Problems meet solutions

Implementing
Micro-
and
Nanotechnologies

Eminent Report 9/2003

Table of Contents

1 Introduction

1.1 General remarks

This interim project summary report is an initiative of EMINENT participants for suppliers – the Micro and Nanotechnology (M@NT) community – as well as for the – new, potential - users of M@NT. You will find chapters valuable for all target groups. Some chapters are especially useful for the suppliers, some for the users. We hope, that the table of contents serves to navigate through the summary. Full information including work packages and relevant tables and overviews are available under:

www.eminent.ivamnrw.com.

The national branch organisations for companies active in the field of M@NT, enriched with institutes and universities, active in this field, started an EC funded cooperation project called EMINENT.

The objectives of this project is to accelerate the business to business activities for mainly SME's that deal with M@NT and more specifically to start common activities to achieve this on a European scale, thus also becoming an intermediate partner for other branch organisations, the European Commission and national policy makers.

It will disseminate non-confidential information, based on the work packages of the project as well as on the knowledge of each participant.

This summary covers first evaluations and results of the project, thus being incomplete. It is planned to extend and complete this report in a second version at the end of the EMINENT project. A lot of detailed information, tables, overviews, as well as all public deliverables can be found on the web. There you will also find information of the national participants involved.

We would appreciate to receive your comments, additions, suggestions and criticism in order to improve the final report, that should be available to all persons involved in the magnificent scene of M@NT. In advance we would like to thank you for your contribution (please email to: eminent@ivamnrw.com).

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

1.2 EMINENT – The European B2B accelerator for M@NT SME's

In times of international markets and a common European economic and scientific policy, the challenges and duties of branch organisations and interest groups cannot be fulfilled without international co-operations. Acting on an international level requires international discussions and decisions, to come to a European opinion.

EMINENT is the nucleus of a European organisation in the fields of Micro- and Nanotechnologies. It is the start of a European cooperation, which aims to be the international European representation of the enterprises and organisations, esp. SMEs, acting in the fields of Micro- and Nanotechnologies.

The targets are:

- To accelerate B2B activities, especially for SME's
- To give access to European activities
- To intensify the cooperation between the participants and other branch organisations
- To support existing regional organisations and initiate the start-up of associations in non covered countries
- To be a European representation of SMEs in relevant business and governmental forums

Therefore, EMINENT's activities are:

- Cross linking of application domains, bringing users and suppliers together
- Website, presenting all regional member organisations and related information
- Public relations, presentation and workshops
- Extensive information exchange with adjoining branch organisations on a European level
- Include further national M@NT organisations
- Close cooperations with the market multipliers in the branch organisations
- Broaden the basis to NAC

The EMINENT participants have been working in these fields for many years. With their experiences they will be able to give all the support that is needed. They have been working in the national networks as network coordinator, source of information and central point for all questions concerning micro/nano. With more than 350 members in more than 15 countries all over the world, every kind of Microtechnology product, production process, service and application is covered.

EMINENT would like to welcome new participants from all over Europe to join the community, as we want to be the 'European union' in the Micro- and Nanotechnology world.

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2 Objectives and scope of the report

The aim of this report is to create easy and logic access to gathered information that can benefit our target groups:

- members of the national EMINENT organisations,
- allied branch organisations and their members,
- the industry in general as well as
- governmental institutes,
- policy makers and
- tutors.

Since EMINENT focuses on Business to Business, the objectives of EMINENT are related to application creation and marketing.

Seen our target groups we will not detail too much and prefer to be understandable for all people directly or indirectly involved and refer to the relevant work packages and deliverables, mainly available on our website. More detailed information thus easily can be found.

Our main focus is based on the added value creating manufacturing chain.

At project start we gathered an overview of items relevant for M@NT SME's, active in this field. The top-ten issues for the members of the EMINENT participants are given in the following table.

Ranking of the relevant TOP 10 issues for M@NT active SME's

1. identifying synergy potential in non M@NT markets
2. website linking to all relevant user/supplier websites
3. reliable market information
4. overview of national initiatives for M@NT
5. creating access to R&D results (universities, institutes)
6. forming joint workgroups for identified technologies
7. listing supply chain relevant themes
8. overview of relevant European initiatives
9. joint workshops for mutual perspectives information
10. identifying successful research/development/product/market examples using seamless M@NT production

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3 The innovation processes by implementing disruptive and incremental M@NT technology

3.1 Creating B2B opportunities for M@NT SME's

Main objective of the EMINENT project is to contribute in business acceleration of M@NT SME's based on a close cooperation of national M@NT branch organizations (the EMINENT participants) and by establishing cooperation with relevant product/market oriented branch organizations. These cooperations result in joint activities, where users and suppliers will meet.

In order to achieve more understanding of the hurdles at one hand and the possibilities for business generation at the other hand, this chapter will give an overview of:

- disruptive and incremental technology
- value chain characterization
- national differences in the supply chain strength
- four basically different business models characterizations

A better understanding will help to define business opportunities for both users and suppliers and in some cases also to identify potential risks.

3.2 Disruptive technology characterization

Disruptive technologies have to develop their specific manufacturing steps, design and simulation tools, marketing and sales methods and organs and in many cases also to generate new markets. Examples of disruptive devices based on micro electronics are: computers and computer peripherals and controlling devices, such as (mobile) telecommunication, world wide web, television, audio, as well as industrial production and process controllers.

Disruptive technology basically starts as technology push with science as driver and return of money is only generated by companies that can repeat in a cost effective way higher added value for the delivered functionality costumers are willing to pay for. Reaching this, a new killer application has been generated.

At the beginning micro electronics was a disruptive technology, using a "new" material (silicon), using new production processes, design tools, creating intelligent devices and generating complete new industries, products, trading regulations and trading channels, information exchange, etcetera.

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Nowadays micro electronics technology has been incorporated in our daily life, is highly standardized and most developments are highly predictable.

The general trend of miniaturization, function integration, higher intelligence and easier use of products will be further accelerated by increasingly complex software and hardware. The latter mainly realized by the rather new M@NT technologies.

In micro electronics we basically use one material characteristic of silicon: its semi conductivity. And all applications are based on the flow of electrons and protons, thus mainly on the electrical behavior and some other material properties used for metallisation and surface modification. In M@NT we use many material characteristics and all kind of material shaping processes, partly coming from the micro electronics industry, partly from the precision engineering and mainly completely new developed for M@NT applications. It thus combines every knowledge we have about materials and processes and challenging us to further developing of new or bettered manufacturing technologies.

Disruptive innovation will not lead to products on the markets. For this, incremental innovation is still necessary (see next chapter).

3.3 Incremental innovation characterization

Main difference between disruptive and incremental innovation is the possibility to use for a great deal existing infrastructure and know how. This means knowledge and availability of materials and fabrication processes, design and simulation tools, sales methods and/or organizations, consulting, funding and financing, and so on.

➔ Technology push has been transformed to market pull.

By adding new essential product functionality and/or miniaturisation by implementing M@NT, "new" products with higher added value can be created. The technology now is used in existing product/market combinations and can use all already available tools and means. Costumers more easily will understand this new product and will have less psychological obstacles to overcome for purchasing.

As disruptive technology originates from scientists, incremental technology originates from engineers. Therefore it is essential to have engineers with knowledge of new (disruptive) technologies in order to implement these.

➔ Technology is no product to sell; only applications are to sell and buy.

It will be clear that M@NT will influence all products where higher functionality and miniaturization at reasonable costs can be integrated. It therefore will influence our

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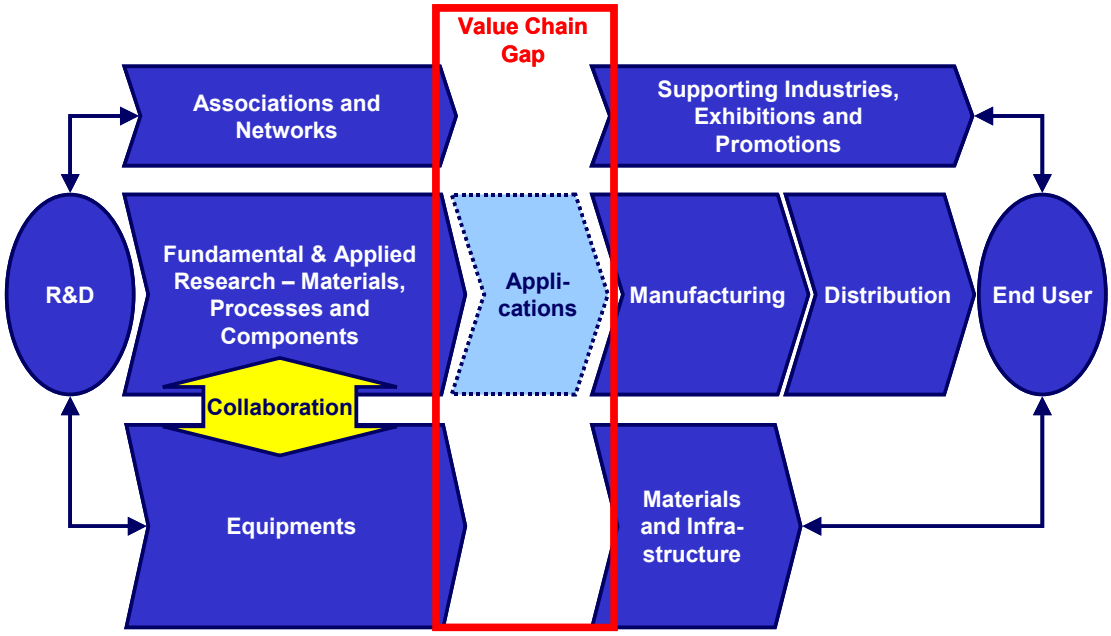
complete scenery. In manufacturing, nutrition, telecommunication, services, leisure, security, etc. In all aspects of our daily life.

3.4 The innovation process through the value chain

3.4.1 Value chain characterization

In work package 3.1.1 the value chain for M@NT is introduced, showing a disruptive break through all relevant aspects and the missing of applications, but also in manufacturing equipment and branch organisations.

The following chart illustrates a rough overview of the current value chain for M@NT SME's. 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.



Picture: The value chain for nanotech products.

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3.4.2 Hurdles and potentials in the supply chain (development and manufacturing)

The explanation of the different steps and gaps in the supply chain will assist suppliers and their customers (often infected with high expectations) to be aware of these hurdles and to tackle these phenomena, based on a market oriented business model.

3.4.3 The supply chain with gaps

Supply chain links description
Below you will find a description of the different segments in the supply chain. Additionally a survey of the author gives a comparative impression about the national scores of the different EMINENT participants countries.

Fundamental research and technology development
Fundamental research and technology development mainly take place at universities and institutes. Technology development meanwhile is mature and becomes more predictable. Almost all of this kind of research is technology drivenThe EMINENT participants in general have good access to these information sources and are able to address specific technical interests of companies.
Although most research still is linked to silicon, other materials like ceramics, shape memory alloys, glass and a lot of plastics become increasingly important.
The moreover multi domain active layers, downscale and quantum effects have a broad attention.

Gap 1: technology transfer
In order to be able to use developed technology it has to be available by design rules and manufacturing processes. Additionally micro/nano technology needs specific knowledge about surface behaviour, physical down scaling effects and high yield manufacturing processes and tolerances. Technology transfer in general is still immature and partly core business for design houses. and done by projects and programs like Europractice, Eureka, euspen and many national and European initiatives and projects. A relevant overview of European initiatives is given in work package 2.1,

➔ The EMINENT participants contribute in closing this gap by organizing workshops, seminars and exhibitions and informal information exchange by all kind of networking events.

Product development and design
Since knowledge often starts at universities and institutes, most often starters (science oriented) become the first users of these technologies and carriers for innovative product development (an engineering discipline) with a strong interdisciplinary character. In general product development is still immature, mainly

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because early manufacturing involvement in too many cases is neglected and production up-scaling therefore results in needed additional development. Good science oriented engineers are able to develop complete new products, in some cases with killer application potential; they create the technical paradigm changes and also changes in society behaviour.

Gap 2: industrialization
New (disruptive) technologies normally have no connection to existing production facilities. The designer in general has little knowledge of the constraints to upscale production. The industrialisation of M@NT therefore is immature.
Functional micro and nano structures/systems have to be connected to the real world, this means with interfaces and dimensions adapted to human beings. Due to down scale effects, many assembly processes influence the system (in many cases a process even influences another process or product behaviour).

Manufacturing (front end, back end, component assembly)
In general the product unfortunately has to be reviewed in order to reach stable manufacturing processes. Often the needed manufacturing infrastructure is not sufficiently available, with the chicken-egg problem for investments. Needed in-process-testing often has to be developed too. For many products the needed production infrastructure therefore is immature, except for most system suppliers that have their own product specific manufacturing infrastructure.
In many M@NT cases assembly takes 60-80% of the product price and should be cut down to at least 15-25% of the manufacturing costs.

Marketing and sales (sales and distribution)
The market for M@NT SME's seldom is the consumer market. In most cases customers will be system suppliers or system integrators, often an OEM, who already have market access and who use the micro/nano technology for product innovation or to explore new market share.
Depending on the business model (techno start-up company, subcontractor (design house, manufacturer, system supplier and incubator company) market approach will differ a lot. In paragraph 3.6 you will find an explanation about these different models and their consequences.

3.5 Supply chain strength evaluation per country

3.5.1 Germany

- technology development (mainly driven by automotive and medical applications) and transfer is mainly done by Fraunhofer Gesellschaften (FhG), Forschungszentrum Karlsruhe (FZK) and IMM Mainz.

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- technology development takes place all over Germany by different centres (like Dortmund, Karlsruhe, Mainz, München, Freiburg)
- several universities (like Freiburg) and technical High schools have special several M@NT educational programs
- for technology transfer several governmental programs are running (like TIP (technology initiative program, BMBF programs); a lot of coordination has been done by VDI-VDE
- for marketing and application search specialised branch organisations like IVAM, ZVEI, AMA and VDMA are active
- a lot of spin-offs come from universities and institutes after a longer incubation time and with non-commercial based support
- the high quantity of funded projects on different levels realised a dense network all over the value chain
- German industry seems still to stick on the traditional wish to exploit as many manufacturing links over the value chain as possible
- different suppliers of back-end and assembly equipment developed special lines for M@NT applications

3.5.2 France

- a high concentration of scientific research and technology development is concentrated in a few centres (like Grenoble, Lyon, Besançon, Lille) and is driven by aeronautics, defence and telecom
- there is a strong involvement from both government and big industries
- spin-offs are being nursed till they have been grown almost to adulthood, prepared to grow further with less protection and did find its market place
- a lot of different industrial activities take place in front-end and back-end equipment and services, rather than in applications or assembly activities

3.5.3 Switzerland

- an important role for technology transfer play the technical universities of Zürich and Lausanne, as well as CSEM (a national public/private financed institute for micro electronics and precision engineering) in Neuchatel
- there is strong industrial involvement in almost all development programs, both from SME's as from big industry; thus these activities are mainly application driven, pragmatic and rather low funded
- industrialisation of complex products into mass production is part of Swiss genes and skills
- spin-offs and start-ups are almost mature, have a complete management team, and are well financed before they leave the protective infrastructure of universities and institutes
- traditionally there is a strong equipment industry, also for M@NT

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3.5.4 Belgium

- Belgian government does not show specific interest in M@NT support and the degree of organisation of this segment is rather low, although growing
- Important drivers are the universities of Louvain, Brussels and Gent, but especially the IMEC institute
- like in France and Switzerland most spin-offs and start-ups have been nursed till maturity and a solid financing has been established
- the design, development and manufacturing infrastructure is rather closed and mainly available by subcontracting

3.5.5 The Netherlands

- there is a strong scientific interest in M@NT at three technical universities (Twente with the MESA institute, Delft, with the DIMES institute and Eindhoven)
- there are important scientific education programs running many years
- traditionally the Dutch have some trouble in industrialisation and M@NT is no exception
- technology transfer mainly takes place by funded joint pre-competitive development projects, where industry is involved as (potential) user groups
- originating from Philips, there is a strong front-end and assembly equipment manufacturers infrastructure, mainly operating for the semiconductor industry, but taking up M@NT

3.6 Four M@NT business models

3.6.1 General remarks

It is the feeling of the EMINENT participants that in the end only real money is coming from sales to the market. It is obvious, but not always recognised, that business activities have to reach the market and every business therefore must have a direct link to the market or being a link in a chain that reaches the market. This also includes products like information and protected knowledge.

100% funded development, not leading to market sales by anyone in the value chain, or a contribution to other business, is completely wasted money and anyway no business.

We recognise different types of companies active in the M@NT field:

- techno start-ups
- subcontractors (design houses, manufacturers, equipment suppliers)
- system suppliers
- incubators

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The importance of the recognition of these different models is that they all need different market approaches and will have different business plans. In general they have to deal with Business-to-Business and hardly with Business-to-Consumers, with quite different marketing approaches.

Most SME's belong to the first two mentioned models and we will concentrate on these. As start-ups in many cases are willing to reach the model of system supplier, we also will give some insight in this model.

3.6.2 Techno starter

"I have such an interesting technology, everyone will buy it"

The goal of a techno starter is to create a killer application. The right combination of technology, product, time to market and profitable market share. In case of success the pay-back is very high. These "golden apple" as low hanging fruit introduced too high expectations during the last decade of the last century.

The company has to overcome all hurdles as mentioned in chapter 3.4.3.

Statement 1: technology itself only becomes valuable in applications, preferably with unique selling points and covered by patents and/or licences.
Many start-ups, coming from universities and institutes and confronted with a specific technology, or even better, a specific market need, intend to build a company, without experience and in many cases with too less skills. Their job is a tremendous one, because they have to overcome a lot of hurdles, of which to overcome all disruptive aspects and changing these in incremental ones is very M@NT specific.

Statement 2**:** the (mainly scientific oriented) entrepreneur has to form a team that covers all different aspects of the management needs.

Statement 3: every business has to be based on a thorough and complete business plan, without wishful thinking and with a thorough SWOT analyses and market study incorporated.

Statement 4: every start-up needs at least one launching and profitable market recognised customer at an early stage of the business.

Statement 5: networking is essential. To be effective it is essential to have functional linking pins (persons that link at least two disciplines) in your network.

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3.6.3 Subcontractor

"My knowledge, infrastructure and skills result in the best price/performance ratio"

Subcontractors cover a part (one link or more links) of the value chain. This can be a small part with high investments e.g. a specific manufacturing technology or a broad multi-link covering e.g. gap-closers and all in between.
In this report we will cover the design and manufacturing part of the value chain.
Some technology push still have to be performed till M@NT has become an engineering character and sufficiently M@NT educated engineers are working at companies.

Statement 1: the subcontractor needs ultimate knowledge and skills and sufficient infrastructure to reach the needed price performance ratio

Statement 2: the subcontractor needs multidisciplinary in order to understand customers needs and to be able to assist in components specifications and process validations, as well as the ability to cover the specific needs for the boundary conditions higher and lower in the value chain

Statement 3: profit is based on repeating procedures; customers should have long relationship potential; be aware that the customer covers the value chain and will be profitable themselves

Statement 4: where the techno starter will search for the customer, the subcontractor mainly has to be found by his customers; marketing effort here is becoming widely know within his group of potential users

Statement 5: a clear positioning in the value chain is very useful and the availability of proven partners upfront and further in the value chain could be decisive

3.6.4 System supplier

A system supplier originates from an existing market. System supplier search for profit optimization by higher added value, cost savings, growth. Often they are original equipment manufacturer (OEM). They are experienced and have organized and control the whole value chain. Additionally they act risk avoiding.

System supplier have the power to create and implement business plans and to complete the value chain, either by own developments and existing infrastructure, shared developments, or by buying expertise, licenses or (parts of) companies and have the power to hurt competitors. They are recognized in the market.

The moreover they can afford to have their own M@NT specialists, that can define all essential specifications and can review potential partners. Implementing M@NT is a

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strategic decision and therefore partners will be qualified and experienced subcontractors. System supplier are willing to pay for risk reduction; either in time and/or money. Business preparation often takes a lot of time.

Statement 1: system supplier need big business in order to have sufficient ROI;

Statement 2: techno starters should end as system suppliers

Statement 3: development focuses on (potential) customers need(s); there will be hardly any budget for other trials or developments

Statement 4: system suppliers will try to get as much as information "for free",

Statement 5: either long term relationships or an essential contribution in a specific project are the only reasons of a system supplier to deal with a M@NT SME; the added value of the SME must be clear and confirmed

3.6.5 Incubator

Seen the fact that for new business creation it is essential to have full value chain knowledge and control, the interaction within and in between the different links in the value chain, the financial risks, legal problems due to interfacing uncertainties and problems to define who bares final risks, it is logic that incubators will have an important role in the application realization aspects of M@NT.

3.7 Shared experiences – benefit from the learning curves of SME

3.7.1 Don't act without a realistic business case

- be fair and honest to yourself
- define your mission, main objectives and strategy (with indication of core competences, SWOT analyses, competition analyses, product/market combinations, finances)
- show how you will build a strong management team that covers all needed disciplines
- realize costs will double, development time will double and sales will be half of planned, without becoming desperate
- VC's have not just to bring money, but also management and market support; a VC with knowledge of your market (finances already another company active in your market) brings added value

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3.7.2 Technology marketing and how to introduce a new product successfully

- become part of and cover a whole value chain with clear interfacing and responsibilities
- focus on your main activity and make this clear to the outer world
- the end-market dictates your way of acting and it has its own rules you ought to know and to take care of
- be part in several relevant and active/effective networks

3.7.3 Design for micro assembly, early manufacturing involvement

- product development is a joint effort of technology suppliers, design houses, foundries, assembly specialists and sub-contractors; detailed know-how has to be integrated in every product concept and development
- products from universities and institutes still have to be industrialised; usually taking a factor of four more time than expected by the technology supplier

3.7.4 Strategic partnerships, clustering and cooperation as key to success

- cover the supply chain by strategic partnerships, cooperation agreements for a specific aspect and by clustering; both for being competitive as well for information exchange

3.7.5 Relevant themes for business realization

A list of different topics regarding the importance and value-adding impact for three segments (Microelectronics ME, Microsystems MS, Nanotechnologies NT) is given below as part of work package 3.1.1.

Relevant Topics for Business Realisation	**ME**	**MS**	**NT**
Cooperation with			
universities, education and competence centers in order to develop new job and education profiles	■	■	■
relevant forums and branch organisation which are closer by the end user	□	■	■
relevant platforms and network associations to accelerate international knowledge exchange	□	■	■
private equity associations in order to ensure the near development based on capital market's requirements	■	■	□
regulation authorities in order to develop common industry definition and standards	□	■	■

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Relevant Topics for Business Realisation	ME	MS	NT
Joint activities with			
the financial service industry in order to develop appropriate financing products	■	□	
media and opinion leaders in order to ensure publicity and increase awareness of citizens/societies		□	■
research and database agencies in order to ensure availability of information and benchmarks		■	■
industry partners in order to support, motivate and push the development of new applications and products		■	■
governments and economic promotions in order to ensure efficient capital allocation and support initiatives		■	■
law associations to address critical issues concern-ing patents, trademarks, contracting, product and data security		■	■
the supporting industry (e.g. consultants, human resource agency) in order to ensure global competitiveness	□	■	□

□ Low Priority □ Medium Priority ■ High Priority

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4 The EMINENT information services

In this chapter you will find an overview of relevant work packages of the EMINENT project related to a specific subject. All listed work packages are available on the website as pdf-download. Some of the tables are extracted and directly available.

www.eminent.ivamnrw.com

Overview of the work packages (WP) on the website:

WP 1	**Linking the EMINENT nucleus participants**
1.1.7	questionnaire; results of an inquiry what issues are of most importance for M@NT SME's
1.2	extending participants; an overview and validation of M@NT regions for EMINENT extension
WP 2	**Linking the market place**
2.1	EU + branch initiatives; an overview of relevant initiatives for M@NT
2.3.1	overview of branch organisations that could be interesting for assistance in market entrance
2.4	an overview of websites of interest for companies and institutions active in the M@NT field
WP 3	**External activities**
3.1.1	supply chain relevant themes for business realisation, including nano and microelectronics
3.1.4	M@NT financing issues
3.3	ppt presentation of the EMINENT objectives (Hanover Micro Technology, COMS, etc.)
3.8	generation of a M@NT growth index
WP 4	**Project management**
4.5	project summary implementing micro and nano system technology

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