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# 1 New Business Models	
## 1.1 Beyond Lean Manufacturing The set of methodologies of lean management defines the management system in series production. The transformation and adaptation of these methodologies towards higher complexity, higher variants and changeable manufacturing aim at activating productivity potential in series and small batch production. Lean management methodologies, which have been successfully implemented in automotive and supplier industries, are quasi standards of today’s efficient manufacturing. The competitiveness under the European conditions of high wages and changing markets and technologies revealed that lean management is a prerequisite but cannot reach the cost advantages in general. Lean management methodologies are required for customised manufacturing.	M ST
### 1.1.1 Preventive Quality Management The quality and reliability of products, services and industrial operations (business processes) are preconditions for High-Adding-Values and the growth of demanding manufacturing sectors. Following the trends towards customised products and build to order strategies in manufacturing, new and efficient methods are required in all manufacturing sectors, in order to assure quality and reliability in early phases of products. Preventive quality management approaches are required. They include innovative methodologies for the introduction and management of the life cycle of new generations of products, such as those including mechatronics and intelligent products. There should be a focus on the design of quality and reliability and the design process should include the ability to forecast the utilisation and life time of complex products. Methodologies have to take into account the development of products by co-operative and networked engineering, the capability of the design, manufacturing and measurement processes and the influences of manufacturing technology choices.	S ST

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Several main results can be envisioned: (1) Basic methodologies for preventive and life cycle-oriented quality management including improved design (2) Increased reliability of complex products (3) Development of an European product documentation system (4) Reduced losses caused by quality problems (5) trans-sectorial implementation for pushing High-Adding-Value in the manufacturing of complex products.	
1.1.2 Manufacturing Fitness, Balancing Reactivity and Efficiency	M ST
Industrial manufacturing is oriented towards achieving the main objectives of time, cost and quality. Industrial paradigms strictly follow conventional paradigms like balancing the capacity or management of resources with high rates of utilisation. The next-generation manufacturing is characterised by customisation which reduces the lot sizes and increases the variants and specific products, manufactured in a short time. Another specificity of next-generation manufacturing is the increasing complexity of products. This challenge can be overcome through actions like the development of methodologies for future manufacturing management, based on new and innovative paradigms, mainly aiming at achieving following goals: single customer order, flexible work time and high reactivity, especially in the sectors of customised products. Market influences and changing customised products by reducing the lot sizes to 1 with increasing inefficiencies, requires new methodologies for the balancing of capacities in turbulent markets. These are intended to support the: • Flexibility of resources and flexible work management • Situation, based on balancing of the capacity load • Self-organisation and self-optimisation, self-controlling with autonomous work groups and business units • In-situ Management • Learning organization	
1.2 Survival Strategies in a Turbulent Industrial Environment and High-Adding-Value in the Life Cycle	L ST
The development of the market depends mainly on economic factors. In many industrial sectors and especially in investment sectors, the normal good cyclic fluctuations with strong ups and downs represent main factors of market turbulences. Many enterprises are not capable to remain competitive or at worst, they do not survive in these cyclic	

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phases. Other challenges are issued by market strategies of competitors, which operate in areas characterised by lower wages and higher flexibility of the work force (hire and fire). European human-oriented culture and social standards on the one side and high fix costs caused by capital intensive production on the other side highly reduce the chances of surviving. European manufacturing industries, operating under the increasing pressure of making short time profits, represent another turbulence factor. All these factors reduce the employment and sustainability of many industrial sectors. The current economic models are mainly oriented towards growth and are following the preventive strategies coming from product innovations. There is a requirement for manufacturing strategies and methods for: • Balancing the load in mid-term cyclic markets • Overcome critical short-term situations • Dynamic forecast • Adaptation of fix costs (dynamic systems) • Dynamic work force models • Financing of critical phases. These strategies represent the main directions on which research and technological development activities have to be oriented, with high priority on short term horizons.	
1.2.1 Transformation Management Strategies for Survival and Success in Turbulent Environments Manufacturing enterprises are influenced by multiple dynamic external factors concerning the products behaviour in global markets, the strategies of competitors, the regional level of wage and reward systems including management of employees healthcare cost, regional infrastructure, the pace of technical innovations, the financial requirements of the investors and the financial constraints of operations, the robust supply of materials and components. Internal business factors such as qualification and capability of employees and the management, the demands and systems required by different customers, the utilisation of resources and the capability of processes as well are influencing factors. The enterprise environment is tough and turbulent. Only those enterprises can survive and be successful in this turbulent environment which are robust enough and have the capability to continuous adaptations and transformations. These challenges are particularly acute for SMEs which operate in traditional and new technology sectors and do not have the scale and resources to address all the changes in their environment. The technical content of transformation management strategies for survival and	M ST

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success in turbulent environments is the development of such strategies that recognise the evolution of the manufacturing business environment. Research challenges envisioned here include: identification of methods for small businesses aiming at recognising and responding to external threats; determining and assessing candidate business models for SMEs to assist their survival and transformation; defining mechanisms that allow SMEs to take similar advantages from manufacturing in the enlarged Europe in comparison with those accessible to large companies; determining the required competences and mechanisms for SMEs to form co-operative transient business networks to increase their scale and to respond to opportunities; determining and disseminating best practice survival and transformation mechanisms developed by successful SME businesses or agencies; generating tools and techniques that support transformation; and the development of economic regulations and financial instruments that support transformation.	
1.2.2 New Product and Process Life Cycle-Oriented Strategies	
The new paradigm of manufacturing is oriented towards the optimisation and value creation of products along their whole life. This assumes the prediction and understanding of the future user requirements and design of products (customisation), the manufacturing, product-near services and end-of-life. The global market is registering an increasing demand of customised products, which have a short delivery time: in parallel, a continuous shift of business is taking place towards the development of a new and innovative system of products and services, capable of fulfilling specific user demands. Under this perspective, the analysis and the best orientation of the product life cycle, to achieve maximisation of potential and of related business opportunities, are crucial elements that have to be exploited. Furthermore, the integration of new technological developments in products and consequent modifications in the production process are driving the manufacturing sector towards complex and articulated dynamics that require strategic intelligence and a new role of workers. To properly face these challenges, the production process shall be analysed and optimised in its structural and functional aspects, considering the total life cycle, in order to identify qualitative aspects, which have to be enhanced, new performance factors, networked integration and interaction aspects, and environmental factors which have to be achieved. Innovative and new combinations of the following elements – customisation – production – service – end-of-life, including within each element the solution of “what, how and when” in order to introduce knowledge, know-how and technologies, represent valuable solutions to the above stated challenges.	M MT

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Several main development issues and targets at network and factory level have to be mentioned: • Methodologies for regulating the new paradigm with strategic intelligence on markets, products, technologies and human resources (success stories, best practices, innovation laboratories) • Methodologies and tools for understanding product/service potentials and for identifying new business opportunities with respect to new market/consumer demands, in terms of product enhancement and new consumer-oriented services • Process architectural analysis, process functional analysis and performance calculation, multi level simulation, process performance optimisation product/service related • Tool and methodological support for the integration of state-of-the-art industrial paradigms for manufacturing fitness, balancing reactivity and efficiency • Tool and methodological support for integrating systems and processes of suppliers and customers capable of supporting continuous adaptation.	
1.2.3 New Consumer-Oriented Business Models for Product Life Cycle Integrating systems and processes of suppliers and customers which are capable of supporting continuous adaptation to market needs are needed to strengthen the competitiveness of European manufacturing and logistics companies, facing new opportunities and threats due to continuing globalisation. The main development issues and targets are a further transition from products to solutions (services), improved and increased involvement of the consumer in more parts of the value chain and managing the consequences of the reduction of the vertical integration traditional in larger businesses. Further, environmental drivers and an increasing recognition that manufacturing businesses do not benefit sufficiently from the value that they create, emphasises the need for the development of a whole new life cycle-based business model that minimises environmental impacts while maintaining economic sustainability. The focus should be to resolve the challenges that need to be addressed to encourage businesses to work in open collaborations within a production and logistic network across the whole life cycle; the development of new cross-company business models, addressing aspects of cost, benefit and risk, sharing within coherent financial and intellectual property frameworks which give mutual benefits; and to define and create the supporting technologies and tools, which are necessary. These new business models should cope with new product concepts, also including aspects	M MT

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of dismantling and recycling, and providing a set of services and functionalities, including a potential to upgrade products by “after sales”. The projects are expected to have a successful technology demonstration, technology transfers and training activities. The performed research aims at achieving the following main results: an increase in added-value, productivity and economic sustainability in Europe through an industrial stakeholder involve-ment. New industrial strategies will increase and sustain production capability and capacity and responsiveness, improve manufacturability, quality and reliability as well as decrease the consumption of raw materials and energy.	
1.3 Management of Complexity The manufacturing enterprises have to handle new demands arising from the market, from new technologies or restriction by pollution, from the society as a whole, becoming ever more complex in all aspects in the past years. The global economy and the socio-political scenarios are increasingly more intricate, more fragile and difficult to understand and manage. Management of complexity is a very important issue for harmonising all these demands in a practical way, in a management strategy. It implies identifying how complexity starts and works in the complete manufacturing and distribution process. The process of handling and managing complexity has to consider the development of tools for: • Complex visualisations • Interdependent visualisations • Scenario management, if –what analysis • Complex simulations • Reducing and optimising processes, interdependencies and connections. The management of complexity will lead to successful manufacturing operations, allowing manufacturing enterprises to be successful in their markets and be more accurate and rational in their manufacturing processes and their product range.	L ST
1.3.1 Innovation and Transformation Processes The transformation from basic research to application is essential for the effectiveness of the research system and market success. Many companies invest only a small part of their turnover in the development of new products, based on new results of basic research. It is	S MT

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known that aggressive technology leaders combining product, production and marketing strategies are more successful than followers. This is due to the structure of the research system but also a question of reliability of the transformation process. The main constraints from industrial perspectives are: • Missing models for technology management and the integration of manufacturing strategies in the strategic planning processes. • Missing methodologies for the integration of new technologies in the resource planning processes. • Uncertainness about the potential and the effects in manufacturing. • Missing experiences of practical points for reliability • Process chains from research to practice To overcome the above stated challenges and to accelerate the knowledge transfer for innovation purposes, research and technological implementations aim at the development and evaluation of methods for technology evaluation, the integration of manufacturing strategies in business planning and on time information about knowledge of new technologies. This includes the economic potential analysis of new technologies by practical procedures: feasibility and reliability studies, forecast and simulation, organisational integration of operations like simultaneous strategy planning.	
1.3.2 Change and Modification Management Due to increasing dynamics in the markets and decreasing product life cycles production ramp-ups have to be performed both more often and within shorter intervals in many high-volume industries. Especially suppliers are facing time and cost problems in serving different original equipment manufacturers. In order to reduce development time, avoid late product changes, and improve the co-ordination of development, engineering and production, the simultaneous engineer-ing approach has been developed and diversely applied. As a result of increasing product variety and augmenting fragmentation of the value chain amongst many companies, the traditional SE-approaches are not enough so that new approaches are required. The results of a performed research in this field aim at expanding original SE approaches in three dimensions. Firstly, a company must be harmonised along its supply chain, supporting the fast and flexible dissemination of technical changes in products over all participants of the value chain. Secondly, while an increasing variety of products use the same resources, solutions for handling changes shall be developed.	M MT

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Thirdly, a company has to be able to propagate ramp-up activities throughout its global production network (e.g. start-up and launch of a pilot line at site A, afterwards shifting of series production to site B. Projects should address improvements especially for suppliers on all levels of the value chain, e.g. in automotive industry.	
1.4 Machine Tools and Centric Business Models	M MT
Changes connected to the adoption of new business models for machine tools have special impact on the relationship between MT producers and MT users. In particular, the changes have impact on the responsibility of the results of operations, actually shared between builder and user. A builder is responsible for aspects which are mainly connected to the machine's safety and performance (precision, speed, reliability), while a user is mainly responsible for the parts which have to be realised (supplying man power, raw parts, tools, testing facilities, etc.). Adoption of new business models would affect this traditional model, in three aspects: 1. better definition of the 'grey areas' in machine tools of the producer/user relationship: some activities are not actually well covered by both of the two, such as machine installation in the job shop, its final testing, the definition of reliability-connected aspects (MTBF, MTTR, TCO); some performance measurements, etc. 2. NBM-oriented technical aspects: the adoption of a new type of relations between customer and MT producers, such as 'pay per use', 'Pay per part', etc. will move some responsibility of the production from MT users to MT producers, with consequences from a technical view point. 3. The more extreme possibility connected to the NBM and MT user/customer relationship is to transfer the complete responsibility of production to machine tool builders. Then, they will be responsible for parts of the design, technological cycles, machine tool definitions and set ups, raw parts procurements, man power; etc. The only difference between this model and the usual activities of Tier 1 is connected to the localisation of the production facilities in the end user plant. Then, the machine is owned by the producers, run with the producers' personnel, is maintained by the producer, discarded parts are just cost for MT producers; the end user just pays for finished parts. Taking into account the above mentioned aspects, a deep reconsideration of the roles and activities of MT builders and users, as well as of the technical, managerial, economical, financial, normative and legal aspects, might be taken into account.	

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The above mentioned aspects require a deep investigation and modification of the traditional way of working, involving a wide number of scientific and technical disciplines, as well as various industrial sectors. This will be done with the target to use the European machine tool knowledge of manufacturers, acquired in decades of activity. This knowledge can then be used to help the progressive loss of technical specialisation coming from many industrial sectors, in which the focus has moved from production to business, from commercial to financial aspects, and to help to reduce the effects of progressive aging of population and of the reduction of interest for technical professions coming from youth. • Machine tools: the actual machine tool concepts might be reconsidered to be adapted to different applicative contexts. In particular, they might be focused towards a higher flexibility and reconfigurability, in order to be adapted to various operational situations. • Control and diagnosis: a wide use of ICT technologies can be useful to keep track of all the conditions of running machines located at customers' sites, as well as to define the number of manufactured parts and defect ratios, in order to allow the payment by the customer made under 'pay per …' strategies • Project capabilities: Machine tools manufacturers might enlarge their knowledge base in order to cover the development of process and pro-duct designs. This would also lead to the integration of activities for a group of SMEs, in order to create a critical mass to face this challenge, helping to increase regional, national and European level collaborations • Rules and standards: the actual standards and rules, connected to the use and testing of machine tools are focused on a traditional way of using machine tools. New concepts for testing might be developed in order to meet the requirements and avoid contrasts. • Law aspects: the European and national legislations might be reviewed to cover the new kind of relationship that will derive from the new way of cooperation between MT users and producers, avoiding contrasts and respecting rights and commitments for all of them • Financial and risk reduction aspects: the machine tools producer might deeply change its financial and risk management approach. In fact, in the traditional model, risk is evaluated ex ante, during the definition of contracts and with market analysis of potential customers, while financial aspects, connected to machine development and production, are covered with own capital or with bank financing or leasing, guaranteed by the contract signed by the MT user. With new types	

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• of business relations, a deep involvement of new participants (such as insurance) will be necessary; again, the formation of consortia and association of companies will be necessary to create the critical mass to manage such aspects • Intellectual property: new kinds of instruments for knowledge defence might be developed, in order to protect the rights of all actors involved in the NBM-based machine tools, giving also instruments that preserve information ownership during the design and commercial discussion phases • Training activities and social aspects: the machine tool sectors will increase their attractiveness for young workers by multidisciplinary and will represent a very interesting playground for innovative forms of training, based on multimedia, virtual reality and other ICT-technologies. The development of NBM-oriented machine tools is on the one hand, a multidisciplinary and transversal activity and, on the other hand, it will innovate one of the column of European industrial tissues, making it more fundamental for the worldwide manufacturing and ensuring a base of know-how, coming from the cooperation, based on co-design, co-technology and co-manufacturing with a wide number of customers, belonging to all manufacturing sectors worldwide.	

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2 Adaptive Manufacturing

2.1 Assembly Systems

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The assembly of customised and build-to-order products is one of the core competences of manufacturing. Short delivery times and an increasing complexity of products require high flexibility and permanent adaptation of the assembly systems. Hybrid systems with mixed automation, manual operations and assistance by robots are objectives of the technical development. Adaptation without losses of efficiency by set-ups can be realised by modularisation und plug-in technologies. The assembly execution system recognises the actual situation of the system, available resources and orders which are connected with links to PPC and MRP in real-time. The implementation of principles like self-organisation, self-learning and self-optimisation, which are based on the integration of multi-sensor/actor systems, leads to intelligent systems. But the variety of assemblies in customised manufacturing makes it necessary to change the operations in-situ between automation and human work.

2.1.1 Adaptive Technologies for Joining Processes

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A specific element of this action is the integration of non-joining processes and assembly. The system has to be linked to the documentation of assembled parts and components as well as to measurements and physical tests. In-process measurement for quality reduces time and costs. Intelligent cognitive elements of adaptive assembly systems are the ability to learn, diagnostic features and in-situ simulations. It can be added by Internet information systems and human interfaces with voice processing and tactile feed-back.

By the employment of the above presented enabling technologies, several relevant results can be obtained: (1) Configurable systems for assemblies reduce costs and time even in customised manufacturing; (2) Front-ranking of the European manufacturers of assembly systems; (3) Adding-value in sectors of assembly suppliers, IT for manufacturing, control systems and services; (4) Benefits for the

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users, mainly in sectors of automotive, electric and white products; (5) Leading the world market by the application of assembly technologies.	
2.2 Flexible Machines for Rapid Reconfigurations	M MT
The mechatronic components are widely used in end-products, for example in the automotive and aerospace industries. With increased autonomy they will offer a very effective way to configure robots and handling units. With increased precision and reliability (including fail-safe hard and software interfaces) they will become promising objects for the construction of rapidly reconfigurable manufacturing equipment, suitable to be used in a flexible, agent-based production environment. The main objective is to create radically new, self-adaptive machine structures with online self-optimisation, based on mechatronic modules. The knowledge-based and/or self-learning intelligent systems can feature multi-layer control, sensing and actuator structures with a high level of redundancy guaranteeing a high level of reliability and allowing optimal performance of a production system under different conditions. Innovation lies in moving from current ‘assembled’ sensor, actuator, and control system architectures to truly integrated mechatronic knowledge-based systems. Main development issues expected in this area are: 1. Development of tools for integrated optimised system configurations based on a mechatronic simulation with respect of the resulting performance (including damping characteristics, working envelope, etc.), 2. Development of adaptronic modules and their integration into intelligent manufacturing equipment: • active intelligent components (integrating sensors, actuators, control, mechanical structures), adaptronic modules and interfaces, MEMS, MOEMS) • enabling the production of micro systems, micro technologies (e.g. human machine interfaces dedicated to micro systems manufacturing, miniaturised manufacturing equipment…) • enabling advanced automated process control 3. Enabling knowledge-based, self-learning systems through the development of multi-layer controls and model based real-time compensation routines, embedding machining process knowledge 4. Development of flexible signal processing methods, and wireless communication mechanisms and flexible system busses with integrated power supply,	

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5. Standardisation of mechanical, electrical and software interfaces. 6. Using the above, break the limits of conventional/existing manufacturing processes (machining, tooling, technologies), realising breakthrough of manufacturing methods and processes Expected results are (i) tools and methods for mechatronic manufacturing systems and components modelling, set-up and use; (ii) demonstrating applications for mechatronic modules and their usage in machines and production systems.	
2.2.1 Advanced Monitoring of Complex Manufacturing Systems Today, the monitoring of complex systems requires complex measurement and analysis functions. Algorithms use different sorts of knowledge but often depend on a regular up-date of a database or on the contact to a central knowledge base. Learning capabilities and the use of environmental data are limited. Analysis systems for an advanced monitoring of manufacturing systems or complex products should work decentralised to evaluate the state of the monitored systems. Knowledge is essential for such tasks, so new concepts for knowledge acquisition and use are required. Innovative systems also use decentralised and distributed knowledge, new mechanisms for integration of heterogeneous data sources or completely new ideas concerning time and location of the knowledge-generation and use. They utilise a wide variety of locally available data to give advice to the operator, including the remaining operating time, system degradation or time to the next service or repair. Also new concepts for user interaction to communicate the condition of the monitored system are applied to make operations more intuitive. User interfaces should reduce complexity for the operator but simultaneously maintain the full extent of the system's control. To cover new requirements or changed system environments, the functionality of the used measurement components can be changed by configuration and software adaptation; configuration of whole subsystems can be adjusted on the basis of experience and history.	S ST
2.2.2 Cost-Efficient Condition Monitoring Systems The research area should focus on developing systematic condition monitoring methodologies that are robust and cost-efficient, following possible directions:	S ST

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• Introduction of physical models of the machine's behaviour in condition monitoring systems. This should reduce the required training effort, involved in state-of-the-art condition monitoring systems. The models should match the machine's operations at any state of degradation. To limit the modelling effort, the physical machine model is ideally composed of physical component models, delivered by the component supplier. • Introduction of new sensors in production machines for condition monitoring should be minimised to reach cost-effectiveness. This can be achieved by advanced signal processing using existing sensors better. The above mentioned scientific research goals can be achieved by: • Combining information of multiple available sensors and controller signals (i.e. sensor fusion) new information can be obtained. A virtual sensor is realised like that. • Also, sensors can be used more extensively, e.g. in transient modes of the machine. Hence more information can be obtained from already existing sensors.	
2.2.3 Planning Tools for Open Reconfigurable and Adaptive Manufacturing Systems	S MT
Process planning and process engineering are parts of the chain from design to manufacturing. Taking into account new solutions for configurable manufacturing systems, it is necessary to develop new and knowledge-based tools for the support of planning. The implementation of a knowledge system in this process can be realised by a platform for process planning which is integrated in the information and execution system of factories. Elements of this platform should be: actual data of the factories' resources and capabilities, modules and standards of processes, interactive and participative systems for process planning, design of specific equipments for time and cost calculation, programming of machines, robots and automated systems, communication and distributed work. At the horizon, virtual-real workplaces are able to optimise and monitor manufacturing, wherever in the world the processes are running. Acceleration of planning processes for fast and reliable manufacturing in all sectors of manufacturing should be achieved through implementing this technology.	
2.3 Cooperative Machines and Control Systems	L MT
The transformation of traditional production line concepts to non-hierarchical agglomerates of autonomous manufacturing units is a key	

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technology for the new European production. Research and development has to focus on the application of agent control technologies e.g holonic manufacturing systems, service-oriented control architectures for autonomous manufacturing components in the main European manufacturing domains. Novel approaches in these domains shall encompass the life cycle of the production systems from the development of generic manufacturing ontologies, methods and tools for the design of co-operative production systems, integrated engineering systems, monitoring and control systems, HMI for integration of human workforce, reconfigurability and behaviour. R&D projects should lead to generic system solutions and demonstrate applicability and current limitations in specific manufacturing domains. The research efforts will demonstrate the feasibility and technological advantage of the new European production in the core industrial domains. It is expected, that the results will stimulate important industrial innovations in production technology and enhance industrial work environments. The developed technology will drastically improve the international market position of European manufacturers in respect to reactivity on new manufacturing processes and product innovations.	
2.4 Intelligence-Based Process Capability Enhancement Manufacturing processes are instable because of the high number of dynamic influencing factors (deviations of material, wear, dynamic of machines, etc). Manufacturing instabilities combined with the inaccuracy of measurement are compensated by the tolerance system. Tolerances are more and more reduced to guarantee the functions of products and to ensure the quality. Additionally, tolerances are defined for designing the end of manufacturing, but not the steps of processes (tolerance channel). To optimise the capability (cp) of processes today's post process measurement should be displaced by in-process or pre-process measurements. In order to control the process it is essential to integrate process models in the control system. This can include methodologies for signal analytics and machines – self-learning by implementation of cognitive systems. Specific features are the integration of sensors for measurable parameters under the specific conditions and systems for process control and monitoring. It is the objective to stabilise the process capability towards cp >2.0 even over a long time of usage of machines, taking into account the deviation and wear. All conventional and innovative technologies (casting, forming, cutting, joining, surface protection, laser-assisted technologies) are fields of this research towards intelligent manufacturing.	M MT

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Main outcomes of the above presented enabling technologies represent the push of the manufacturing quality towards zero defects in processes and process chains and realise intelligent self-optimising manufacturing systems.	
2.5 Manufacturing Control Systems for Adaptive, Scalable and Responsive Factories	L MT
Modern manufacturing control systems must respond quickly to continuous changes in the next generation responsive factory. With traditional manufacturing control system programming, it is time-consuming to make changes as a result of separate databases for the programmable logic controller (PLC), Human/Machine Interface (HMI), and supervisory control and data acquisition applications or modules. New engineering approaches that ensure efficient, robust, predictable, safe and secure behaviour for multi-scale, distributed, scalable and responsive manufacturing and factories are required, as well. The reconfigurability of software for current machine control systems is very limited, although the concept of component-based software integration has already been adopted in controller software development. Specifically, the following limitations and then the challenges in current control software development practices hinder the reconfigurability of manufacturing: 1) Application software is partitioned and implemented with proprietary information, 2) Control behaviours of the software are either built inside the implementation and hence, not customisable, or not modularised and associated with the corresponding software components, 3) Software implementation is specific to platform configuration. The development of new models of control systems which has to provide control and diagnostic codes, enabling the network architecture, data mapping and control and diagnostic system to be designed and integrated in a unified and single tool, represent the main research objective in this area. The scientific activities and research steps consist of creating a customised process control and quality data interface system to network stand-alone pieces of manufacturing equipment, such as PLCs, robots, process machinery, and test stations, at all levels of the next generation responsive factory, respectively from the network of factories to manufacturing processes.	
2.6 Interdisciplinary Design of High Performance, Reliable and Adaptive Manufacturing Equipment	M MT
Interdisciplinary design aims at supporting the mechatronics design approach towards rapid and cost efficient and effective design and	

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implementation and operation of next-generation production systems. In order to achieve this, new ways of interdisciplinary system modelling for the design phase have to be developed and then exploited. The initial design phase mainly focused on insight, abstraction, cross-fertilization, domain-independence (multi-disciplinarity) aspects, has to be supported by new approaches such as structured, innovative, fast and synergistic conceptualisation and diagnostics (learn from previous mistakes). On the second design stage the following fields are of high relevance: domain-specific dynamics and control, (differential) geometry, network and graph theory, statistics and measurement, tribology, construction, etc. Tools supporting them are already available, remaining in many cases scattered, fragmented and isolated. The aim is the development of a design environment integrating the existing tools and combining them with a proper common library environment that enables quick retrieval, reuse and tracking of the corresponding design methodologies and tools. Even more essential, a methodology which supports the modelling and design decisions has to be developed. The methods should provide sufficient insight of what the design tools are actually doing and point out throughout the whole design process the need for additional expert support. One of the main benefits of this environment is not only the support of the design process, but also the contribution to the continuing education and training of the users. Such a support should also keep the designer from drifting away from the original goal (functional requirements, adaptability, life-cycle cost, etc…). Furthermore, it should take the user out of his common context and terminology and thus facilitate the communication with team members to stimulate synergy and cross-fertilisation. The integration approach is holistic, in terms of enabling flexible optimisation of multiple criteria, including default attention for sustainability in the sense of reduction of material, energy consumption, waste and noise production, addressing all aspects of both production equipment and product, both at the technical and management level. The main research focuses in this area are: (1) Development of new methods for optimisation by co-design/ establishing the right conceptual system design format (function modelling…) (2) Development of a design environment by integrating domain-specific tools, focusing on the following main research directions: integration of and creating the synergy between existing tools; simulation of holistic production systems and of machines/equipments; development of design advisory systems, used to manage complex models and the modelling process itself – decision support of transferring functional specs into	

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specific domains (hardware /software); domain-independent general structures combined with domain-dependent libraries and toolboxes; standardisation and synchronisation of information which has to be exchanged between tools; distributed simulation/co-simulation The challenge related to the design and development of the desired environment resides in the complexity of integration of heterogeneous methodologies and tools, which maintain their own business models, procedures and data locally and in the requirement of dynamical data exchange. State-of-the-art ICT has to be employed in a platform of development. Related issues to the challenges presented above are: structuring and generalising the (knowledge) content of existing tools; data management of complex mechatronic objects; combination of engineering (design) tools and planning / marketing / bookkeeping tools; interfacing between humans & simulation; Business models for modelling by industry (open format for modelling components…)	
2.7 Innovative Design of Special Equipment and Tools The sector of tools, moulds, dies and fixtures for manufacturing is a key technology sector of European manufacturing. The definition of the requirement of these elements is under pressure in the ramp-up phases: critical time, responsibility for precision and capability, last-minute-changes, high costs. To support this critical business, it is necessary to develop and implement innovative solutions such as the following: • Technical flexibility made by modular design, flexible automation and soft-tooling (adaptation of the software) • Design systems (3D) with an integration of analytic methods (mechanic, thermal, electric, electronic) • Integration of the management of objects (factory data management, simulation, virtual engineering) into the digital factory • Distributed engineering systems • Knowledge-based information supply • E-tool management and remote services • Integration of RFID and smart factory systems: ubiquitous computing, sentient computing, location systems	S MT

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3 Networking in Manufacturing

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3.1 Networking in Engineering

An important factor for the successful operation of production networks is the design of the network structure and the inter-enterprise processes of it. Adequate models, methodologies, technologies and supporting infrastructures for the network design can guarantee technological, strategic and business goal alignments among business partners in a collaborative networked business environment. Furthermore, network engineering must consider the production and service capabilities of the involved companies as well as the market demands and the life-cycle aspects of the products. This engineering also includes the approach of how the product's value can be maximised collaboratively, by selecting the right partners for the joint product and service offers as well as the optimal distribution of the different adding-value steps within the network. In order to qualify the capabilities and costs of a network and different alternative designs, a network engineering methodology also has to include ways to evaluate the performance of a network at different levels of detail. This includes the definition of common key performance indicators for the different network segments as well as the ways how these indicators can be calculated. The network engineering process has, due to the complexity of the networks, to be supported by tools, allowing a detailed analysis of the network, from a static and from a dynamic viewpoint through simulation, and offering functionalities for the optimisation of network structures and processes.

The changed and still changing market demands require the frequent if not permanent design and re-design of production and logistic networks. Due to decreased product life cycles, the design of the production network has to change often. Important parameters, including production strategies such as make-to-order and make-to-stock, production and warehousing locations, mode of transport, lead times and stock levels, have to be adapted frequently. The production

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networks must strive for both cost efficiency and agility to quickly adapt to the changing customer demands. Current network engineering approaches do not fulfil the new requirements: Today's network design methods for new processes and structures take too much time and effort. The time-to-market for new products is prolonged and the network design is not adjusted to the changing market demands. Consequent aspects like the market demands, company production and service capabilities as well as life cycle aspects of products have to be considered in a network engineering methodology, enabling companies to quickly assess their current network structure and identify improving areas. This engineering also includes the approach of how the product's value can be maximised collaboratively, by selecting the right partners for the joint product and service offer as well as the optimal distribution of the different adding-value steps within the network. In order to qualify the capabilities and costs of a network and different alternative designs this engineering methodology also has to include ways to evaluate the performance of a network at different levels of detail. This includes the definition of common key performance indicators for the different network segments as well as the ways, how these indicators can be calculated. The results will take the form of new network engineering methods, demonstrated and evaluated in industrial settings.	
3.2 Interoperable and Standardised Production Networks Companies can be part of several production networks at the same time, thus making the planning, management and optimisation of these networks a very complex task. Research tasks are the development of organisational concepts, processes and methods for the collaborative planning, management and optimisation of production and logistic resources, including the production planning and capacity management in non-hierarchical company networks. These processes have to be standardised across industries in order to come up with the necessary speed and flexibility in the network integration. Non-hierarchical networks and the resulting decentralised planning and control processes also indicate that the supporting ICT systems for planning, scheduling and control have to be decentralised and based on distributed models and tools. The necessary seamless integration of the business processes and the supporting ICT systems require a common understanding of the exchanged information and the shared functions. Therefore, the interoperability of production networks requires a common semantic of shared information and exchanged services. With these development systems unifying the monitoring, operations	M ST

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and planning across a network, while at the same time providing the specific functionalities for the needs of a company, are possible. Therefore, new added-value logistic services, delivered by network companies, will be designed and enabled throughout a product life cycle. Widespread innovation in reverse logistics services is also expected. The formation and operation of production networks covers the production, distribution, after sales services, and reverse logistics. This requires a strong interoperability between the different business processes, organisational structures, but also technical solutions applied by all of the companies in these networks. The main development issues and targets are the creation of interoperable production networks in respect to reference processes, the semantics of the exchanged information and shared services as well as the application of supporting ICT infrastructures. The reference processes include the planning and execution tasks for the sourcing of materials, the production of semi-finished and finished goods, and the distribution of the finished goods to the customers. Interoperable production networks aim at enhancing the competitiveness of European manufacturing sectors by increasing the capacity of industrial SMEs to operate globally in an agile manner, in order to adapt to the rapid evolutions of existing and future markets. Deliverables will take the form of pilot implementations in industrial settings of European production networks as well as the contribution to standardisation of exchanged information and shared processes.	
3.3 Knowledge-Based Order Management in Networked Manufacturing One research aspect, seen at a very large time scale, is the idea of making the orders the primary driver for adaptability, while this adaptability crosses the different levels of networked production as mentioned before. The aspect of knowledge-based product and network configurations should set the frame for the necessary adaptability of the network. While configuring the products in a knowledge-based way, incorporating the knowledge of the network's structures, processes and adaptability capabilities, the orders should be defined together with the customer, so that the product configuration, delivery performance and manufacturing costs are matched. The management of the orders should incorporate the real-time management of the network, integrating the local decision processes towards the network's wide routing of the order. Finally the ability to decide on structural changes or parameter alterations should be brought down to the	M MT

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local execution nodes and processes so that together with the continuous network performance evaluation self-adaptable networks will be created. The trend towards an international division of labour together with reduced product life cycles and the increasing importance of customised products will significantly change the engineering order management within production networks. The respective engineering departments of the network's enterprise have to collaborate closer and faster in order to meet the increase requirements, especially in respect to time-to-market and product customisation. This requires that the composition of the manufacturing and distributing network must be defined dynamically for each order. This formation of the network partners must match the order requirements with the capabilities and competencies of the manufacturing enterprises. This collaboration of different engineering disciplines requires interoperable methods supported by appropriate tools. Clear organisational structures and processes of the collaborative engineering and order management must be developed by defining activities, responsibilities as well as rights and duties of the ones involved.	
3.4 Factories Integration in Logistics Networks on Demand One important improvement through which European manufacturing companies can gain a competitive advantage is the short-term adaptability of networked production to highly dynamic changing customer demands. This covers all segments of the manufacturing network, from the product design, along the supply and distribution up to the manufacturing system supplier networks. Products have to be (re-)designed, produced and delivered to specific customer wishes as fast as possible, higher product volumes demanded in specific markets should be produced and delivered without raising the costs and the whole network should also adapt to downswings in demands very quickly in order not to focus on products still giving a substantial profit margin. By realising this adaptability, not only the network planning and control processes have to be fast and efficient, but also the single manufacturing and logistic technology has to be adaptable to customised products and product design changes, and should allow scalable manufacturing processes according to the demanded volume. Essential improvements on the operation and control level should also be realised. Here, agent control techno-logy seems to be a promising candidate for realising this operational autonomy. It is necessary to	M MT

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develop an integrative engineering approach for the design and application of these autonomous, agile devices such as storage equipment or machinery, creating the agent-based local intelligence together with technological advances, needed for the realisation of this engineering approach. A further enhancement of the adaptability can be seen in the direct communication and co-ordination between the materials, parts and products created in manufacturing and the manufacturing and logistical equipment itself. Employing advanced ICT such as RFID allows attaching operations and control logics to the physical material flow. In the near future, traditional hierarchical and tight supply chains will have to be much more re-configurable, agile, collaborative and responsive, moving towards a self-forming supply chain and inevitably posing new and demanding challenges on its management. Research targets consist of the development of adaptive manufacturing methods for production and logistics networks. Such methods should apply modern ICT technologies and approaches for intelligent, autonomously operating machines and products. It is necessary to develop an integrative engineering approach for the application and design of these autonomous agile devices, such as storage equipment or machinery, in order to realise a high degree of agility within production and logistics networks.	
3.5 Networked Product/Service Engineering The networked product/service engineering research topic focuses on the segment of product engineering networks, because in this segment a lot of potential is not yet realised. In today's situation, more and more companies in a network with specific competencies are necessary to come up with the design of a new product or service. Furthermore the design process has to be accelerated to shorten time-to-market and extended to integrate the customer demands more closely. Collaborative design will embrace new methodological support and tools for understanding, tracing, and predicting usage modalities of customers throughout products life cycles, thus enabling effective product design, tailored on customer needs. New internet distributed knowledge-based CAD systems will be designed and developed. To realise networked product and service design processes and tools for the collaborative product/service design between customers, partners and suppliers, the possibility of distributing the design work across the global network has to be taken into account. To integrate and collaboratively develop the different competencies of the network companies, an integration of the knowledge resources across networks by specific processes and means has to be targeted.	S MT

Proactive Initiatives	Priority
3.6 Manufacturing Execution Environment for Smart Factories (Internal Networking) Factories and manufacturing resources are permanently changing. Paradigms of the past ignored this by: • Scheduling operations in production planning and control from month down to days and shifts • Manufacturing execution scheduling and supervision including feed back down to hours and minutes • Real-time control in machines down to µsec Modern IT technologies enable the management of the factories in real-time and distribute the information of situations to all the actors in a production system. It is necessary to integrate data collection, data mining and sensors for monitoring of resources in an overall real-time architecture and present the situation permanently in the digital environment for planning, management and support of peripheral actions. This is called the “Smart Factory”. Elements of the Smart Factory are: • Wireless technology in factories • Integration of diagnostic systems • Real-time control and data collection for learning procedures • Location systems for mobile objects • Integration of Factory Data Management (FDM) • Intelligent federation system for information supply on demand The main objective of this research action is the development of a factory management system, based on new communication technologies and open system architectures. A federation platform for the integration of information supply has to be open for the integration of a wide spectrum of automated systems and has to support the execution by visualisation (factory cockpit) in the chains of engineering, order management and resource management. The main goal is the development of a platform for manufacturing execution, integrated in the digital factory environment of manufacturing engineering, process planning and continuous optimisation (learning elements).	L MT
3.7 Real-Time Enterprise Management Global businesses are involved in many complex product life cycle relationships in terms of design, engineering, manufacturing, life time service support and final product environmentally-friendly disposal. This involves businesses in a vast array of different relationships with	L MT

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various suppliers and customers, each having their own dynamic limitations and requirements. For organisations involved in these partnerships, there is a deep and complex requirement to manage their enterprises on a real-time basis, meeting and managing the conflicts of multiple products, multiple customers in differing supply chain positions and product life cycle stages. For true adaptability, flexibility and ability to improve productivity, these situations must be managed on a real-time basis, using data, information and knowledge, distributed throughout the supply chain and customer environment. Particular research challenges and barriers include: a drive towards true inter-operability both within and between enterprise management systems; the availability of inter-enterprise information on a real-time and intelligible basis; the ability to agree and make inter-enterprise decisions on the basis of mutual trust and benefit and finally, the ability to distribute new inter-enterprise schedules and agreements. All of these abilities can be achieved within the development of changing economic, highly adaptive and increasingly complex business process models. The development of suitable tools for enterprise and supply-chain management will support knowledge-driven outsourcing business models on a global scale.	

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4 Knowledge-Based Manufacturing Engineering

4.1.1 Renewing Industrial Engineering

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Manufacturing engineering is the key technology to implement innovations and to design products, services, processes and manufacturing systems. The implementation process requires the employment of efficient tools, based on the state-of-art knowledge, expertise and best practices in manufacturing engineering.

Manufacturing enterprises, called factories, have to rethink their organisational structures and basic activities to accommodate the changes foreseen in manufacturing processes. Manufacturing engineering addresses simultaneously all interrelated aspects of a product life cycle from design to recycling and disposal.

The area of manufacturing engineering is the centre of manufacturing development. It is embedded in networks of product engineering, material and component suppliers, manufacturing suppliers and customers. Manufacturing engineering processes take place in the manufacturing system.

Manufacturing engineering is a holistic approach including the engineering of the factory structure, the development of the organisation, the design engineering, the process engineering and the development of the required tools and application systems.

At all levels, e.g. manufacturing network, segment or system, machine or equipment, subsystems and processes, the factory and its manufacturing processes can be defined in their ‘current’ and/or ‘future’ states, under the so-called ‘digital’ and respectively ‘virtual’ representations. This relates to the employed models, methods and digital tools or simulation applications and systems used to represent the static or the dynamic states.

4.1.2 Digital Manufacturing for Rapid Design and Virtual Prototyping of Factories on Demand

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Consumer needs and expectations of the future will require a continuously and rapidly evolving production framework: thus production

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systems, from small to large scales and integrated factories, shall be conceived and set up in more and more shorter times. This will require a conception and development of new methodologies and innovative tools, which enable and support the rapid design and prototyping of the entire production system. The creation of a holistic, up-gradable, scalable virtual factory can foster high cost savings in the implementation of new manufacturing facilities, thanks to the effective representation of buildings, resources, process and products. Decision makers and designers can benefit from the closer integration of product, process and plant developments through advanced modelling and simulations. • Development of a virtual factory framework, focusing on a development of a reference (standard) factory data model, generic architecture for collaborative virtual factories and products through integration of heterogeneous models, methodologies, technologies and corresponding tools of digital and virtual factories; • Employment of virtual/augmented and mixed reality technologies and tools for enhancing the factory experience and the immersion and presence of humans in the environment of virtual factories; • Development of technologies and tools for factory, product, process modelling, simulation and virtual prototyping; • Support for the integrated process/product engineering and implementation of production processes simulator architectures for the automation systems development and configuration; • Integration of digital manufacturing technologies (industrial process simulation). The envisioned main results of these research activities represent a complete detailed framework for the virtual factory and tools for the quick, reliable and optimised creation of knowledge-based manufacturing systems and factories. They should enable collaborative, interdisciplinary and multicultural design/analysis and optimisation of processes to be executed effectively and efficiently in global virtual company networks. The required tools should consist of software, using intelligent databases and data analysis and presentation methods, complemented by models, processes and guidelines enabling their usage. Their capability needs to be proven through successful employments in European manufacturing companies, resulting in significant measurable improvements of business success indicators like time-to-market, customer satisfaction, market share and revenue as well as in improved soft factors like working climate, quality of life, environmental protection and innovativeness.	

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4.2 Configuration Systems: Customisation of Products and Services to the Market Requirements Configuration systems are key tools in supporting the enterprises to quickly bring out innovative and profitable products to the market. The current systems for product services customisation allow customers to specify their requirements by selecting and configuring products and the related services. Customers' individual requirements beyond product configuration and adaptive configuration of complex items (products or services) cannot be fulfilled in these systems. However, such systems, typically designed for expert users, are too technical for the average customer. The integration among the product customisation system and other application systems of the enterprise is rarely considered. Systems enabling enterprises in order to meet the customers' individual requirements more effectively, by providing more customisation approaches, represent one of the main requirements related to the design and development of the new generation of modern manufacturing systems. Through system integration for continuous manufacturing management, the system as a whole eases enterprises to optimise their product and service development processes and supply chains according to the customers' requirements in a systematic way. Several weaknesses of the current systems have to be overcome: • The current systems are designed for one typical user class, not approaching the fact that users differ in needs, knowledge about the product details, and expertise. • Many configurators are product-oriented in their communication process, ignoring the needs of large user groups, e.g. goal oriented customers, who cannot deal with, are not interested in product details. Design and implementation of user-adaptive configuration systems for products and services towards the enhancement of the existing customer relationship management systems (CRM) represent the main research activities that have to be performed. The modern user-adaptive configuration systems have to cope with the above mentioned challenges through: • Enhancement of the usability of already existing configuration systems by extending them with user-adaptive interfaces, supporting and guiding the user through the configuration process in a personalised way	M ST

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- Development of new models of representation of knowledge about products and services, having as a result the so-called customer-driven product and service generic model
- Development of new techniques to support the adaptive configuration of items, which is essential to comply when purchasing a complex product, or registering for complex services, through a user-driven management of the product and service model, the personalisation of the interaction, and user-adaptive explanation of conflicting requirements is identified in the customisation process
- Development of new modes of integrating the user interaction with configuration, through intelligent user interfaces mediating the user and the configuration system.

The integration of the envisioned user-adaptive configuration systems for products and services with the CRM systems improves the overall communication with the user and supports the satisfaction of users' individual needs at the cost of mass-production.

4.3 Tolerance Systems for Micro and Nano-Scaled Products

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For the normal use, industrial tolerance systems are standardised down to µm. In the dimensions of micro and nanometer, they have lacks because of extremely influencing factors of capable measurement (roughness, form, position) and influencing factors of the environment (temperature, contamination by particles etc.). The tolerance systems have to be scaled down to support the reproducibility of parts and components in combination with measurement procedures and technologies. Problems of calibration, management of measurement and of high precision technologies have to be solved by industry. Tolerance systems have to be integrated into the design and quality management, especially under the aspects of micro and nano manufacturing, aiming at increasing the reliability of micro- and nano manufacturing as a base for future standards and the design of reproducible parts and components.

4.4 Knowledge-Based Process Engineering

4.4.1 Hybrid Systems

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Hybrid systems are characterised through a mixed and changeable degree of automated and human work. Human work is essential for changing operations like in a series production with high numbers of

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variants and customised orders. Process planning, supporting the preparing and optimising of manufacturing operations, has to execute the work under strong time pressure and with high accuracy. Defects in process data and process parameters, programmes for automated operations, are creating losses and defects in the shops. They need tools for efficient planning in the chain between engineering and execution, with a link to the shop real situation. A possible solution for the above mentioned challenges represents the embedding of knowledge in the process planning by means of elementary standards of work (global process standards), experience-based and cognitive learning, data, knowledge and best practice-based integration in real-time manufacturing execution systems and real-time resource management. The implementation of vision systems for processes in distributed (networked) manufacturing and for capability of resources have a main relevance for this topic. In recent years, the developments of vision systems have concentrated on solutions that detect defects earlier in the process or prevent them from being created at all. As an example, so called vision labs have been deve-loped, designed to automatically sample sets of containers from the production line and perform a series of highly accurate tests. These measurements are monitored with special software for control variations, where actions can be taken to prevent the problem drifting to an out-of-specification state. Thus, quality can be maintained or improved, efficiencies increased, and costs minimised. Several solutions and tools should support the objectives' achieving: knowledge support of the so-called Intranet federation platform, cockpit application for planning and execution in partly autonomous socio-technical environments of manufacturing.	
4.4.2 Process Planning in a Customised Production Regarding the increasing demands concerning flexibility and cost reduction in car body manufacturing, flexible forming systems which can be used for the realisation of complete car body parts, offer the chance to achieve considerable economic effects. These systems can be used for the realisation of different parts of the same part family (e. g. doors, bonnets …) or for the manufacturing of complete parts of different part families. Using these systems, it is possible to form the main part geometry as well as special designs or functions defining features. The main component of such a manufacturing system can be represented by a forming device, which consists of a forming tool (in a press) or a 'self-driven' forming tool, respectively. The forming tool itself can be based on several components, such as 'multi-useable' modules or part-related segments (e. g. for corner	M MT

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areas). Beside the main forming steps, other operations can also be integrated (e. g. calibrating, punching, trimming, joining …).

An important precondition for the realisation and use of such manufacturing systems is the development of a method in order to identify the process steps for the realisation of the special part geometry. Following know-ledge-based aspects have to be included:

- A scanning system of the part geometry (CAD data)
- An automatic part classification
- An automatic identification of the main geometry and special geometric features
- A determination of forming processes and required tool components

To guarantee the feasibility, automatic FE simulation and optimisation loops (if required) should be also implemented.

Deliverables include (i) methods for the development, realisation, configuration and reconfiguration of flexible forming systems, (ii) the automated coupling of the process planning and forming device configuration with FE simulation and (iii) a prototype flexible forming system.

4.5 Digital Libraries and Contents for Engineering and Manufacturing

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In many fields of the engineering area, such as electronic engineering or mechanical design, the new designed and developed products are mainly based and then defined of already existing components. In order to increase the efficiency and the quality of the design process, the digital libraries have to feature a high level of availability regarding stored information on the already existing components, and of exchangeability or remoteability access through networks. In the last years, several requirements emerged, regarding parts and components catalogues. With the development of digital mock-ups in a number of industries, the need is to fully access digital representations of all the parts intended to be used in new products. A solution for this typical data modelling problem represents the PLIB (ISO) standard, which uses EXPRESS information modelling language. The development of electronic versions of paper catalogues and their distribution over the Internet, identified as typical document structuring problem, has as a possible solution by using the XML tagging technology. Since the PLIB approach is not suitable for the purposes of browsing, presenting and understanding this information, the new XML-based exchanging technologies seem to be appropriate, but not enough reliable to be

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used by applications that should exploit the meaning of the structured information. The conversion digital library information in catalogue format, the publishing of this information in the Internet and then the integration into the factory collaborative information environment, represent a challenge which will be faced in the next years by fitting the needs of engineering and manufacturing with the progress in the advancement of digital libraries ICT research field. The research aims at defining the digital library services as a key component of factory digital infrastructures, allowing content and knowledge to be produced, stored, managed, personalised, transmitted, preserved and used reliably, efficiently, at low costs and according to widely accepted rules, standards and protocols. Several scientific goals are envisioned: • Ensuring the long term accessibility and usability of the content of the digital factory, respectively parts and components, which have to be available in digital form through digital libraries, • Development of new and more effective technologies for intelligent content creation and management, and for supporting the capture of knowledge, its sharing and reuse, • Development of new methods for supporting people and organisations to find new ways to acquire and exploit knowledge, and thereby learn. Design and implementation of the so.called authoring environments for engineering and manufacturing, aiming at supporting the design activities, based on new forms of interactive and expressive content using and motivating the multimodal experimentation and exploration of the design space. These design environments for engineering and manufacturing will facilitate the content, sharing automatic tagging (XML DTD) of existing multimedia content of parts and components. This content will be stored by using open standards, as annotated output in scalable repositories, enhanced with integrated indexing and search capabilities.	

5 Technologies for Future Products

5.1 Integrated Technology Management in Design-Intensive Product Environments

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The European manufacturing industry is shifting its focus towards design-intensive knowledge-based products with integrated services via an ever-increasing involvement of leading-edge technologies. This shift affects all industries, but the most revolutionary rethinking is fuelled by the fierce competition in mass production segments that are close to the consumer and rely on fast changing technological environments. European economy can only react by forming intermeshed trans-sectorial technology networks of SMEs and large global companies that are leading innovators in their areas and will enable strong technology platforms.

In this environment, technology management plays a decisive role because it can empower European high-tech companies to identify, analyse and implement those technology platforms that are vital to their success.

European technology companies have to become the leader in technology management if they want to stay leading in technologies. This will be made possible by the results of the projects under this topic. Methodologies will be developed to integrate technology management efficiently into European management procedures. A trans-European roll-out of increasing technology management activities has to be enabled by the assessment of the best practices and a strong dissemination background, which will be tailored towards the specific European needs.

5.2 Technology Monitoring and Scanning

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In a technology-driven competitive environment, management of technology has to steer the build-up and the usage of technological competences in a company. Technology monitoring and scanning are

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the first of the four central steps of a state-of-the-art technology management process. A fully functional technology monitoring has to identify candidate technologies for the following steps of assessment, planning and the usage of technologies. Effective technology monitoring assures that attractive new technologies are identified early, their development can be predicted and expected discontinuities in the development of technologies are detected faster than the competition in order to be able to react to these insights. Technology monitoring itself consists of the determination of information needs, of obtaining and analysing information and of communication. In recent years, technology monitoring has, especially due to the ever rising efforts that are undertaken in cooperation with other companies or bought externally, become an even more important and complex task for companies. Technological know-how is bought externally in the form of components or technologies. Because of this reason the internal view of the innovation and technology development processes has to be expanded by the external perspective, which consists of external acquisition and the usage of technologies. As important a process as technology monitoring and scanning is for the mid- and long-term success of any knowledge-based enterprise, as hard it is to implement it efficiently, especially for SMEs who lack the international resources of global players. The central challenge for SMEs is to, despite of their limited resources, still cover a broad range of interests with a thorough assessment. In most cases this can only be realised through networked co-operations. Projects answering to this call should focus on the development of toolboxes that enable European SMEs to monitor and scan technologies with a networking approach. Based on this, the specific needs of knowledge-based European SMEs need to be assessed and new methods, tailored towards these needs, have to be developed. The industrial involvement should be strong and results need to be validated through quantifiable positive effects in industrial trial applications.	
5.3 Next-Generation High-Adding-Value Products Science-based high-adding-value products are a key result to be achieved for moving the European manufacturing sector towards a new competitive advantage on the global scale. Such an RTD activity needs a strong exploitation of world-leading developments in enabling technologies such as new materials, nano-, bio-, info- and cognitive technologies. Next generation HAV products for the final consumer have to be 100% personalised, comfortable, safe, healthy, and eco-sustainable.	M MT

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Therefore, the following major RTD sub-topics have to be addressed:

Introducing innovative sensors, actuators and embedded cognitive technologies for active products, supplying functionalities and services for comfort, health and safeness of the consumer;
Introducing bio, micro- and nano-components, as well as intelligent and multifunctional materials, for self-adaptive and eco-sustainable products.

Main development issues and targets, and deliverables are:

Methods and tools for forecasting consumer attitudes and needs based on social and cultural aspects to conceive disruptive new products-services, anticipating the market dynamics;
Knowledge-based collaborative environments for the design of next generation products, integrating new materials, nano-, bio-, info- and cognitive technologies;
New manufacturing processes for next generation consumer oriented science-based products.

RTD activities have to be developed with reference to relevant manufacturing sectors as benchmarks with reference to:

Traditional industry (e.g. textile, wood and leather products);
Mass production (e.g. automotive and white sector);
Specialised suppliers (e.g. aerospace, machine tools);

In order to shift such manufacturing sectors towards more science based HVA solutions.
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<h2>5.4 High-Added-Value Product Design and Virtual Prototyping</h2>
A market’s success of new products or services is largely determined by decisions taken during the design phase. An interdisciplinary and intercultural design team needs the ability to anticipate the future preferences of the customer in order to be able to develop attractive products. Successful development projects focus on the integration of customer influences in the design and development process and the related demands for manufacturing processes and thus enable intelligent customer-driven innovations. The need for a deeper integration of customer preferences from the timing, quality and product capabilities perspective creates entirely new challenges both in the execution and the management of development projects. These challenges are of a threefold nature:
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