in a fab, but still be flexible enough to be competitive in medium-volume foundries.

Out of the five resources mentioned as the most important, the authors consider manufacturing and process skills to be the one where SMI has the best position at this moment. According to Barney, the strategy should be focused on capitalizing on this resource and for a foundry this capability will be the foundation for all business made. Being the basis of the company's strategy, this resource will have to be the main argument both for acquiring investments and customers. However, it will be impossible to fully capitalize on this resource if SMI does not have an in-house production plant since the customers will not connect the skills with SMI but with the company housing the production.

7.2.6 Organizational Capital Resources

Apart from the resources that were high-lighted in the scenarios some others are worth mentioning. The strong links to Philips have been argued to be a key resource when it comes to opening channels to large customers. The access to Philips internal market, their IP-portfolio and their expertise in a large number of technological markets is also factors that make this resource very *valuable*. There are quite a few companies that are spin-offs from larger companies, but in general this resource has to be considered as very *rare*. It is also a resource that is virtually impossible to *imitate* and, as long as the trend that large companies refuses to buy products from small start-ups, it will not be *substituted*. The only obstacle from transforming the resource to a sustainable competitive advantage is to have it *organized* in a way that it strengthens SMI's strategy. During the case-study, evidence has been seen that the resource is not properly organized and even though exchange is being made between the two companies it is not sufficient. Lack of overall MEMS-strategy within Philips is the main factor preventing the resource to be used properly.

Another resource that will be valuable and hard to imitate is the level of experience found with SMI's management team. University spin-offs or regular start-ups in the foundry business will not have the credibility towards investors and customers that SMI enjoys. The business relation networks of the managers will open doors to customers that would otherwise be closed. The experience from senior levels in a global company also allows SMI to immediately work on a global market and they will not face the same risk of being unfairly exploited in a strategic alliance as a less experienced team would do.

7.3 Acquiring Resources through Strategic Alliances

Chapter 7.1 SMI in the MEMS Market presents two alternative business models suggested by the authors, both adopted from empirical findings and also balanced with given theory. In Chapter 7.2 both models are extended with the key resources from the Scenarios. These two business models will also strongly affect the discussion about strategic alliances and private equity, since the future funding strategy is to a large extent influenced by which of these two models SMI choose.

Due to the large set-up costs for a strategic alliance, the leverage on the used effort will be quite low when acquiring certain resources; few companies form strategic alliances to obtain base resources. The more complex the resources get, the higher the leverage of the alliance. Since not everything can be bought on the open market, a company that is willing to share their complex internal resources with the partner will be a very desirable ally.

Strategic alliances could be formed with companies from all the different fields of the value chain and with all business models mentioned in Figure 3.1 and also with customers. Two general alliance structures have been derived based on the two business models and are seen as the most appropriate solutions for funding through a strategic alliance.

7.3.1 Business Model with Manufacturing as Core Activity

The business model with manufacturing as core activity is in many ways suitable for a strategic alliance. First, the upper part of the *resource pyramid* has to be strengthened to be able to attract customers. Second, if SMI is focused on manufacturing; complementary activities can be performed in an alliance without affecting the core activity.

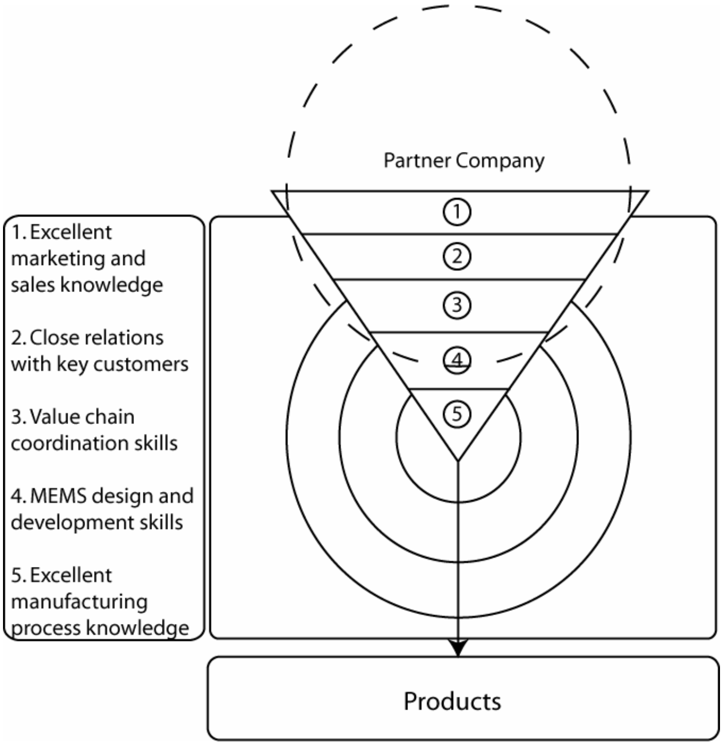


Figure 7.7 Proposed alliance structure in combination with the business model with manufacturing as core activity.

Reasons for Forming the Strategic Alliance

The value creation in an alliance with the core activity business model occurs when SMI finds a partner in need of production capacity. This type *co-specialization* alliance helps SMI both to access new markets and building new business. As seen in Figure 3.1, a partner could be either a system integrator or design-houses in need of production capacity. A partnership with a system integrator is a forward integration that would enable SMI to benefit from the market pull that the integrator has established. There will be a large difference in the amount of value added by the alliance depending on whether SMI gets a first or second souring relationship to the partner. A first sourcing contract will make SMI a far more integrated part of the alliance network and give SMI the opportunity of learning and internalization; value coordination skills as well as marketing and sales knowledge are strengthened and able to be used on other markets and customers. A second souring contact with a large system integrator will not give the same opportunities and therefore a deeper collaboration is both unlikely and undesirable.

Partnering up with one or many design-houses in different niches could increase SMI's chances of finding and contracting a killer application. The application is traded through the design-house's customer channels and SMI would contribute with manufacturing capabilities and process knowledge. An early involvement from SMI's technicians would also ensure that the design-houses had manufacturing in mind when they develop the applications. This would shorten the development cycles and improve the quality of the products.

Setting the Scope of the Strategic Alliance

The *strategic scope* of an alliance with this business model is defined by the market addressed by the allied company. SMI will therefore be able to conduct business on markets not coved by the strategic scope and successful operations on other markets will decrease the strategic risk faced by SMI. If the allied partner enlarges their product portfolio, SMI will likely get the production contract and the strategic scope is therefore expanded.

The *economical scope* will have many similarities with a traditional customer – supplier pricing mechanism. SMI must be prepared for a fluctuating demand and need to have a flexible organization to be able to fill up the fab with external customers in times of low demand for the alliance's products. A large amount of trust between the partners is also needed to avoid costly transfer pricing and revenue share discussions. Since this business model only will have a manufactured unit as the transferred product, the economical scope will be less complex than in the other proposed business model.

The interface in the *operational scope* of the alliance will initially consist of collaboration within the resource of MEMS design and development skills. A system integrator or a design-house will develop customer specific MEMS solutions that SMI prepares for production. As the alliance grows stronger the operational scope can be extended to include joint market operations. This motivates a deep collaboration, such as a joint venture or a partnership.

Acquiring Resources

Enhancement of the resource pyramid plays an important role in the creation of an alliance with this business model. The more resources the alliance incorporates the more value is created in the alliance, since all the resources are vital for success in the MEMS market. SMI is currently in control of the fifth resource in the pyramid. Without very strong manufacturing process knowledge, SMI will not have the ability to provide enough in the alliance. An in-house production plant will eventually be necessary to have and will also help to set up a mutual dependency in the alliance that will make it rigid and likely to be long-lived. Through the cooperation with the Fraunhofer Institute, SMI is able to organize the fourth resource in the pyramid. MEMS design and development skills will be an important resource to strengthen internally since it will constitute the interface in the alliance. SMI's expertise in this area will have to be further developed and adapted to the partners need. The relatively low added value that manufacturing provide augments the importance of having the resource internally and capitalize on it. SMI will then need a partner with the three remaining resources. Otherwise, absent resources must be developed by either SMI or the partner company.

The alliance gives good opportunities to learn and transfer resources from the pyramid to SMI, especially if having a first souring agreement with a system integrator. Then SMI will become a part of a larger network which will expose SMI employees to challenges in marketing and sales, design and development as well as value coordination skills. This can let SMI gradually develop the resources and allow a future transition to the second business model proposed by the authors, if they find reasons to do so. The transition can then be made on markets not addressed by the partner company and SMI's position could grow stronger.

Profile of an Appropriate Partner

As stated before, SMI must be considered as a new-comer in the MEMS market. This gives two possible alliance formations in combination with the business model with manufacturing as core activity, either a *new comer – new comer alliance* with focus on *co-specialization* or a *new comer – leader alliance* with focus on second sourcing. Since second sourcing does not constitute a strong basis for a strategic alliance, this will not be further discussed.

A *new comer – new comer* alliance should be an alliance with a system integrator or a design-house. The authors are convinced that SMI has to get closer to the end-customer and that SMI should act as a bridge between the technological push and the market pull. The technological push is already strong in the market and forward integration will be the best way to bridge the gap to the market. A system integrator that is specialized on integration and coordination in the value chain is therefore the most appropriate partner. The partner will have to have a strong customer portfolio and high growth potential since SMI's success initially will be very dependent on the growth of the partner.

Another important aspect on the alliance partner is their financial situation. Alliances including equity transfers between the companies are by theory more likely to succeed and can support SMI's future funding. Finding a *newcomer* with a financial situation that allows them to invest in a majority share of SMI will however be difficult. Since very few new MEMS companies have succeeded to reach a strong positive cash-flow, SMI will have to rely on attracting a partner that has received venture capital or has a strong mother company as a financer. A joint construction of a fab could be a way of handling the equity transfer; since it is then obvious what benefits the partner company would get from the invested capital.

Difficulties and Risks

Without yet proven production capabilities SMI have to convince a partner of the given quality and the importance of their strategic position. SMI's experienced management team and the creditability of Philips will play a vital roll in the process. Official certifications and customer qualities approvals can also help SMI to appear more attractive to potential partners. In an alliance with a new-comer, SMI is exposed to the same uncertainty concerning partner. It is therefore important for SMI to continue activities on markets not affected by the alliance to hedge risks.

Exiting the Alliance

This alliance has the potential to be a rigid and long-lived alliance, especially if an equity transfer is involved. A complete acquisition by any of the partners is a potential exit that does not necessarily need to be the end of the collaboration between the involved companies. Should SMI succeed with their strategy and become a large foundry on the MEMS market, an IPO could be a lucrative exit for the partners and SMI would have the possibility to further scale up their business.

7.3.2 Business Model with Independent Core Businesses

The authors strongly recommend that the core businesses of SMI is not fully integrated in an alliance since the company then would risk to loose its identity and be very vulnerable in case of a failure for the alliance. When aiming at developing *service*, *innovation* and *manufacturing* as core businesses this obviously limits the possibilities for a strategic alliance. The proposed alliance structure can be seen in Figure 7.8 and is an alliance between SMI and a key-customer.

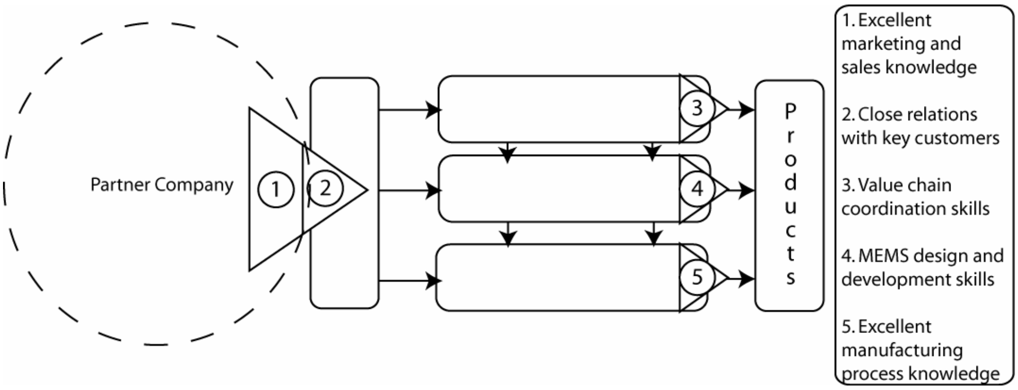


Figure 7.8 Proposed alliance structure in combination with the business model with independent core activities.

Reasons for Forming a Strategic Alliance

An alliance with a key-customer would enable a stronger pull from end-customer needs, a factor that is imperative for the success of this business model. The value in this form of alliance could be derived from *co-specialization, internalization and learning* and *co-option.*

The key-customer will be able to contribute with their knowledge about the technology behind the produced systems and combined with SMI's MEMS knowledge the *co-specialization* value in development projects is evident. Above this, manufacturing needs and fab capacity are complementing factors that will create value in the alliance.

SMI could also gain value from an indirect *internalization and learning* process by taking part of large customer projects. These would expose SMI to challenges from all of the three core businesses and their experience and competencies in these fields would increase dramatically. The partner company would gain value from learning more about the potential and benefits of using MEMS in their products.

The partner of SMI would get *co-option* value from having a feeler in the MEMS industry and thereby hedging its technology portfolio against the risk of losing ground to its competitors if MEMS should become a key technology for the products. The possibility for SMI to develop long-term technological roadmaps can also be seen as value creation through *co-option* since SMI would become more effective as a supplier and increase the accuracy in their forecasts.

Setting the Scope of the Strategic Alliance

The *strategic scope* of the alliance is in Figure 7.8 proposed to be a close customer-supplier relationship and will only cover the products that are jointly developed by the partners. This enables SMI to be active with other customers as long as the key-customer does not oppose. To propose an *economic scope* in these kinds of alliances has historically shown to be difficult. The main challenge consist of deciding on a fair transfer pricing since it will be difficult to assess how much of the development that has been carried out by the different partners. The *operational scope* of this alliance will mainly include joint development projects and sharing of market intelligence. Expansion of the different scopes will only be possible in terms of more products.

Acquiring Resources

The most obvious resource that will be strengthened by this form of strategic alliance will be the close customer relation that will be the direct outcome of the alliance. Marketing and sales skills are not likely to be affected by the alliance but enforcing this resource is currently mainly a question of employing more personnel that can act as application managers. An alliance involving equity transfer would let SMI spend more money on wages and building up the sales unit. The customer awareness can however be increased if a large company enters a partnership with SMI.

The three core businesses and the belonging resources seen in Figure 7.5 are not included in the alliance, but will be strengthened nevertheless. To develop these resources, SMI needs exposure to the challenges of the fields and this will be provided by a close collaboration with a key customer. The market pull approach of the alliance will also assure that these key resources will be well adapted for dealing with the customer market.

Profile of an Appropriate Partner

The partner company should be a company that fits in the description of a killer customer presented in Chapter 7.2.1. The manufacturing needs of the partner will help to strengthen the manufacturing process knowledge while the service needs will help SMI developing their value chain coordination skills and their MEMS design and development skills. To reduce the risk of being dependent on the success of a single project it is also important that the customer potentially will integrate a number of MEMS systems in their products.

The company should be very close to the end-customers to maximize the benefits of the market pull. A partner that is a leading customer in their market is also desirable since this would open the door to a large number of other customers in the industry.

The purpose of this thesis is not only to acquire resources to SMI; it is also dealing with the reduction of Philips' ownership. A strategic alliance will not fulfill the purpose unless it involves an equity transfer or is combined with a private equity investment. To convince a killer customer to invest in SMI will be difficult since the customer is in a very strong position and could get the same type of collaboration with any MEMS foundry, without having to do an investment.

Difficulties and Risks

SMI is a small company that has yet to prove their capabilities and to convince an appropriate partner join the partnership will be the main difficulty. To convince the customer to make an equity transfer and become a majority shareholder in SMI will be even more difficult. The incentives for a partner to make an investment in SMI are small and the alliance will not need this level of integration to succeed. Having a customer as a majority shareholder will also have a serious impact on the view of SMI as an independent foundry. If SMI wants to continue with the strategy of not owning or developing products they will have to construct the alliance in a way that the border between the partner and SMI is clear and to always transfer the ownership of products out of the alliance to the partner.

As stated in the theory, alliances between leaders and newcomers are associated with some difficulties. SMI will have to be aware that they risk being dependent and exploited by the larger partner. These risks could be mitigated if an equity transfer is realized since the development and growth of SMI will also give a positive return on investment for the partner.

Exiting the Alliance

Changes in the business environment or internal factors will almost certainly make the alliance to eventually come to an end. The impact on SMI will be dependent on how well they have managed to attract more customers besides the partner and on what kind of exit that is made. A complete acquisition by either Philips or the partner is possible and does not have to change the relation to the selling partner in terms of business exchange. An IPO is also a possible and attractive exit scenario that could be used as an argument to attract a potential partner; by helping SMI to grow during the years of the alliance could make them a world leading MEMS company, highly valued on quotation.

7.3.3 SMI's Possibility to Attract a Strategic Partner

SMI will have to convince a potential Strategic Partner of their strong strategic position to be attractive for a partnership. The partner company will probably not enter the venture only because they expect high returns on the equity transfer and if they do, the strategic fit between the companies is low and the alliance will probably not last for long. It will be more difficult to attract a partner based on the business model with independent core businesses since the value created for the partner is not as evident as in the other proposed alliance.

7.4 Acquiring resources through Private Equity

Most of the lacking key resources are, as stated before, human capital resources. Although scarce, the main part of them could be acquired directly by equity in form of wages and other investments. The impacts of private equity will differ depending on which of the business models that is chosen. Still, the authors also believe that the adopted business model to a very large extent will affect SMI's ability to attract private equity. If SMI would like to use private equity as funding, the most attractive business model for a private equity investor must be chosen.

7.4.1 Private Equity and Business Models

The first business model that rests solely on SMI's ability to manufacture MEMS and to develop this ability an in-house production plant will eventually be needed. The large investments needed to erect a modern silicon fab makes it virtually impossible to acquire enough capital only through cash-flow from products made in the fab they have access to today. A large investment will hence be needed at some stage. No investor will consider making this substantial investment in SMI until the potential of their business model have been shown and that the returns are expected to be large. It is therefore imperative that SMI start enforcing the other resources needed to attract customers and to take part in MEMS development projects. As stated in prior chapters, a strategic alliance is likely to strengthen these missing resources and therefore should not a private equity funding for this business model be sought until an alliance is in place. This business model is not attractive enough without control of the complete *resource pyramid*, since an investor is much more interested of the returns then the strategic position of SMI.

The second business model on the other hand has a larger market potential, is more aggressive and thereby more attractive for a private equity investor. The market potential is greater due to the larger amount of customers that can be addressed; *service, innovation* and *manufacturing* capabilities let SMI compete for a larger piece of the growing MEMS market. As highlighted in the theory, market size and growth as well as potential market share is the most important factors considered in a due diligence. Hence the second business model is the most appropriate when approaching private equity. The obtained capital should initially be used to strengthen the marketing and sales skills to be able to attract customers. These customers will help SMI to further the resources connected to their core activities. Eventually SMI will have a market position attractive for an alliance with a potential killer customer. A combination of a strategic alliance and private equity is from the authors' point-of-view a viable funding solution for SMI. Who to address first will be dependent on the choice of business model though.

7.4.2 Resource Enhancement by Private Equity

A close relation to a key customer cannot be bought with capital and will therefore not be directly affected by a capital injection. Venture capitalists typically have large industrial networks, but it is unlikely that these networks are more useful than the ones already found with SMI's management. A venture capitalist is mostly involved in smaller business ventures and has therefore few contact points with the large companies that are believed to constitute SMI's customer portfolio. Marketing and sales skills on the other hand is very suitable do enhance through capital; the recruitment of sales personnel is vital for the success of SMI. The value chain coordination skills and MEMS design and development skills will be difficult to strengthen through capital, more employees in these fields would scale up the company but they will have to be involved in customer projects to get the needed training and become a resource that will give a competitive advantage.

The discussion on leverage on the efforts used in the resource acquiring is interesting for private equity as well. Basic resources that are, in their complete form, available on the open market are likely to be obtained directly through capital investments. More complex resources will have to be further developed internally if they are acquired through private equity and the effort of developing them should be less significant than to set up an alliance to acquire them if the use of private equity investment should be considered. Consequently, different resources calls for different funding strategies and a mix between the two identified methods could be applicable.

7.4.3 Attracting Private Equity on the German MEMS Market

Private equity is returning to the German capital market and evidence from other countries show that MEMS companies have attracted investment during 2004. Although the private equity market situation is positive, SMI still has to convince investors that their business model is profitable in the next years. With a high perceived quality of the management team as well as their experience and entrepreneurial knowledge SMI should be able to convince an investor about their outstanding strength as a MEMS foundry. The flexible manufacturing contract with the Fraunhofer Institute and the connections with Philips also strengthen their position against other foundries trying to get funding. The big issue for SMI is however to prove that the MEMS market is ready for pure foundry capabilities. Private equity investments in other markets is long-term beneficial for SMI; investments in bio-tech and high-tech companies will eventually increase the demand for MEMS solutions.

7.4.4 Profile of an Appropriate Investor

SMI will find it difficult to find a single business angel that is willing to invest the amount of capital needed to take a majority share in the company. If a larger number of business angels could be found within the management's networks this could be a viable solution, but the most likely solution is to get funding from a venture capital fund.

Since SMI has an experienced management team, the provided capital from the venture capitalist will be far more important than the other resources an investor can contribute with. Therefore all funds with fitting investment strategy are appropriate. This will obviously expand the search field but funds with prior knowledge from the MEMS market should be approached first; these funds are more likely to invest in SMI.

7.4.5 Difficulties and Trade-offs

SMI will have to be prepared to make some sacrifices of their strategic freedom if collaborating with a private equity investor. As argued above, only one of the business models will be attractive enough to receive funding from private equity investors and there are therefore inherent strategic limitations when choosing private equity as funding model. Board positions will also most likely be assigned to the investors and this will have impact on an operational level of the company's decisions. The experienced management team of SMI is not likely to be replaced in a first round equity investment.

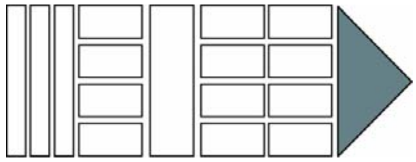
Due to SMI´s investment plan, where manufacturing capabilities will be gradually expanded, a staged investment does not constitute a problem for SMI. However, there are examples of foundries that have received large initial investments, sufficient for a complete fab. A staged investment could although be a problem for Philips since they would be majority share holders for a longer period of time. As stated in the theory, it is also uncommon that a venture capitalist takes a majority share of the company and a pure venture capital funding that solves Philip's risk reduction ambitions will be difficult to find.

7.4.6 Exit from the Investment

A venture capitalist will try to drive the company to an IPO since this is the far most profitable exit. All venture capitalists are aware of the fact that portfolio companies very seldom can be publicly quoted and a sell-back to Philips will be considered as a good exit. A complete divesture to an external part is less likely since the information asymmetry will be large and thereby also the investment risks.

8 Conclusion

The conclusion chapter contains the authors' recommendations for solving SMI's sort and long term funding. The purpose of the thesis is answered through connections to the analysis chapter. To be able to summarize the discussion and use findings from different parts of the analysis the sub-chapters are not kept.



8.1 Strategic Consequences of Using a Strategic Alliance

SMI is lacking a number of important resources that will be crucial for their success as a MEMS foundry. Five key resources have been identified whereof SMI is in control of the most fundamental; manufacturing and process knowledge. All the other resources will need to be strengthened and this can be done either through a strategic alliance or via a private equity investment. How the resources are acquired and how they are organized will have a strong strategic impact on the company's future development and this impact have to be in line with SMI's strategic ambitions.

To show how these resources can be organized, the authors have derived two different business models. One links the resources tightly together to let customer needs be transformed into manufactured units whereas the other organizes the resources more independently and the outcome does not necessarily have to be a manufactured unit.

If a strategic alliance is chosen as funding model for SMI, the business model with manufacturing as core activity is the most appropriate model to adopt. SMI has an important strategic position in the market, a crucial factor for forming a strategic alliance. The partners in the alliance will be focused on obtaining similar goals and the exchange surface will be large. The value creation in the alliance will also be equally beneficial for both partners and a jointly constructed fab is a potential way of motivating the equity transfer. SMI will also have the possibility to strengthen internal resources by learning from the partner and use this new knowledge on other markets.

8.2 Strategic Consequences of Using Private Equity

The nature of the key resources makes them possible to strengthen through capital investments and private equity is therefore a possible funding model. Business angels do not have the financial strength to take a majority share of SMI and can only be seen as supplementary investors. These supplementary investments will however be very important since marketing and sales knowledge focused on complementary markets is a resource that will benefit from good leverage on capital investments. Venture capitalists would be attracted by SMI's experienced and well-balanced management team but the demand for large returns on investments calls for an aggressive business model. The market size and potential market share is larger for the business model with independent core activities and this model would have to be adopted if SMI wants to receive venture capital funding.

8.3 Recommendations for Funding Supporting SMI's Growth

With the position and the resource portfolio currently found with SMI, the authors recommend SMI to adopt the business model with manufacturing as core activity. This business model takes full advantage of the strong process knowledge found with SMI and it is in manufacturing that the majority of a foundry's value will be added in the future.

This business model relies on a strong strategic alliance to be successful and this is therefore the recommended funding model. A strategic partner should be a system integrator with strong internal MEMS-knowledge that is in need of manufacturing capability. The partner should be established on an attractive market and have a strong customer base. The partner also need to have good knowledge in the first three resources of the resource pyramid and be willing to conduct MEMS design and development projects together with SMI. Joint marketing and sales efforts and market building actions will also be a part of the alliance operational scope.

In order to attract a suitable strategic partner, SMI will have to reinforce their strategic position and communicate their vision and goals to potential partners. Concurrently SMI has to benefit from a closer relationship with both Philips and the Fraunhofer Institute. Apart from their manufacturing knowledge, these connections can help SMI attracting a strategic partner.

With a successful alliance in place and growing demand for MEMS products, SMI will reach a level of maturity attractive for a venture capitalist. Having financial support and strengthened set of resource from the alliance, SMI can restructure their activities and enter new markets with a business model with independent core activities. This allows SMI to address a larger array of customers and reach a higher market share.

SMI will have to be careful to not find themselves in a dependency position towards the partner company and should continue to work actively on markets not covered by the strategic scope of the alliance. At the same time, SMI should never take advantage of the partner's dependency on SMI's production capacity; this would inflict damage on the relation and seed miss-trust between the partners.

The close integration between *service*, *innovation* and *manufacturing* will have to be maintained, even if the first two are partly found with the partner company. If not, SMI risks loosing their strong strategic position and being very vulnerable to price pressure and competition.

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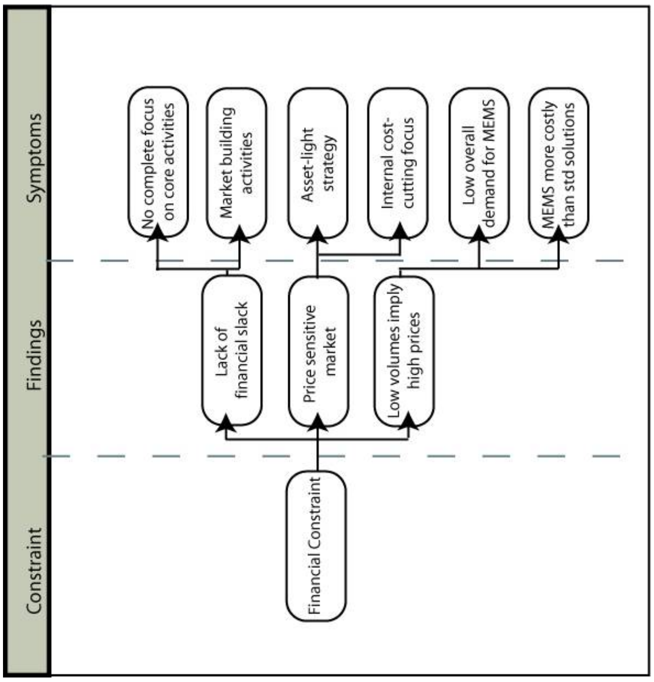
Peter Draheim, Chief Executive Officer, SMI
Wolfgang Weggen, Chief Financial Officer, SMI and Philips Semiconductors
Günther Kowalski, Chief Technical Officer, SMI
Bernd Schünemann, Business Development Manager, SMI
Georg Menges, Marketing and Logistics Manager,SMI
Thilo von Freyhold, Sales Manager, SMI
Christian Bröker, Controller, SMI
Martin Hoffmann, R&D, SMI

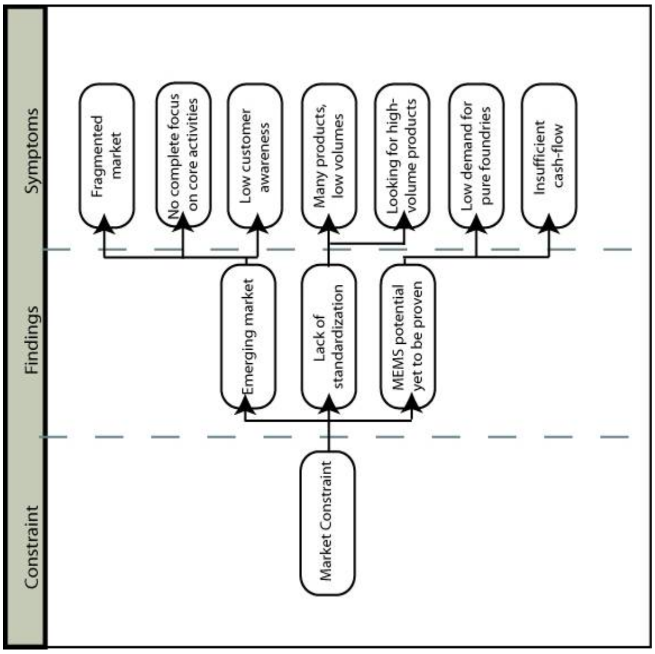
Funding Model Strategies
- a Case Study on a German MEMS Start-up

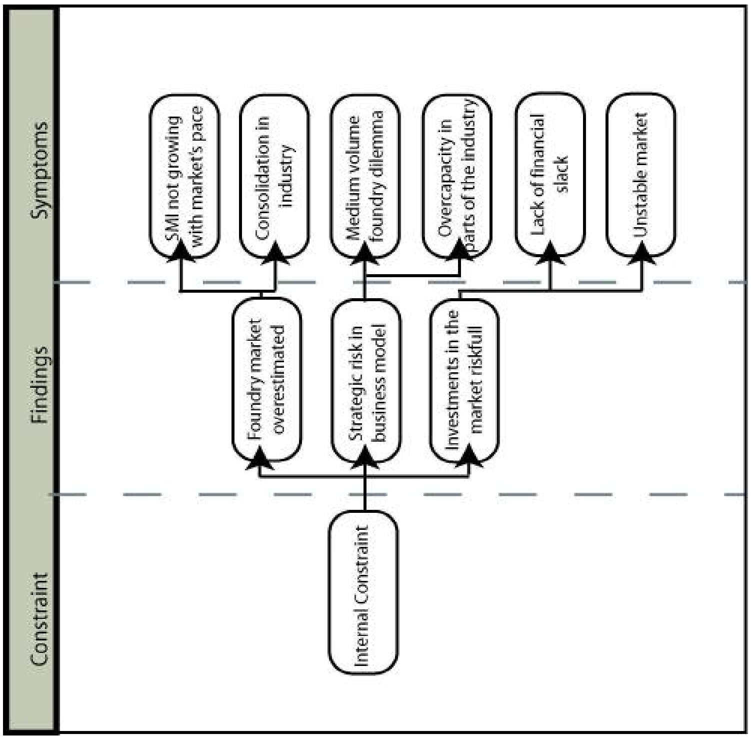
Andreas Brenner, F&A, Philips Switzerland

Thomas Laurell, *Department of Electrical Measurement, Lund Institute of Technology*

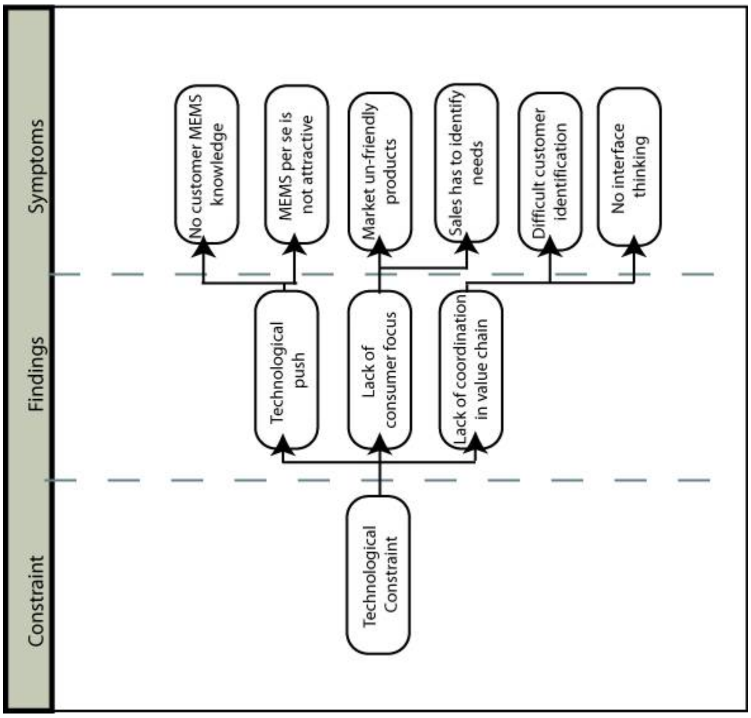
10 Appendix 1 – Deriving the Scenarios






Constraint
Findings
Symptoms
Internal Constraint
Foundry market overestimated
Strategic risk in business model
Investments in the market riskfull
SMI not growing with market's pace
Consolidation in industry
Medium volume foundry dilemma
Overcapacity in parts of the industry
Lack of financial slack
Unstable market

11


Constraint
Findings
Symptoms
Technological Constraint
Technological push
Lack of consumer focus
Lack of coordination in value chain
No customer MEMS knowledge
MEMS per se is not attractive
Market un-friendly products
Sales has to identify needs
Difficult customer identification
No interface thinking

Appendix 2– Scenarios

Scenario I: Waiting for the killer application

The External View

The MEMS market is highly fragmented, consisting of large number of development companies. Everyone is trying to find a killer application based on MEMS technology that will reach a high volume market. This application could show the potential of MEMS products in general and give the company sufficient cash flow to finance further growth in the MEMS market. A handful of applications have already been successfully commercialized, but these applications are highly specialized and have not managed to convince other industries about the strength in MEMS technology. These MEMS products are typically produced in-house or by traditional semiconductor foundries and used as a small part in a large system. The lack of standardization creates no opportunity to sell these products to other customers than the intended one.

I 1. *This is a* ***correct*** *picture of the* ***present*** *external situation.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

I 2. *This is a* ***correct*** *picture of the* ***future*** *external situation, which SMI will face in 12 months.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

I 3. *If the above-mentioned obstacles in the MEMS market are* ***resolved****, the market will explode.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

The Internal View

SMI is currently a company that is waiting for a killer application. In the mean time, SMI tries to finance the company by taking contracts not always in line with their strategy as a MEMS foundry. The capital gained from these contracts is spent on process research to stay in the frontier of manufacturing technology. This is intended to make SMI prepared to be the best choice when the developer selects a foundry for the killer application. To gain the best competitive position and understand technical and market needs, SMI collaborates with both important potential customers in different high-tech industries and with developing firms believed to have a strong future growth. SMI acts as an intermediary between customers and suppliers, providing knowledge and links to turn ideas into functioning applications. Far reached plans exists for an own, very flexible, manufacturing plant to respond to production needs set by the market. When the killer application emerges, continuous process developments will be implemented to be competitive for high volume manufacturing.

I 4. *This is a* ***correct*** *picture of the present internal situation.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

I 5. *This is a* ***correct*** *picture of the* ***future*** *internal situation, where SMI will be in 12 months.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

The Worst Case Future Scenario

SMI manages to establish a large portfolio of contacts with both developers and customers but, for financial reasons, has to continue providing services not entirely focused on MEMS. After a period of time, an application with the potential to reach high market penetration is presented by one of the developing firms in SMI's portfolio. SMI mediates contact between the developers and a customer and produces the initial batches. Over time, however, SMI's strategic position is seriously diminished due to a close collaboration between the developer and the customer, which leads to a transition vs. in-house production. No incitements for standardization are found, neither with the developer nor the customer. Production capacity is not shown to be a valuable and rare resource and SMI's margins are decreasing.

The Best Case Future Scenario

An early investment from a venture capitalist gives SMI the financial possibility to focus on developing their MEMS manufacturing IP-portfolio and knowledge. Having established strategic alliances with a number of developing firms makes SMI a nodal company through which all customer contact is directed. When a killer application is presented SMI quickly realizes the potential of the new product and the manufacturing plant is restructured to respond to the future demands on the application. Through its knowledge in MEMS SMI is able to generalize the application to a number of different customers and to set a standard, which developers of future products uses.

I 6. *I believe that the* ***worst case*** *future scenario is…*

More likely	Equally likely	Less likely
☐	☐	☐

…than the best case future scenario.

I 7. *Please rank* ***top five*** *key success resources (1 – 5) in this scenario.*

__ Access to financial slack

__ Clear vision, mission and strategy

__ Close relations with MEMS design-houses

__ Easy access to packaging and testing

__ Excellent marketing and sales knowledge

__ In-house production plant

__ MEMS design and development skills

__ Strong management group

__ Value chain coordination skills

__ (Other) :[ ]

__ Broad customer portfolio

__ Close relations with key customers

__ Dynamic and inventive organization

__ Excellent manufacturing process knowledge

__ Financially strong stakeholders

__ Lean and cost effective organization

__ Shareholders with good reputation

__ Strong protection from IP

__ (Other) :[ ]

__ (Other) :[ ]

I 8. *SMI is* ***currently in control of*** *these top five key success resources.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

If any resource is ***missing****, please state which one(s)* : [ ]

Scenario II: Catch 22 – Price vs. Volume Dilemma

The External View
The market is prepared for the transition from large assembled products to single chip MEMS applications. The technology to complete the transition is also present. The only obstacle is the price vs. volume dilemma. Low volumes imply high prices due to the large fixed costs in production and to the high costs of developing specialized packaging and testing. High prices imply low volumes due to the markets price sensitivity, MEMS chips need to be cheaper than the products they are set to replace. To overcome the dilemma and reach profitable volumes, an initial price-reduction could be a viable way to build a market for MEMS based products. To afford this price reduction, access to financial slack is vital, a rare resource in the aftermath of the dot com-crash.

II 1. *This is a* ***correct*** *picture of the present external situation.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

II 2. *This is a* ***correct*** *picture of the* ***future*** *external situation, which SMI will face in 12 months.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

II 3. *If the above-mentioned obstacles in the MEMS market are* ***resolved****, the market will explode.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

The Internal View
To be able to get a first mover advantage, SMI works actively with both cost cutting and capital acquiring. Cost cutting is done through process research to be able to reduce unit prices. Financial slack is searched from external investors and by selling profitable products and services that are not always in line with the overall strategy. When sufficient finances have been secured SMI plans to provide low-margin,

promising products as a market building activity with the prospect of future high volume products. Collaboration with potential high volume buyers is initiated to strengthen these efforts. Although capital consuming, SMI believes that the access to an in-house manufacturing plant will reduce production costs to a level where high volumes can be reached.

II 4. *This is a **correct** picture of the present internal situation.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

II 5. *This is a **correct** picture of the **future** internal situation, where SMI will be in 12 months.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

The Worst Case Future Scenario

A venture capitalist is attracted by SMI's business model and provides funding for the construction of the manufacturing plant. The cost reduction obtained by the new plant is not sufficient to lower the unit prices to stimulate the market to purchase higher volumes. The high demands of return on investment from the venture capitalist consume all the financial slack generated from the new plant. Other foundries are still using flexible, contractually based manufacturing capacity and use their access to capital to build their markets. Volumes start to grow and SMI's competitors are able to internally finance specialized production plants.

The Best Case Future Scenario

A venture capitalist is attracted by SMI's business model and provides funding for the construction of the manufacturing plant. Shortly after the opening of the plant, an order from a large customer is secured providing a high degree of utilization and enough margins to cover the venture capitalists return demands. The success of the plant allow further capital injections from investors and enables SMI to ramp up production of low margin, high growth potential products. The volumes of these products quickly augments and having a first mover advantage against competitors and a fully operational MEMS plant, SMI has the possibility to repeat the strategy for other product groups.

II 6. *I believe that the **worst case** future scenario is…*

More likely	Equally likely	Less likely
☐	☐	☐

…than the best case future scenario.

***II 7.** Please rank **top five** key success resources (1 – 5) in this scenario.*

__ Access to financial slack

__ Broad customer portfolio

__ Clear vision, mission and strategy

__ Close relations with key customers

__ Close relations with MEMS design-houses

__ Dynamic and inventive organization

__ Easy access to packaging and testing

__ Excellent manufacturing process knowledge

__ Excellent marketing and sales knowledge

__ Financially strong stakeholders

__ In-house production plant

__ Lean and cost effective organization

__ MEMS design and development skills

__ Shareholders with good reputation

__ Strong management group

__ Strong protection from IP

__ Value chain coordination skills

__ (Other) : [ ]

__ (Other) : [ ]

__ (Other) : [ ]

***II 8.** SMI is **currently in control of** these top five key success resources.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

*If any resource is **missing**, please state which one(s)* : [ ]

___

___

Scenario III: MEMS – A technology, not yet a product

The External View
Insufficient MEMS knowledge among customers and lack of customer focus in the MEMS business makes the products unattractive. The knowledge gap between developers and customers lead to strong technological push in the market; new inventions are generally not derived from market needs. Developers might have problems finding buyers for their products and customers are unlikely to realize how MEMS can be used in their applications. Developers have too much focus on their specific technology and the result is a market unfriendly product or just a concept. MEMS companies are struggling with the 'black box' or interface thinking, but the lack of overall coordination in the MEMS industry limits the progress.

***III 1.** This is a **correct** picture of the present external situation.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

***III 2.** This is a **correct** picture of the **future** external situation, which SMI will face in 12 months.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

***III 3.** If the above-mentioned obstacles in the MEMS market are **resolved**, the market will explode.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

The Internal View
SMI adds value to their customers, not only by producing the actual silicon structure, but also by facilitating the use of MEMS applications. With a technological know-how in the whole value chain SMI helps developers to adapt their designs to production and prepares the product for packaging and testing. Sales and marketing is focused on helping customers realizing the potential of using MEMS in their

applications. Capital or partnerships are used to acquire knowledge concerning the complete product perspective. SMI intends to build a plant in cooperation with another company in the value chain to be able to deliver more consumer friendly solutions.

III 4. *This is a* ***correct*** *picture of the present internal situation.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

III 5. *This is a* ***correct*** *picture of the* ***future*** *internal situation, where SMI will be in 12 months.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

The Worst Case Future Scenario

In their ambition to provide consumer friendly turnkey products, SMI teams up with a slightly smaller packaging company. The technological uncertainty still makes the customers unwilling to use MEMS in their products and despite an aggressive marketing effort very few new customers are tied closer to SMI. To mitigate the risk, large customers chooses to use large semiconductor producers as suppliers for both MEMS and IC, since they are looking for best performance, not MEMS per se. To be consumer friendly was shown not to provide turnkey MEMS application, but having the expertise to sell solutions for technical problems. The decreasing amount of orders affects the smaller packaging company severely and the plant is not even complete when they exit the coalition.

The Best Case Future Scenario

In their ambition to provide consumer friendly turnkey products, SMI teams up with a slightly smaller packaging company. The consumer friendly products quickly open the eyes of customers in a wide range of industries. Seeing the benefits of MEMS applications, large customers consult SMI to show where MEMS could be used in their industry and to master the development of these circuits. SMI’s strategic position, as a gatekeeper between customers and developers puts them in a very strong competitive position. The good position allows high margins for both of the companies in the coalition and the construction of the plant strengthens the position further.

III 6. *I believe that the* ***worst case*** *future scenario is…*

More likely	Equally likely	Less likely
☐	☐	☐

…than the best case future scenario.

III 7. *Please rank* ***top five*** *key success resources (1 – 5) in this scenario.*

__ Access to financial slack

__ Clear vision, mission and strategy

__ Close relations with MEMS design-houses

__ Easy access to packaging and testing

__ Excellent marketing and sales knowledge

__ In-house production plant

__ MEMS design and development skills

__ Strong management group

__ Value chain coordination skills

__ (Other) : [ ]

__ Broad customer portfolio

__ Close relations with key customers

__ Dynamic and inventive organization

__ Excellent manufacturing process knowledge

__ Financially strong stakeholders

__ Lean and cost effective organization

__ Shareholders with good reputation

__ Strong protection from IP

__ (Other) : [ ]

__ (Other) : [ ]

III 8. *SMI is* ***currently in control of*** *these top five key success resources.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

If any resource is ***missing****, please state which one(s)* : [ ]

Scenario IV: SMI – Dropped off in the middle of nowhere

The External View

The MEMS market is booming, the main technological obstacles have been solved and customers from all industries are starting to appreciate the possibilities of MEMS. Recent figures show that the market is growing with over 20 percent annually. Due to the quick expansion, the market has not yet stabilized, leading to overcapacity in certain parts and under-capacity in other. The strategic positions and how revenues are distributed in the value chain is not well defined. These uncertainties make it difficult to predict which business models that will be successful, thus investments and strategic alliances are associated to large risks. A number of newly started developing companies have grown to become important players on the market and consolidations are more and more common.

IV 1. *This is a* ***correct*** *picture of the present external situation.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

IV 2. *This is a* ***correct*** *picture of the* ***future*** *external situation, which SMI will face in 12 months.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

IV 3. *If the above-mentioned obstacles in the MEMS market are* ***resolved****, the market will explode.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

The Internal View

SMI is a part of a growing market, but today's management has not been able to explicitly choose their business model, due to the company's prior history. SMI is not growing with the same pace as the rest of the market and the reason for this is their position in the value chain. The MEMS foundry market was largely overestimated and is wedged between large, specialized in-house production plants for high volumes and multi-technology hybrid facilities for both design and production of low and medium volumes. The medium volume foundry dilemma is that there are products with good margins but they only fill a fraction of a production plant. The high volume applications are highly specialized, with lower margins and are not suited for production in a flexible foundry. Despite the tough climate for foundries, SMI is convinced that their excellent manufacturing process knowledge will give them a possibility to capitalize on this market – the best player will succeed even in a vulnerable market. The superior way to implement their process knowledge is to complete the production plant.

***IV 4.** This is a **correct** picture of the present internal situation.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

***IV 5.** This is a **correct** picture of the **future** internal situation, where SMI will be in 12 months.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

The Worst Case Future Scenario

The market continues to grow but SMI is struggling with low margins and a thin order book. In an attempt to attract larger customers the production plant is completed. However, the market does not, for many years, reach a level of maturity where manufacturing process skills are considered as an order-winner, as the focus on product development is the key driver. The low degree of utilization in the plant makes the fixed costs per unit very high with uncompetitive prices as result. The vast amount of capital tied to the plant makes any changes of business model impossible.

The Best Case Future Scenario

The market continues to grow but SMI is struggling with low margins and a thin order book. In an attempt to attract larger customers the production plant is completed. After a period of time a lot of products have reached a level of market penetration where they fill a medium sized foundry and attention is drawn to SMI's effective manufacturing processes. Consolidation in other areas has lead to overcapacity in specialized high volume production and SMI stands alone as an owner of a state of the art medium volume foundry. The flexibility and degree of utilization enables very good margins for SMI. With a strong management and close customer relations they are able to make profit on production of systems that grow to larger volumes, by subcontracting them to specialized producers in low-cost countries.

***IV 6.** I believe that the **worst case** future scenario is…*

More likely	Equally likely	Less likely
☐	☐	☐

…than the best case future scenario.

IV 7. *Please rank* ***top five*** *key success resources (1 – 5) in this scenario.*

__ Access to financial slack __ Broad customer portfolio

__ Clear vision, mission and strategy __ Close relations with key customers

__ Close relations with MEMS design-houses __ Dynamic and inventive organization

__ Easy access to packaging and testing __ Excellent manufacturing process knowledge

__ Excellent marketing and sales knowledge __ Financially strong stakeholders

__ In-house production plant __ Lean and cost effective organization

__ MEMS design and development skills __ Shareholders with good reputation

__ Strong management group __ Strong protection from IP

__ Value chain coordination skills __ (Other) :[ ]

__ (Other) : [ ] __ (Other) :[ ]

IV 8. *SMI is* ***currently in control of*** *these top five key success resources.*

Completely agree	Mostly agree	Mostly disagree	Completely disagree	Uncertain
☐	☐	☐	☐	☐

If any resource is ***missing****, please state which one(s)* :[ ]

V. Summarizing questions

V 1. *I think, that Scenario…*

1	2	3	4	None of them
☐	☐	☐	☐	☐

*…is the **most accurate**.*

V 2. *In the chosen scenario, the…*

Financial	Market	Strategic	Technological
☐	☐	☐	☐

*…risk is the **most** potent.*

V 3. Additional comments

[ ]

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12 Appendix 3 – Resource Mapping