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ΣMINENT

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Supply Chain Relevant Themes for Business Realisation - Value Chain Discussion

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ΣMINEnT is an EU funded IST-2001-38176 Thematic Network project with IVAM as Contractor and nucleus participants ADEMIS (France), APTE (Switzerland), MINAC (Netherlands), MINT (Belgium) and OGMS (Austria) for business generation in the nano and micro(system) technology field.

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1 Introduction

One of the main objectives of the European initiative "EMINENT" is "…strengthening the external cooperation with relevant forums and branch organisations, through which our participants can reach the potential users, creating application work groups in order to accelerate business, assistance in Technology Marketing, organising workshops, etc.". In order to build a successful cooperation platform among different countries and involved parties, an appropriate understanding of industry structures, conditions and behaviours is tremendously important. Not just the expertise of technology developments and cooperation networks between university and industry partner but also the know-how about successful consumer introduction and marketing helps to develop appropriate activities for SME support. Innovation is "creativity, successfully filtered by the market".

This document is the first step to develop a mutual understanding between the project participants about "what is business realisation relevant and what is not". Therefore, a transparent overview about the whole Micro- and Nanotechnology value chain, which not only presents newer technology innovations but also requirements and constraints of end users, helps to identify relevant areas for improvement. During the course, the following questions (selection) should be addressed:

- What is necessary to successfully introduce new applications concerning customer awareness, partner commitments, market readiness, and support of the backing industry?

- How does the feedback process from the end user to the development industry have to be arranged regarding different levels of value generation, interfaces and involved parties?

- How does the industry change its structure and behaviour during its evolution process? What are the crucial patterns, which indicate the differences of an upcoming to a mature industry?

- What are the roles and value contribution of additional market participants like network associations, public organisations, consultants/lawyer, media and opinion leaders?

2 Objectives and Scope

This document has the following objectives in order to progress the European initiative "EMINENT":

1. Get a common understanding of relevant areas of business realisation in the Micro- and Nanotechnology industry, which includes
    - A first presentation of three different value chains (Microelectronics, Microsystems and Nanotechnologies)
    - A description of several examples within the value chains in order to highlight recent developments and give awareness about the different evolution stages
    - A listing of meaningful statements which characterise the specifics of Microelectronics, Microsystems and Nanotechnologies
2. Comparison of the different value chains and listing of supply chain themes which are relevant for business realisation
3. Identification of future research and development activities, proposal of possible next steps

In order to ensure an efficient and effective project work the scope of this deliverable was tightly defined. Especially the following presumptions have to be communicated in order to have a clear understanding of the presented results:

- The research work was focused on the development of a comprehensive picture ("big picture") with mega trends and interdependencies, detailed analysis was not covered
- In order to follow the 80/20 rule only a few market players (representatives) were discussed
- This document is a discussion paper, which means that we try to raise different relevant topics, make assumptions to create awareness and highlight themes which we consider to be relevant. Due to the shortage of time not all conclusions could be analysed in detail. Nevertheless, a detailed analysis of the industry should be conducted in the near future (see also chapter 6).

3 Discussion Framework and Definitions

In order to understand relevant topics for business realisation and potential areas for improvement within the supply chain, an appropriate picture of the existing value chain, which characterises the Micro- and Nanotechnology industry, is crucial. Concerning the fact not to stress technology themes or developments, the focus of the discussion framework has to lay on the comprehensive presentation of industry conditions, marketing structure and industry development stages. Additionally, the used approach bases on the experience that well developed, market-proved technologies have clearly defined, well-organised market structures with long-experienced players, are broader developed concerning the improvements of the application for end users and are intensively covered with additional market players like business consultants, head hunters, lawyers, network- and marketing partners.

To identify and assess the necessity for development of supportive activities in business and marketing realisation especially in areas of newer technologies, we structured the Micro- and Nanotechnology industry in three segments (Microelectronics, Microsystems and Nanotechnologies). The comparison of the three analysed segments with different evolution stages provides valuable insights. As example, on the one hand the Microelectronics can be characterised as well-developed and commercialised industry, on the other hand the Nanotechnologies is still in the research and development phase. The understanding of improved marketing structure and conditions supports the developments of newer segments.

In order to provide a mutual understanding among the project participants we would like to introduce the following definitions for the defined segments:

Microelectronics
Microelectronics is defined as the development, fabrication and application of semiconductor components and integrated circuits with the objective of implementing electronic and logical functions in continuously smaller devices. (Dictionary of Microelectronics and Microcomputer Technology, Attiyate/Shah, 1984, VDI Verlag)

Microsystems
A microsystem is defined as a miniaturised system combining functions such as intelligence, sensing, processing, and actuation. A microsystem would be normally realised by combining two or more electrical, mechanical, optical or other functions on a single chip or on a hybrid module incorporating several components. (Microsystems in the 4th Framework IT, Sept. 1996)

Microsystems - NEXUS Task Force Definition
Microstructure products have structures in the micron range and have their technical functional provided by the shape of the microstructure. Microsystems combine

several microcomponents, optimized as an entire system, to provide one or several specific functions, in many cases including microelectronics.

Nanotechnologies

It is first necessary to explore the boundaries of the term "nanotechnology," a word whose overuse has led to confusion about its intended meaning. A glance at only a few experts' descriptions of the term reveals slight discrepancies and vague generalisations in usage.

The **National Nanotechnology Initiative** describes the critical characteristics that distinguish the field:

- The essence of nanotechnology is the ability to work at the molecular level, atom by atom, to create large structures with fundamentally new molecular organisation. Compared to the behaviour of isolated molecules of about 1 nm (10 -9 m) or of bulk materials, behaviour of structural features in the range of about 10 -9 m to 10 -7 m (1 to 100 nm – a typical dimension of 10 nm is 1000 times smaller than the diameter of a human hair) exhibit important changes. Nanotechnology is concerned with materials and systems whose structures and components exhibit novel and significantly improved physical, chemical, and biological properties, phenomena, and processes due to their nanoscale size (Interagency Working Group on Nanoscience, Engineering, and Technology, "National Nanotechnology Initiative." February 2000, pg. 15).

In his book Nanosystems: Molecular Machinery, Manufacturing, and Computation, Institute for Molecular Manufacturing (IMM) Research Fellow and Foresight Institute Chairman Dr. K. Eric Drexler distinguishes a specific branch of nanotechnology, which he terms molecular manufacturing (MM):

- The construction of objects to complex, atomic specifications using sequences of chemical reactions directed by no-biological molecular machinery. Molecular nanotechnology comprises molecular manufacturing, together with its techniques, its products, and their design and analysis; it describes the field as a whole (Drexler, K. Eric. Nanosystems: Molecular Machinery, Manufacturing, and Computation. Pg. 1).

Finally, Dr. Eugene Wong, former NSF Assistant Director of Engineering, expresses the fact that, contrary to a fairly widely-held belief,

- not all science and engineering that occurs at the nanoscale is new. Photography, for example, is a relatively old nanotechnology. Most of molecular biology also works at the nanoscale and some of it is clearly not new. What is new is the degree of understanding we are able to achieve with the new tools and precision and control that we are able to exert on the … molecules and devices at this scale (Dr. Eugene Wong, House Subcommittee on Basic Research, "Nanotechnology: The State of Nanoscience)

Taking these three explanations into account, the following is a concise and unifying definition used in the context of this paper:

- Nanotechnology, synonymously called nanoscience and engineering, is an all-encompassing phrase given to the study, design, and synthesis of structures and devices with at least one dimension measured in nanometers (10 -9 to approximately 10 -7 meters). Due to the phenomena emergent at this length, these technologies exhibit novel properties. A specific subset of the field, molecular manufacturing, deals with the atomically-precise manufacture of objects as small as the nanoscale, and as large as mundane items.

This definition can be illustrated with specific examples from the promising areas of research identified by the Interagency Working Group on Nanoscience, Engineering and Technology (IWGN), a team comprised of representatives from all key nanotechnology funding agencies. Over the course of a year, the IWGN met and discussed a possible research agenda for the next decade (and its prospects for the Next Decade." June 22, 1999. Pg. 6). In doing so, they identified the overriding themes that constitute nanotechnology:

- **Biological, chemical, materials science, electronic, magnetic, optical, and structural properties of nanostructures**;

- **Synthesis and processing at the nanoscale;**

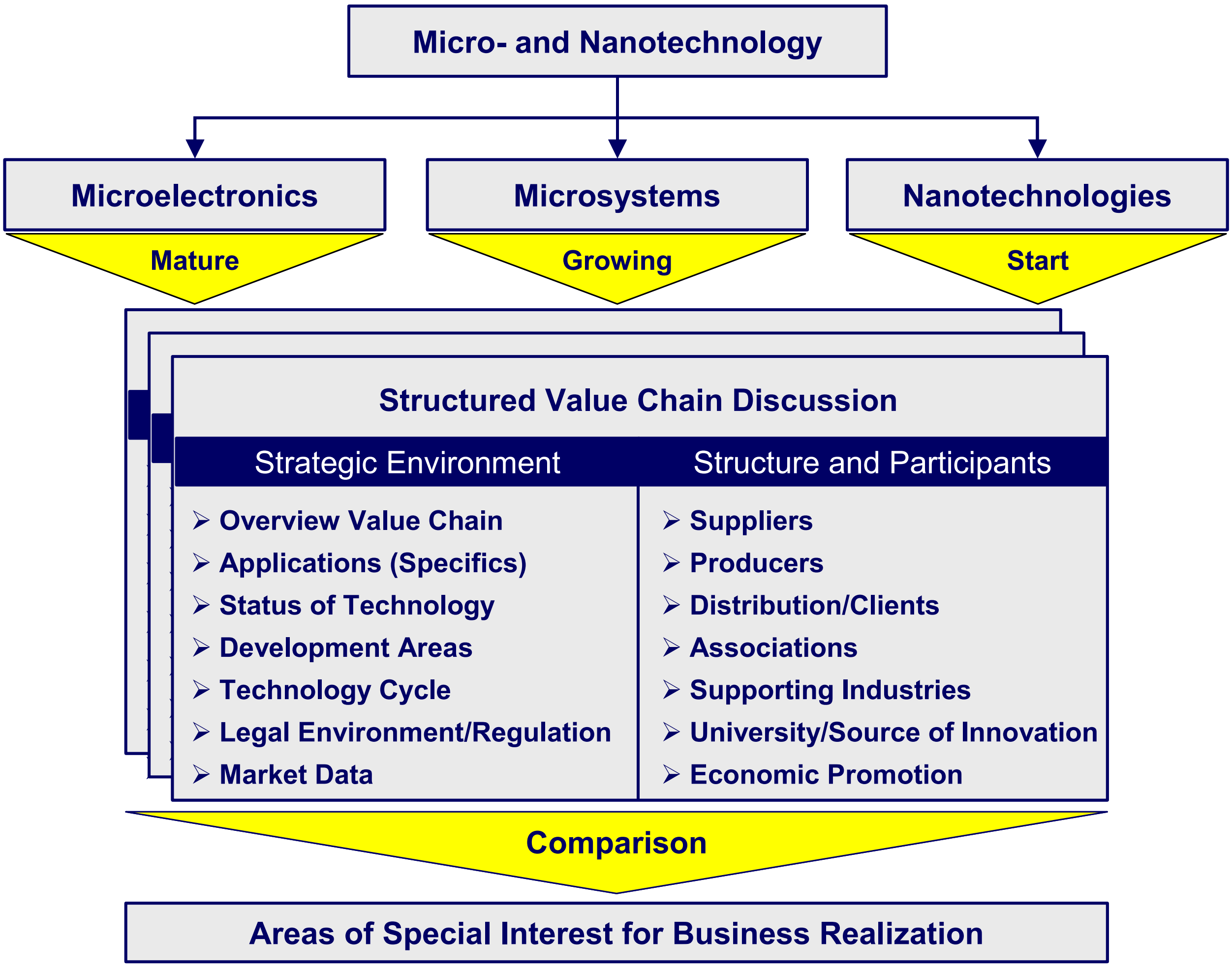
- **Characterisation and manipulation at the nanoscale;**

- **Modeling and simulation of the nanoscale; and**

- **Device and system concepts (applied research/applied nano technologies)**

This is a very general listing that can lead to a wide variety of possible scientific and engineering proposals. What should be clear, however, is the following: nanotech is the science and engineering that reaches the nanoscale from the "bottom-up," rather than the "top-down." This stands in contrast to top-down technologies such as Micro Electro Mechanical Systems (MEMS) and microprocessors, which arrive at tiny lengths via a manufacturing process that begins with a large amount of material (i.e.-silicon) and creates a tinier structure. Since some scientists and engineers refer to such top-down technologies as nanotechnology, those who advocate the bottom-up approach typically refer to their field as molecular nanotechnology (MNT). Thus, the remainder of this paper will use the words nanotechnology and MNT interchangeably.

The following chart gives an illustrative overview about the discussion framework and the area of special interest which has to be analysed.

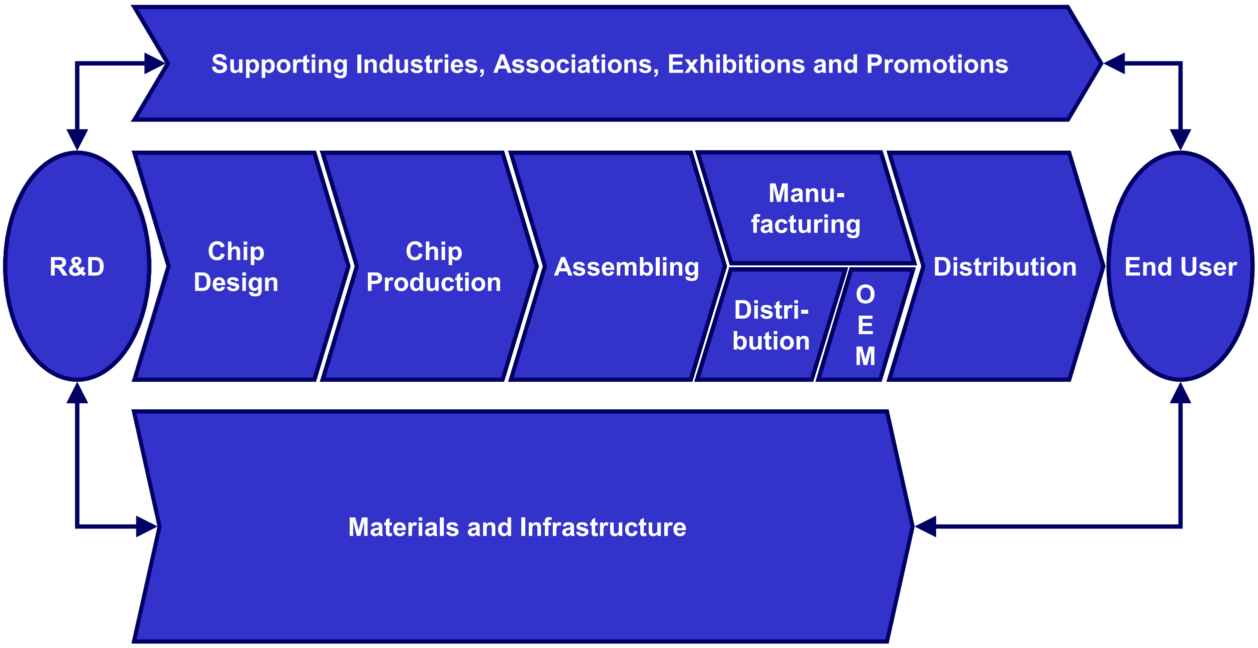


4 Industry Examples, Statements and Comparison

4.1 Microelectronics

4.1.1 Value Chain Overview and Examples

The following chart illustrates a rough overview of the value chain within the segment "Microelectronics". It should also figure out all major value generation stages and interdependencies of involved participants.



In order to highlight the recent market evolution and give awareness about the well-organised and mature segment of the "Microelectronics", we listed below a few examples.

In the past years, industry developments in the "Microelectronics" show moves towards specialisation and standardisation. As an example many Microelectronics design houses (e.g. Crossmos GmbH) became independent from chip producers (e.g. EM Microelectronic-Marin SA). One of the reasons for the increasing existence of fabless design houses is the complexity and variety of design products which allows designers to stay as single and sustainable business (concentration of core competences) as well as to give the opportunity to choose among different production technologies. Nevertheless, design houses are tightly bounded to the success of their products in the end product manufacturing stage due to the agreed dependence of royalties (the design development normally just covers the costs). This example shows clearly how a mature industry arranges itself under the pressure of competitive market condition.

Due to high efficiency and effectiveness of the Microelectronics´ value chain, industry participants, who intend to successfully compete against other players, are increasingly forced to understand in depth their own value proposition and to concentrate on their major strengths. In the case in which consumers value more the cost of end product than the pure improvement of technical functionalities, suppliers start to focus their development efforts on improvements in production procedures, on the definition and standardisation of business processes and on potential opportunities to outsource their non-core activities. As successful example among big players, Nokia and Ericsson have changed their production behaviour in the past five years. Both have dramatically outsourced large parts of their microelectronic and printed circuit boards' production. This strategy was only possible because of global initiatives regarding the definition and settlement of common production procedures and standards.

In established industries, not only market players like suppliers, producers or distributors gain on professionalism and efficiency but also additional participants such as consultants, lawyers and network partners can improve their value contribution due to increasing experiences and know-how. Hereafter we would like to present you an example of successful networking between a SME and a large corporation. The Swatch Group has decided to invest in the development of the second generation of Swatch pagers. They have set up a project with internal team participants and during the execution they realised that the planned milestones could not be reached with their internal competencies. In order to stay on track, they asked the author of this paper for the most appropriate partner in the development of the required semi-custom microprocessor. Through the long-lasting experiences and broad developed contact network of APTE Association, the intensive communication as well as the mutual understanding of the current challenges of the Swatch Group between all involved participants, the right person could be quickly identified and pursued to work on the project. The second-generation pager of the Swatch Group was delivered in "Time-to-Market".

4.1.2 Statements About Industry Characteristics

In order to summarise a mature value chain like the segment of "Microelectronics" we can mention the following statements:

- Competition in an established industry is high and drives the way how players think and act. This forces all market participants to increase efficiency ("doing the things right") and effectiveness ("doing the right things"). The consequences are higher specialisation, standardisation of the different processes, concentration on core competencies and an increase of the outsourcing business.

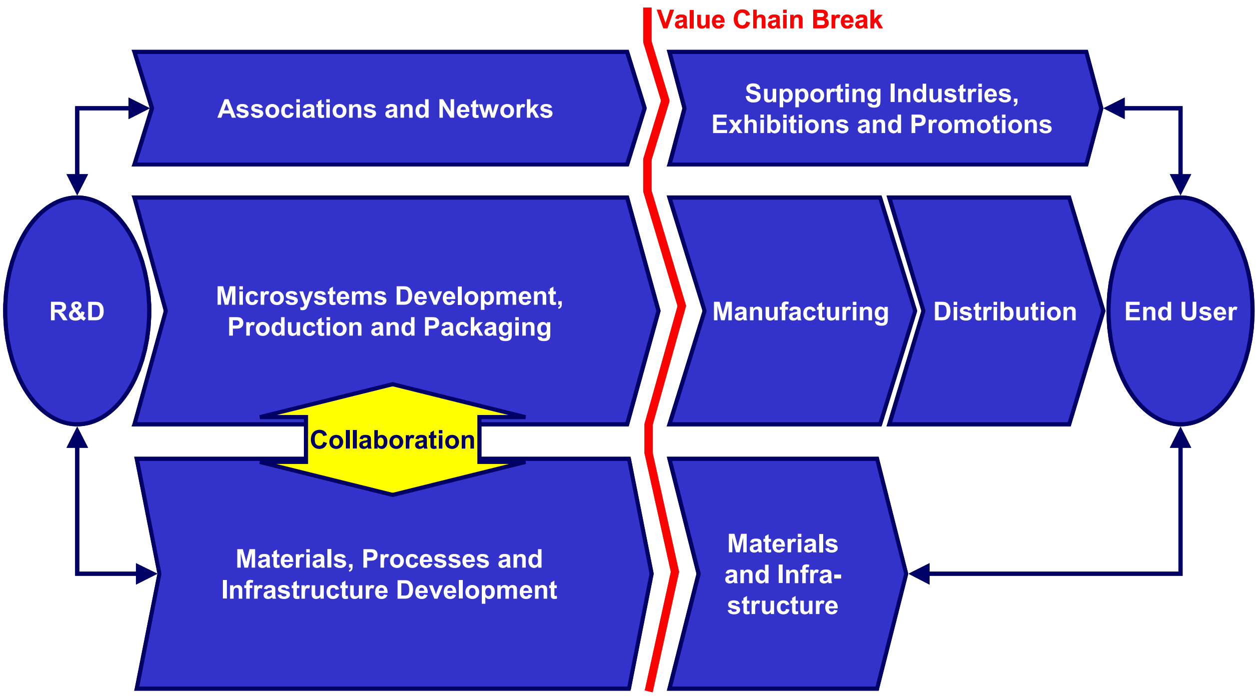
- "Consumer gets more for less money". This influences the development of the consumer market. On the one hand an increasing number of customers give the suppliers the opportunity to cover their infrastructure costs (economics of scale) and to decide about new investments. On the other hand the retention of existing customers establishes excellent feedback processes, which are crucial for innovation based on users' requirements.

- Despite the great history of the Microelectronics industry and the success story of several major players there is still room for improvements. For example, opinion leaders insist on developing new job profiles which master the challenge to bridge the gap between understanding customers´ needs and the development of state-of-the-art technology and products.

4.2 Microsystems

4.2.1 Value Chain Overview and Examples

The following chart illustrates a rough overview of the current value chain within the segment "Microsystems". In conclusion, this sub industry can be characterised as fast growing. All major players are more or less well established and connected in the market. Nevertheless, there is still room for improvements. Obviously, the segment indicates a low specialisation degree concerning types of companies, which normally gives indication about weak competition and potential areas for improvements in efficiency. Especially to mention is the fact, that a value chain break can be identified between the design & production and end product manufacturing companies. This circumstance indicates that this sub industry is very well experienced in the development of customised products but still has to exploit the potential for mass production.



The Swiss Center for Electronics and Microtechnology CSEM is a privately held company carrying out 1) Applied research work, 2) Product development and 3) Prototype and low quantity production. By offering its high-tech know-how, competencies and expertise, CSEM anticipates and fulfills the needs of industrial partners. In particular, it supplies customised microsystems, microelectronic designs and system solutions, as well as specialised coatings and materials. CSEM also develops its own commercial activities, either with existing companies or through the creation of start-up companies. CSEM was founded in 1962 as the Centre Electronique Horloger (CEH) with the intent to design a new generation of wristwatches for mass production. The following example should demonstrate the ability of CSEM to integrate innovative solutions into competitive products. By combining original concepts with innovative components CSEM has developed an optical reader for payment slips, which significantly eases modern e-banking. This unique micro-opto-electronic technology brings new potential for a variety of other applications, in addition to enhanced performance and cost effectiveness. Beside a profound basis in technological know-how acquired by research and development activities, this process requires product engineering skills that range from component optimisation, production test and quality management, to appropriate manufacturing partner networks. Not just that the product was successfully launched in the year 2000, but also a spin-off company was founded (xemtec optical sensing solutions).

Sometimes it is an advantage if entrepreneurs, despite pressing deadlines, do not entirely throw their free time to the wind. It was while wind-surfing that Jean-Daniel Carrard of JDC Electronic SA came up with the idea of developing a small, handy velocity gauge. Now, surfers, sailors and motor boat captains around the world are snatching up his "Speedwatch". Most of them would like to know how much "speed" that have attained with their board, dinghy or yacht. Not only for fun. Knowing the exact velocity allows them to make dependable travel time. Velocity is not usually measured at the same place where the result is to be displayed. It is therefore generally transferred over a cable or a wire. With water-vehicles, there is the problem of how to keep the hull of the boat from becoming damaged. The system of wireless magnetic data transfer (a JDC patent) solves the problem: the distance between the measuring- and display- instruments can be up to a meter. The magnetic transfer, combined with a solar panel, a measurement probe and a display in one user-friendly system – this is JDC's product innovation. JDC had already developed the cableless magnetic data transfer earlier. In the early days, all the components for it were produced by the company. Later, JDC got involved with a development engineer for a project dealing with a use-specific integrated switch for velocity measurement and display. The developer came to the conclusion that a microsystem with low power requirements was the right product for this use. The joint work with local players took two years time from the specification of the microsystem to its production. The prototype production was planned so that the "Speedwatch" could be presented at the large nautical trade show "Motor Boat and Sailing" in Miami.

Not every initiative has to be driven by the consumers. As an example for successful business realisation is the development and launch of Microsystems, which continuously measure pressure and temperature of tiers (e.g. SensoNor in Norway). This product will recognise increasing demands due to legal and environmental changes. The development and distribution of products, which are forced to use by government law, will generate by sure sustainable income.

4.2.2 Statements about Industry Characteristics

The Microsystems which presents itself as fast growing sub industry can be characterised as follows:

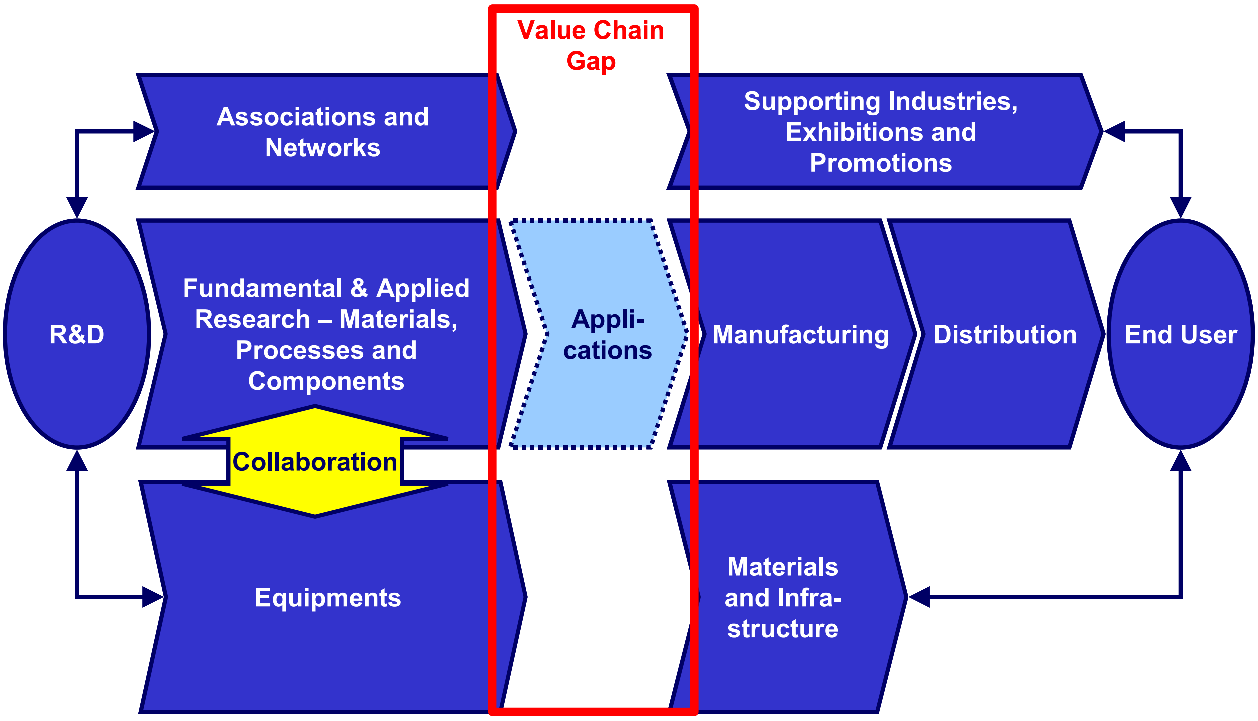
- Only a few established players are profitable, due to their critical size. They currently start to dominate their market niches and cover a large part of the value chain. They still have the potential to launch new applications with attractive margins. Therefore these companies are currently not forced to focus more on efficiencies. This may be a comfortable circumstance for these established players but neither supports the development of a mass market nor the exploitation of the variety of adaptations. Additionally, the absence of increasing standardisation interrupts the evolution of specialisations which normally influence the potential leeways of outsourcing business and to possibility the concentrate on core competences.

- The capital market normally supports the development of new businesses as well as increases the level of competition, as it was also identified in this sub industry, but today additional capital is practically inexistent due to downturns and investors' concerns. Many start-up companies, which were funded just a few years ago, are currently running into problems due to continuous burning costs. In smoothly functioning markets start-ups take the role to compete against established players and ensure continuous industry evolution. This market mechanism does unfortunately not work in the Microsystems segment at present.

4.3 Nanotechnologies

4.3.1 Value Chain Overview and Examples

The following chart illustrates a rough overview of the current value chain within the segment "Nanotechnologies". In conclusion, this sub industry can be characterised as starting. The reason is that still not every stage is settled with relevant market participants. The value chain gap indicates an insufficient commercialisation of applications, which is one of the most important value generators between research & development and end user. There are a number of different options how the value chain could develop in the near future. One possibility is the forward integration of the missing stage by companies specialised in fundamental and applied research. An other option is that the manufacturing industry enhances their business towards research. One of the most realistic scenarios is the emergence of new ventures due to their flexibility and the possibility to create business through new models. Nevertheless, there are currently only a few venture capitalists focusing on the nanotechnology segment (e.g. capital stage).



There are not a lot of single examples in the Nanotechnologies´ segment, which demonstrate successful business realisation. One of this few examples, in the nano-machanical/nanosystems field is that in June, IBM announced the production of a nano-scale storage system capable of a data storage density of 1 trillion bits per square inch — 20 times higher than the densest magnetic storage available today.

Nevertheless, the reasons are that this industry is still in the starting phase of evolution and there exists a widespread potential to improve medicine, manufacturing, computing, chemistry and the environmental applications. This increasing specialisation in the individual technological research areas will force Nanotechnology companies to work together more closely. Going forward, inter-company cooperation in networks will play an important role. The efficient utilisation of specific technological know-how, particularly in an environment that is so influenced by the supplier industry, will become an economical survival factor and therefore must become a key competency of given company. All of this generally applies to every high-tech firm. But because the Microtechnology field already today is a typical supplier industry, this development must be paid a particularly high level of attention.

In order to build awareness of the importance for cooperation along the value chain we intend to replicate the results of a recent study conducted in Switzerland. This research demonstrates clearly how a well-organised network is a prerequisite for a smoothly functioning innovation system. The relationships maintained by Micro- and Nanotechnology companies lie at the center of the observations, and the statements are based on the results of interviews with individuals from various groups:

- Cooperation among the companies functions quite smoothly along the lines of the value-adding chain, especially at the beginning of the value chain. As a result, valuable partnerships evolve that enable products of internationally outstanding quality to be manufactured. Cooperative efforts of the companies in joint research projects with universities also function smoothly and are deemed successful by the majority of participants. Nevertheless, the fear of competition is noticeably high. This leads to a degree of reticence. The consequences of such reticence and a resolution focus on one´s own activities lead to the observation that the same, or similar, technologies are being developed at various sites in Switzerland. However, the supposition can be made that, through increased transparency among the given companies, redundant development efforts - and thus the squandering of valuable resources - could be reduced.

- At younger companies there are signs of a cultural change taking place in the direction of greater transparency, a situation that hopefully will lead to successful cooperative efforts also in regard to development projects. On one hand, this could be attributable to a younger generation of entrepreneurs who, already during their school years or in their earlier professional activities, have come to learn and appreciate the positive effects of cooperation. When it comes to companies that have acquired outside financing, on the other hand, another key element is most certainly the obligation to provide transparency in the financial sector as imposed by the provider of capital or also the SWX New Market.

- Cooperation between companies and universities is fostered via a number of federal initiatives, for example by conducting the Swiss Priority Programs of the Swiss National Research Fund. Micro- and nanosystem technology was supported from 1996 to 1999 with CHF 15 million (about EUR 10 million) in annual funding. Substantial contributions emanate from private sources (contract research, cooperative ventures with companies), and the trend is increasing. Roughly 80 companies and 31 institutes of higher education participated in these programs. The TOP NANO 21 program is an initiative of the FIT(Swiss Federal Institutes of Technology) Board and has the goal of furthering activities in the research and application of nanotechnology. Cooperative projects, headed by the Commission for Technology and Innovation (CTI) are in the process of being carried out between universities and industrial partners over the period 2000 through 2003. Due to fact that a lot of supportive and cooperative activities take place during the past years in Switzerland, not only between university and research but also with established industry partners, the Swiss Micro- and Nanotechnology industry presents itself as highly competitive and dynamic even in a global context. We can confirm that a lot of pioneer works came out of Switzerland including fundamental and applied research (e.g. IBM research lab in Rüschlikon) and cooperation models between different players along the value chain (e.g. APTE Association)

- The random sampling represented by the survey of companies brought to light the fact that the growth of many small- and medium-sized high-tech firms is privately financed. In the case of start-ups, there are however also renowned multinational companies such as Intel that can contribute to the reputation of a young company by providing early stage investment. Young firms seeking outside financing turn to venture capitalists during their early phase of growth, investors who in turn not only provide them with financial means, but also entrepreneurial support. However, the latter is in many cases still deemed to be somewhat lacking in quality. There is great room for improvement in this regard. Venture Capital companies to a certain extent have recognised that contacts with universities have to be established and nurtured in order for them to fully assess the market potential of a given technology. Such a close bond between universities and venture capitalists is not considered desirable in many quarters because the financial self-interest and the insufficient level of industrial know-how involved pose the threat that start-up companies with little commercial promise will be founded.

4.3.2 Statements about Industry Characteristics

The Nanotechnologies, which presents itself as starting sub industry, can be characterised as follows:

- As mentioned above, there exists a "mega" gap in the Nanotechnologies segment. The lack of the value stage "Application" makes it tremendously difficult to forecast anything concerning business realisation. This circumstance makes it quite impossible for venture capitalists to evaluate risks and chances of technologies and potential start-up. The prerequisites for receiving venture investments are the realistic presentation of a business which shows attractive returns in an acceptable timeframe (normally 3 until 7 years). Investors not only want to target their possible returns but also to know their exit means, which normally will be reached by IPO (Initial Public Offering) or trade sales (sell the company to an established corporation).

- Long-term researches demonstrate that an innovation cycle (period from the start of fundamental research to commercialisation) takes in most of the cases over 20 years. In the case of nanotechnology, the first product will be sold in the year 2012, if we take the year 1991/92 as starting point (e.g. IBM nano-letters) which demonstrates again that we are still far away from business realisation. Nevertheless, we are convinced that nanotechnology will have a tremendous market potential in the future and, if appropriate applied, will change the world. Astonishingly, even if we are in the research phase and the discussed topics are still technical and theoretical, there exits a high awareness in the society.

- However, the first milestone in this segment should be to cluster this widespread potential of innovation options in possible future application themes. From our point of view the single topic should afterwards be developed and improved from different experts along the value chain which includes technical researchers and developers, material, process and product engineers as well as manufacturer and marketing specialists (in order to find out the market potential of the application). To do so the necessity of intercompany cooperation and interdisciplinary networks is obvious. We are convinced that a focused cooperation system will decisively support the future business realisation of nanotechnology developments.

- Even if co-operations and networks are an excellent way to bridge the gap between research & development and the specific requirements of the consumers, they bear the problem to be less efficient concerning time consumption and manpower. An alternative is the development of new job profiles or education programs, which cover the above-mentioned bridge. This kind of new professionals will be able in the future to deeply understand consumers´ needs with the competence to overview the possible solution in a state-of-the-art manner.

5 Conclusion - List of Relevant Themes for Business Realisation

Due to the above conducted discussion and the comparison of the different value chains we can present the following list of potential themes, which from your point of view are relevant for the support of businesses. Additionally we have evaluated the different topics regarding the importance and value-adding impact for the three segments (Microelectronics ME, Microsystems MS, Nanotechnologies NT).

Relevant Topics for Business Realisation	ME	MS	NT
Cooperation with universities, education and competence centers in order to develop new job and education profiles	Medium	High	High
Cooperation with relevant forums and branch organisation which are closer by the end user	Low	Medium	High
Cooperation with relevant platforms and network associations to accelerate international knowledge exchange	Low	High	Medium
Cooperation with private equity associations in order to ensure the near development based on capital market's requirements	Medium	High	Low
Cooperation with regulation authorities in order to develop common industry definition and standards	Low	High	Medium
Joint activities with the financial service industry in order to develop appropriate financing products	High	Medium	Low
Joint activities with media and opinion leaders in order to ensure publicity and increase awareness of citizens/societies	Low	Medium	High
Joint activities with research and database agencies in order to ensure availability of information and benchmarks	Low	High	High
Joint activities with industry partners in order to support, motivate and push the development of new applications and products	Low	High	High
Joint activities with governments and economic promotions in order to ensure efficient capital allocation and support initiatives	Low	High	High
Joint activities with law associations to address critical issues concern-ing patents, trademarks, contracting, product and data security	Low	High	High
Joint activities with the supporting industry (e.g. consultants, human resource agency) in order to ensure global competitiveness	Medium	High	Medium

Low Priority | Medium Priority | High Priority

6 Recommendation and Next Steps

This document presents a transparent overview along the value chain of Micro- and Nanotechnology and increases the awareness of business realisation-relevant topics. The widespread of existing and potential applications is tremendous which is why we have clustered the overall industry in different segments regarding industry condition, structure and maturity stage. This approach helps us to identify relevant fields within the segments for further discussion about potential areas for improvement. Nevertheless, for a deeper understanding of sub industry mechanisms and to develop appropriate measures in order to provide business realisation support, a professional industry analysis has to be taken into account. Therefore, we recommend the following next steps:

- Decide about the areas of special interest for supporting business realisation regarding importance and priority
- Define internal objectives and goals for the intended support activities
- Work out analysis framework, objective and scope of research, develop project plan (concerning the fact to present hard results a close cooperation with the benchmark group is important in order to get a continuous comparison within the different topics)
- Conduct desk and field industry analysis, present new results and findings