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1 Introduction

1.1 Background

The scenarios that were developed within the FutMan project[1] offer coherent long-term visions of 2015-2020 European manufacturing to serve as a base for strategic planning for policy action in support of competitive and sustainable manufacturing in Europe. Within this report the results from The FutMan project are further developed by integrating them with results from the ManVis demand perspective strand.

1.2 Rationale

The core conclusion from the FutMan scenario exercise was that:

“Sustainable manufacturing will only become reality if lead markets for sustainable products and services can be created …”

but

“The creation of market opportunities for sustainable products and services will require the successful alignment of technological, organisational and social innovations”.

However, to achieve such an integrated innovation approach it is necessary to understand the way changes in societal structures interact with development of manufacturing. Within the ManVis “demand perspective strand” the JRC-IPTS team generated some knowledge about the dynamics of interplay between the demand and supply side of manufacturing. This was done in close interaction with stakeholders from various organisations concerned with the topics involved. The aim of this work is now to feed back the knowledge generated within these activities into the FutMan scenarios to then be able to specify the FutMan policy conclusions on how to underpin sustainable and competitive manufacturing in Europe.

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1 For a documentation of the FutMan project and the scenarios developed there cf.: Geyer, Anton/Scapolo, Fabiana/Boden, Mark/ Dory, Tibor/Ducatel, Ken (2003): The Future of Manufacturing in Europe 2015-2020. The Challenge for Sustainability. Scenario Report. European Communities, 2003 EUR 20705.

1.3 Approach

The analysis leading to this report was performed in the following way (see also Figure 1):

Step 1: Interactive workshop with stakeholders from organisations concerned with issues of societal demand on manufacturing (consumer associations, environmental NGOs, unions, student organisation): Task of the workshop: Spelling out of relevant demand side issues.

Step 2: Complementary literature review and comparison of stakeholder views with results from the ManVis Delphi survey.

Outcome:

Two sets of demand perspective aspects

- List of challenges from changing demands on products
- List of challenges from changing patterns of living and working

Step 3: Scenario Workshop: Interactive workshop with experts from academic side concerned with the issues brought up by the first workshop. Tasks of the workshop:

- Translating the challenges from step 2 into possible future features of manufacturing where the challenges would be met.
- Connecting the features to the FutMan scenarios to specify way they are likely to develop depending on different framework conditions.

Step 4: Desk research complementing the results from the scenario workshop and deriving of policy conclusions.

The outcome of the steps 3-4 are discussed in this report while the previous results have been documented within the ManVis Delphi interpretation report.

2 Arising challenges to manufacturing from societal change

Two groups of demand side aspects were elaborated in step 2 of the analysis (cf. ManVis Delphi interpretation report):

- Changing demands of customers, consumers and users on products provided by manufacturing industry
- New emerging patterns of working, learning and living

The key challenges to manufacturing attached to the changes in these two areas can be summarised as follows (cf. ManVis Delphi interpretation report):

Challenges to manufacturing arising from new demands on products

- Facilitating transparent provision of information on products and processes
- Ensuring product usability for groups with special needs
- Preparing for social innovation
- Enabling systemic innovation toward sustainable production and consumption models
- Developing technological and organisational concepts enabling localised manufacturing approaches
- Facilitating user centred innovation

Challenges to manufacturing arising from emerging demands on working, learning and living patterns

- Balancing individual and organisational learning
- Implementing new ways of acquiring skills within manufacturing
- Taking a new approach to workplace innovation enabling contribution to innovation from all workplaces
- Widening the concept of research to include a broader range of knowledge generating activities (open innovation)
- Securing a competent workforce
- Attracting competent people to manufacturing especially women
- Improving accessibility of manufacturing workplaces for groups with special needs
- Foster sustainable structuring of work and facilitate a better reconciliation of working and non-working life.
- Integrating a wide range of societal groups into learning processes.

3 Possible strategies to react to these challenges in 2020

Within the scenario workshop these challenges were translated into features manufacturing would have to embrace in 2015-2020 to meet these challenges (see Figure 1):

- User/Customer centred innovation system
- New Modes of knowledge generation and competence building
- Sustainable high performance working patterns

In the following paragraphs the various aspects related to these clusters that were outlined within the scenario workshop are reported.

3.1 Aspects related to User customer centred innovation system

Shift to Product service systems

The scenario workshop participants expect that companies will shift their focus from selling products to offering integrated product-service systems (PPS) fulfilling customer's needs. It was emphasized that already now the share of GDP from services is steadily growing. Services will develop from an alternative to a general condition of any solution development. It is reckoned that the shift to PSS is one major asset to keep European manufacturing competitive. Nevertheless it is important to realise that while products will come embedded into services, products will still be required within these solutions. Accordingly, there will always be specialist manufacturing elements important in the value chain. So e.g. when big car manufacturers become providers of mobility services there will still be others building the cars … . The main question is where within the value chain innovation is going to happen and who will control the value chain. It cannot be expected that the shift towards PSS automatically leads to an environmental benefit. Furthermore the PSS shift does not necessarily imply abandoning product ownership. Especially when talking of B2C it is likely that even in 2015 consumers will want to own products. Another point that was made is that the product service solutions require a certain level of income and are not likely to flourish in low income societies. How the shift to PSS will work out is depending on the development of social systems within European societies. There were fears that Europe will not be up to this shift without achieving a more balanced distribution of incomes.

Tightening relationship between users and producers

It is expected that customisation approaches as they are currently followed like platform approaches and flexible production systems that enable build-to order will be in-

creasingly used and rise in importance. This will be mediated through market fragmentation and not primarily be focussed on the individual customer. However it is expected for the long term future that a still more fundamental change will take place: There is a clear expectation that consumer producer relationship will become closer throughout the whole product lifecycle. There are several reasons behind this. First of all it is the need for personalisation of products and flexibility in global markets. Furthermore, it is reckoned that cultural proximity and knowledge on how to achieve acceptability becomes a critical advantage in designing products and services in a more complex world. To access this kind of local knowledge, production needs to move closer the customer. This is also considered as an alternative to moving production to low wage locations far off from the final user and customer. Two lines of development were identified along which this "localisation of production" could emerge: Integration of customers into product design processes or "outsourcing" of the final configuration process to the user.

Integration of customers into product development

One way of addressing the issues outlined above from the company side is to integrate customers and especially lead users into the design-production-logistics-service delivering process (co-design, co-innovation). This is particularly expected for complex products. Approaches to co-design can be supported by ICT developments (virtual firms). This was seen as an opportunity for Europe to preserve/strengthen competitiveness in manufacturing. But also non-technical instruments like scenario building together with users and stakeholders were expected to be taken up by companies. Also it was expected that this kind of co-design will be accompanied by new business models. It was stated that the governance of this kind of much more diverse and participative value chain will be one of the main challenges of the future.

Final configuration by end-user

One solution for solving the challenge of providing personalised products for a large diversity of users is "outsourcing" the final configuration of products to the user him/herself. Several expectations in this direction were voiced. In a way this type of solution is the most radical way of placing production close to the customer as an alternative to having products from far off low wage manufacturing centres shipped to European consumers. Two ways in which this might come true were pictured: On one hand there might be highly automated centres where the user comes to and directly manages the assembly process. Another solution might be that households incorporate small scale manufacturing systems to produce products from information input or preassembled parts (Fab Lab). Some customisation steps might also be performed by the

customers via the internet. Via ICT technologies customers might be able to assemble products by combining building blocks. Profound implications for product design are to be expected should this type of solution come true on a large scale. There was some scepticism as to the suitability of current technologies like 3D printing for large scale personal fabrication.

New intermediaries (including policy)

It is possible that market intermediaries will play an increasing role in managing the interface between customers and producers and especially the provision of information about product features. Examples given in the workshop were:

- NGOs providing information about risks and ethical issues of products.
- Client boards, Pressure Groups, Standardisation bodies and Technology platforms will playing an active role in customising services to individual needs.
- User labs and product clinics delivering reliable product information.

A number of contributions in the workshops referred to the role of policy in fostering demand oriented innovation. It is expected that public procurement will play an important role in creating demand for innovation (and especially sustainable solutions). On the other hand it is expected that legislation will be developed to ensure compliance with consumer demands like safety and health concerns or environmental and ethical issues. Also user centred design approaches are expected to be supported by legislation. Certification procedures according to Corporate Responsibility Standards are also expected to rise in importance.

New ways of accessing product information

In the future access to information about products will be demanded more by customers and users. Especially information on quality and ethical issues might be demanded more than now. It is reckoned that from a company perspective the provision of complete information on products will become a competitive advantage. There are different paths that could emerge on how to solve this demand. It was suggested that information on all aspects of product features will be provided in certified databases that can easily be interrogated online. It is even possible that expert systems will provide assistance for the choice. In a similar way labels will facilitate transparency about product features. Another important source of information is expected to come from certification procedures. It was reckoned that policy can play an important role in ensuring transparency of product information through standardisation and regulation. A quite different approach that was suggested is the personal consumption coach.

3.2 Aspects related to new modes of knowledge generation and competence building

Implementing real life learning

A number of participants were stressing that the connection between working and learning has to be reconsidered for the future. To build up the competencies needed in the future people have to be exposed to real life learning. They need to be able to asses, experiment and implement alternative solutions for real life problems. Only in this way tacit and formal knowledge can be simultaneously acquired in the right mix. This could e.g. be achieved in “centres of applied creativity”. These centres would enable real life learning. Through solving real life complex problems people would build up the competences needed. Real life entrepreneurial projects could also be carried out in cooperation between universities and companies as well as within companies. The ROI for this kind of learning should be taken into account instead of viewing it as a cost factor.

Development and integration of different types of knowledge

There was a general agreement that integration of different types of knowledge such as tacit/formal, explicit/implicit will be an important issue for companies in the future. As a particular challenge it was identified to make optimal use of implicit and tacit knowledge sources within the company. A number of participants stressed that this can be achieved by the establishment of appropriate teams where people with different skills and different competencies co-operate and thus different types of knowledge are integrated. It was reckoned that, through systematic teaming it will be possible to benefit from the diversity of the workforce and to combine different views and different ideas into fruitful debates. It was mentioned that these structures need not always be permanent. However, the importance of attracting and keeping competent people with embodied/tacit knowledge was emphasised. As an important aspect of this it was stressed that ways will have to be found to keep and use the often tacit knowledge of older experienced workforce e.g. be through mentoring systems. While most people agreed on the growing importance of implicit knowledge it was pointed out that codified knowledge will gain importance due to increasing efforts in formalisation such as standardisation and modularisation. Companies will have to overcome reluctance of people to give away their knowledge. It was expected that with these tendencies strengthening, knowledge input in the future will less and less be initiated by individual inspiration but more and more by professional processes. A danger was expressed that the current accumulation of knowledge will be met from the loss of knowledge e.g. by migration or mortality of intangibles. The minimisation of this loss might become a key strategic is-

sue for companies in the future. It was also mentioned that tacit knowledge can partly be formalised on the precondition that there is a high degree of job security.

It was seen as a problem that due to the currently weak position of unions and workforce in general due to high unemployment companies are not forced to take enough care of skill development. When skills become scarce in the future they will be lacking the necessary competencies. On the other hand it was stressed that unions as well should focus more on employability (via skill development) then on employment. In the future their will be a need for independent agencies developing competencies for individuals. Bodies like e.g. trade unions might adopt this role and become knowledge developers for some professional groups (such as guilds).

New focus of competence building

- Learning culture

  It was stressed that the establishment of a learning culture within companies needs a fundamental mind-shift from all actors involved. Nevertheless there is an urgent need to move on towards this objective. It was expected that individual learning will be partly for self development and partly in the interest of the firm. Measures proposed were e.g. a reduction of tax for learning components in companies.

- Refocussing knowledge management

  The focus of knowledge management should not be implementation of IT tools but on fostering interaction, learning and communication. Also R&D funding should adopt this focus more clearly and move away from pure IT funding. It was reckoned that knowledge management would shift from more strict approaches to loose structures like e.g. open platforms/ parallel processes.

- Finding the right level of core competence

  By some experts it was reckoned that at latest by 2015 the trend towards outsourcing of functions will be reversed and companies will increasingly seek to “insource” to avoid loss of organisational competencies. On the other hand it was suggested that in the future there might be “knowledge factories” that will send knowledgeable people to solve problems. Furthermore it seems clear that manufacturing competencies will increasingly be developed by networking throughout the supply and use chain.

  The diversity of opinions clearly indicates that finding the adequate level and meaning of “core competency” will be critical for each company.

- Emerging new type of competence

  With the progressive disappearance of manual labour a new type of worker will be emerging. Workers will become “researchers” and “brain workers” with new competencies (problem solving, life long learning, networking). This raises high problems of social disintegration. A social division of the knowing and the not knowing might be the consequence. It was pointed out that an essential new competence for many brain workers is entrepreneurship. It was stressed that managing groups of entrepreneurs requires new forms of human relations and institutional developments.

Attracting and Keeping people

It was expected that human resource management will no longer be looked at as a means to administrate the workforce but as a task that is of strategic importance to achieve the company goals. It was suggested that to attract competent people an enabling organisation should be developed. This implies that personal initiatives, autonomous ways of thinking as well as collective autonomous development must be enabled. Furthermore competent people will need to be attracted by a “clean” workplace, ample space for decisions as well as opportunities for development and gaining experience. Finally of course adequate salaries as well as other incentives such as flexible work arrangements, time credits etc. are crucial.

It was suggested that in the future the “owners” of competencies will have an increasingly important role. It was reckoned that this would mean a reversal of current developments in many European firms. An aspect of particular importance it was emphasised that at latest from 2015 on keeping and developing an ageing workforce will become a core focus of human resource management.

Implementing open innovation

Participants expressed there view that there is a need to adopt a kind of approach towards innovation to face future challenges. The main reason for this was perceived to be the fragmentation of markets that forces companies to integrate a greater diversity of knowledge (e.g. cultural elements). For this there is a need to stimulate and manage creativity in a way that goes beyond classical managing approaches. The new type that could be called “open innovation” (drawing on the open source idea) gives a new organisational framework for creativity. It was suggested that the classical “innovation by specialists” approach that implies highly specialised researchers developing innovations within a narrow field is no longer suitable. Although such an approach might seem the fastest at the first sight, it will more and more lead into a dead end while the “open

innovation" approach might seem slower and demanding more effort, as it is embracing a variety of knowledge sources including the shop floor, but will result in a continuous innovatory activity. Open innovation also includes intensive interaction with stakeholders having different skills and knowledge to facilitate and promote innovation.

New patterns of university/industry interaction

A need was perceived to stimulate new forms of education (primary/secondary/tertiary). Creativity skills should be stimulated (methods like mindmapping etc.). It was reckoned that to achieve this, learning environments have to be changed. The classical schoolroom might be no longer adequate. It was also suggested that companies go into universities/business schools actively engaging to support education and thereby reduce training costs. Intermediaries might be required to foster this. A close interaction between universities and businesses with free movement of personnel both ways was thought critical. However, it was pointed out that this will require adjustment in both systems. It was stated that at the moment universities and companies speak different languages. This hinders the starting of joint innovation projects. So e.g. universities are often very much focussed on publication and do not enough value the creation of applicable knowledge It was observed that less and less students are studying manufacturing at university (and even less the more technical aspects). This might lead to a decrease in EU technical innovation power. Due to lack of brains manufacturing process innovation might seriously become hampered.

3.3 Aspects related to sustainable high performance working patterns

New ways of handling working pressure

There is a danger that there will be increasing pressures due to high workload for smaller shares of population. Such an unequal distribution of pressure will lead to social tensions. On the other hand there may be a "slow down movement" and a trend to replace highly demanding full time jobs by a multitude of activities. To achieve high performance in a sustainable way, concepts of "management by objective" have to be implemented in a way that allows for balancing of individual and organisational goals while taking into account limitation of working pressure. Collaborative working arrangements are seen as a way to balance the trade offs between performance and intensity (team career). To handle the tension between high performance and work intensity the concept of "En stress and De stress" was proposed. This concept combines high responsibility with a high influence on general decision making within an organisation, thereby enabling "sustainable" high performance.

New balances of working and living

It was expected that new balances of working and living will be established in the future. The three step model (education, work, retirement) will be dissolved into a continuous model with fluctuating pieces. One important element of the new type of work life arrangements will be phases of learning.

To reconcile private and professional life implies a deep shift in organisational schemes. Companies will have to adopt several measures:

Job sharing will be established even at high management level. Life working time models will increasingly be applied. Companies will have to develop models for part-time (weekly, yearly …) for executive functions. Organisations should allow different working hours depending on different periods of life as both men and women need to be given the opportunity to arrange working patterns in a flexible way to be able to take over responsibility outside work like childcare etc and preserve a proper work-life balance.

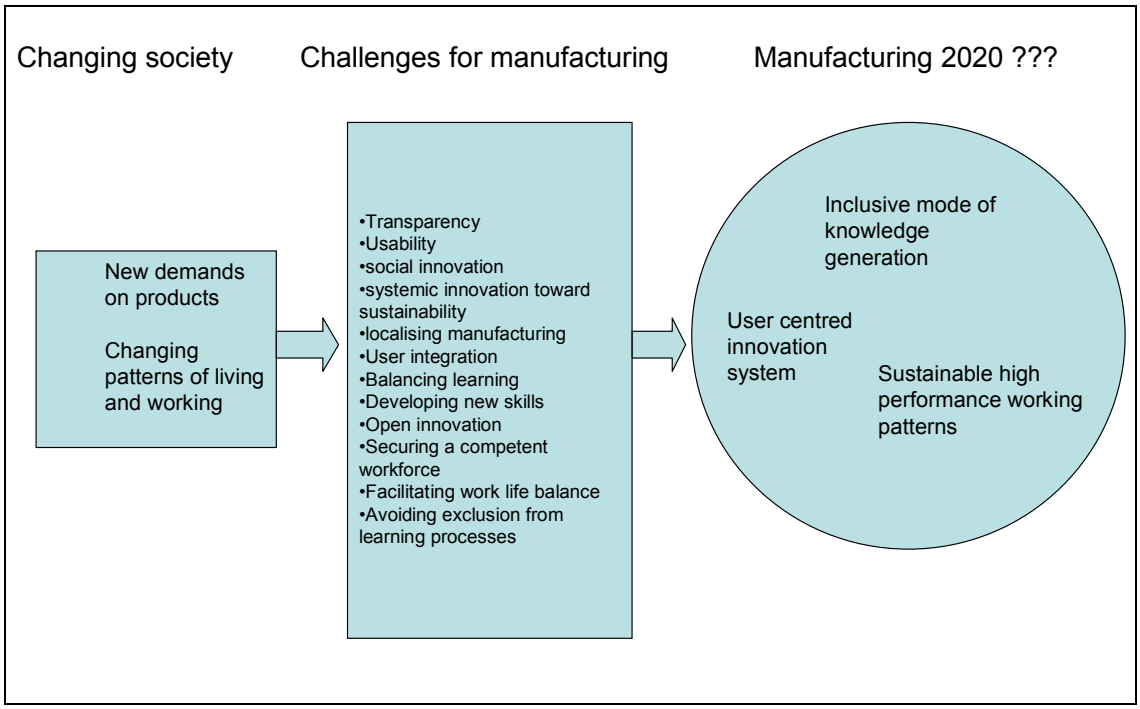

Figure 1: Translating societal changes into future patterns of manufacturing

To realise these changes new management cultures but also new organisational schemes like e.g. networks of SMEs are needed. It was reckoned that at some point socially agreed recreation times will have to be supported by regulation. However it was pointed out that social security is a precondition to realise the reconciliation.

Decoupling of work from fixed location

It was reckoned that, enabled by ICT technologies, labour will become a product carried out at convenient time at convenient location. When this is the case the prime challenge will be to deliver the product at the right moment. Technology and organisation will enable disconnection of working content and working time.

4 Assessing the effect of different framework conditions on the ability of manufacturing to tackle the demand issues – The demand scenarios

To find out what are the framework conditions enabling manufacturing to achieve the transformation that is needed according to the results of the analysis, it was investigated how the patterns of reaction are likely to be shaped depending on the different framework conditions that are outlined in the FutMan scenarios (see Figure 2). This analysis was started within the scenario workshop together with academics concerned with the issues at stake. Later it was complemented by desk research from the IPTS project team. In the following paragraphs, the results are outlined.

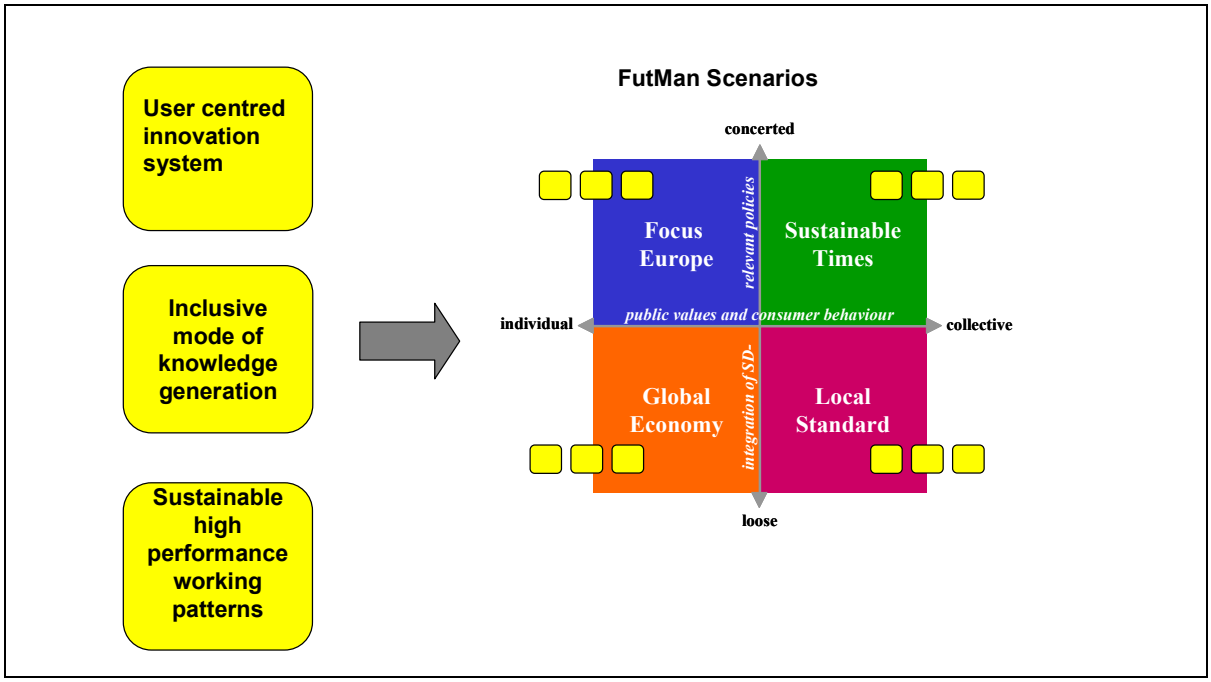

Figure 2: Relating the challenges to the FutMan scenarios

4.1 Scenario Global Economy

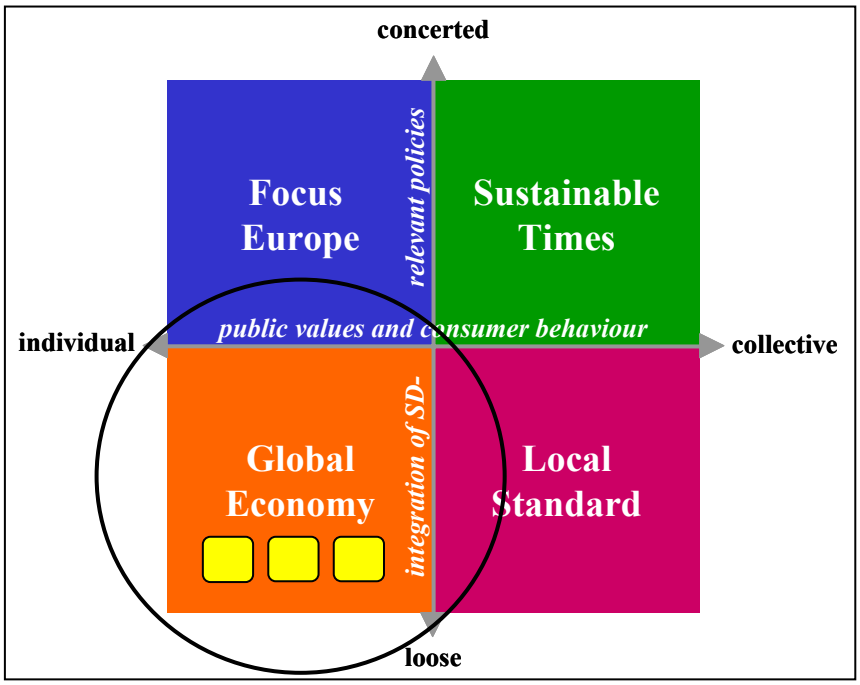

Figure 3: The Global Economy Scenario

The GE scenario is characterised by a loose degree of policy integration and individualistic values.

4.1.1 User centred innovation system

In this scenario substantial technological progress towards sophisticated personalised manufacturing has been achieved. The technological preconditions (especially the ICT side) for advanced concepts of user driven manufacturing innovation have been realised. These concepts are intensively applied to supply customers with personalised products and services within little time margins in a very efficient way. RTD policy has fostered the realisation of highly sophisticated personalisation approaches in manufacturing through targeted support of technological research projects without integrating other bodies of knowledge or other actors. Public procurement will have sought to support technological advancement without special regard to other societal demands such as reduction of environmental impact or usability for groups with special needs. As there has been no particular effort neither from policy nor from consumer side to shape the manufacturing innovation system participative processes involving other societal actors than the actual customer of the product/service have not been implemented. Manufacturing interaction with users and customers has focused on the optimisation of product service systems with respect to the individual customers needs without taking into ac-

count benefits for overall society. Products for groups with special needs will be available but only for those who are able to pay high extra prices. Product information, especially on health related issues, will be accessible from databases via the internet. However the type of information available will widely differ between companies and products as there will be no commonly agreed structure for providing information on products. Also there are some gaps in the information that is available as companies do only trace selected information along the value chain.

As manufacturing in this scenario is operating on a fully global level, communication between users and customers on the one side and manufacturers on the others is to a large extent realised through highly advanced ICT solutions (virtual reality platforms, expert databases etc.). While manufacturers receive the information on customer demands from all over the world via these advanced information exchange networks, they encounter difficulties to realise innovation in continuous interaction with groups of users/customers. This is partly due to the lack of interest from consumers to pursue active innovation initiatives and to solve problems on a collective level but partly also to the lack of small scale manufacturing sites operating on a local level. The provision of personalised product service systems is not fully exploited by companies as they lack the necessary access to local knowledge. Furthermore, as the social security system is somewhat patchy, demand for advanced services is held back because only a limited number of consumers can afford them. Due to these barriers European manufacturing industry did not adopt a radical shift from selling products to provision of functions and personalised product service systems. Accordingly, large parts of the value chain have been transferred to locations outside Europe where the conditions for production are favourable for some reason or other. Manufacturers often move their sites according to changes in these conditions. As personalisation is not a chief concern for large parts of the manufacturing process, being close to customers is only a secondary concern for decisions on location of manufacturing sites. Accordingly, manufacturers do not have continuous access to the high diversity of cultures themselves but rely on customers and users to report their demands. It is difficult for companies to react on changing demands on a local level in a proactive way or even in interaction with local user groups. Due to the lack of concerted policy action but also due to lack of interest from manufacturers radical breakthrough approaches to manufacturing like personalised nano-manufacturing have not been further developed.

The scenario involves substantial technological advancement enabling manufacturing to provide individualised products but radical progress towards user driven innovation is hampered due to lack of concerted socio-technical innovation.

4.1.2 New modes of knowledge generation and competence building

In the Global economy scenario new ICT solutions have enabled advanced modes of information management and exchange along the manufacturing value chain: The growing presence of embedded systems (the result of progress made in new materials and sensors in electronic components) has enabled new forms of information and knowledge management. Information and communication technology has allowed the handling of vast amounts of data in distributed production networks. Advanced knowledge management tools have facilitated the co-operative development of new products (i.e. simultaneous engineering) within virtual factories. Industry has put emphasis on the development of intelligent man-machine interfaces (e.g. common platforms for data management, distributed storage of data, etc.). Expert systems and artificial intelligence application have been developed in order to exploit knowledge and integrate different new types of information in the production process. The focus of knowledge generation and knowledge management in manufacturing companies is on ICT application. At the same time there is a widening spread of labour costs between skilled and unskilled workers. Therefore the level of responsibility and involvement in decisions and knowledge generation is extremely diverse. Accordingly, companies are facing difficulties to establish modes of knowledge generation that include all levels of workplaces. Furthermore due to the high degree of formalization of knowledge that is needed to feed all knowledge elements into the databases and expert systems it is difficult to deal with implicit, tacit knowledge. The exchange of information via ICT systems is the dominant component of collaboration and teamwork. Due to the extremely competitive environment and the growing importance of knowledge as the non-renewable factor of production manufacturing has been driven to make immediate use of best available knowledge at world level enabled by its excellent ICT support tools. Accordingly, knowledge is acquired in a “cherry picking” mode while the long-term competence development is less emphasized in manufacturing companies.

Due to the widening skill gap and “little co-ordination of labour market and migration policies” exclusion of wide parts of the labour force from knowledge generation in manufacturing is likely to occur and cause social tensions. There is a high pressure on individuals to ensure their own employability by continuously embarking on training often in their spare time and on their own cost.

The education and training system is partly privatized and there are a multitude of private initiatives for higher education and industrial training. Universities have become more reactive to enterprise requests by developing into “centres of excellence” supplying inputs (skills, technologies) for industry. Also, there is a strong emphasis on scientific excellence in education and training schemes within traditional science disciplines.

In the GE scenario substantial progress has been achieved in quickly generating, sharing and distributing today's type of knowledge supported by advanced ICT tools. However, radically new modes of knowledge generation that embrace a wider range of knowledge sources are not widely implemented.

4.1.3 Sustainable high performance working patterns

Intense competition and reduced time to market have caused a high increase of productivity. The total labour turnover is greatly increased. Productivity and efficiency guide work organisation. Labour is mainly perceived as a product that has to be delivered at the right place in the right time. Regarding new patterns of working and living there is an emphasis on greater flexibility. Labour cost optimization from a company point of view is the main driver of workplace innovation. In this scenario an increasing pressure through high workload for some people is contrasted by a growing share of population excluded from the knowledge economy. Some workplaces in manufacturing are available for unskilled personnel but with very low wages and little or no opportunity for skill development and learning. The widening gap between insiders and outsiders of knowledge economy is causing social tension especially as social security in this scenario is mainly left to individual's choice and responsibility. At the same time the high workload of highly skilled personnel has caused an increasing number of health problems related to excessive demand such as burnout syndrome. Management concepts like management by objective are extensively applied but with a focus on maximizing the output from personnel. Often objectives are set without providing personnel with the adequate resources to fulfil the tasks. High responsibility is given to single persons without at the same time allowing them to influence the relevant decisions. Although companies have extremely flattened their hierarchies by erasing middle management positions there is a low degree of participation of personnel in companies decision making. Unions have been loosing influence as people were less and less willing to pursue their interests on a collective level. Women are increasingly taking over high management positions in manufacturing companies. Highly skilled people in high positions in manufacturing companies with extremely high workload and long working hours are employing expensive private services for caretaking of family members, catering etc.. Only very few people on this level have reduced their working hours. Recreation times for the workforce are widely spread and fixed only on an individual level. The majority of the population is working on Sundays.

New technological capability in automation and information and communication technologies has enabled extremely flexible working arrangements as to time, location and attendance. Many functions can be performed from home with team working facilitated

by holographic video conferencing. It is common to accomplish working tasks from home in addition to the full time working day.

The three step model (education, work, retirement) is dissolved into a continuous model with fluctuating pieces. One important element of the new type of work life arrangements are phases of learning. However, employees are struggling to follow training courses which they often pay themselves and accomplish during their spare time or holidays. Companies support specific training elements directly related to the job at hand but have little interest in supporting the long term employability of their personnel.

In this scenario high performance is achieved through intense competition and pressure. However, the solutions are often of a short term nature and lack long-term sustainability. Societal interests such as health concerns or social stability are often at odds with companies demands on people.

4.2 Scenario Local Standard

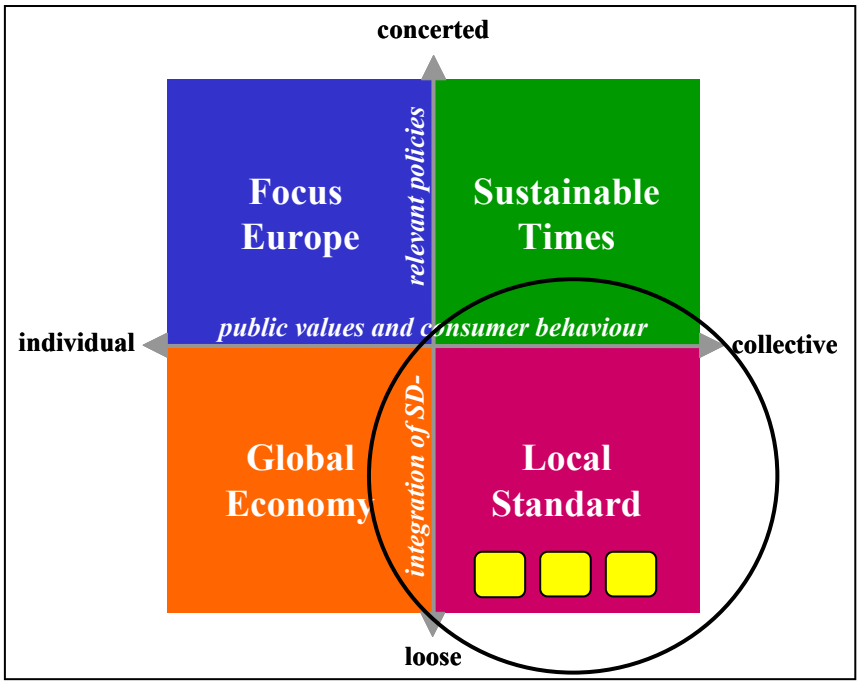

Figure 4: The Local Standard Scenario

In the Local standard scenario collective values prevail but policy is only loosely integrated.

4.2.1 User centred innovation system

In this scenario “the civil society has become an important player in policy-making, especially at local level”. “At local level some very creative environments – new sources of innovation – have emerged.” Local groups of users and consumers are actively pursuing innovation initiatives. On the other hand, due to the lack of coordination of policy, conditions for manufacturing such as transport network, environmental standards, social conditions, taxation and RTD policy are considerably varying across different regions in Europe. Therefore manufacturing has been forced to adapt to a large diversity of local conditions. “Customisation of products takes place in the local and regional markets as manufacturers have adopted sophisticated postponement strategies”. New production concepts such as mini plants enable small scale and highly customised local fabrication. In the Local Standard scenario a user driven innovation system is realised in some regions and locations. Local socio-technical systems such as transport solutions or health systems have been shaped in participative processes with a high degree of involvement of citizens. This has triggered a number of joint learning processes between manufacturers and users. Highly advanced socio-technical solutions embracing a number of different tailored product service systems have been developed and established. Through several feedback processes between users/customers and manufacturers these systems are continuously advanced.

In the LS scenario breakthrough socio-technical innovation has been achieved towards the establishment of a user centred innovation system. However, due to the lack of concerted policy action these developments are confined to a local level.

4.2.2 New modes of knowledge generation and competence building

In the Local Standard scenario manufacturing activities have to adjust to diverse local conditions. For this reason the modes of knowledge generation employed have to be adapted to the regional innovation system. Companies are heavily relying on the access to local knowledge sources. Therefore, they are keen on partly recruiting knowledge and people on a more regional base. Learning environments, which foster continuous development of new skills and competences, have been developed in most communities with strong links to local industry and service producers.

Formalization of knowledge not a prime concern of companies as the need for worldwide knowledge acquisition is less pressing. Long-term competence building is emphasized as the local modes of knowledge generation need to be sustained in a stable way. Companies are continuously engaged in learning processes with local customers

and users. Thus, they have to build up capacities and methodologies for integrating different types of knowledge. These do also serve to integrate more knowledge sources within the company. As collective values prevail in this scenario employers are inclined to share their knowledge. Universities have taken over proactive leadership in supplying knowledge thus becoming more of a local development agent.

Altogether the modes of knowledge generation will be rather cooperative.

In this scenario due to the enforced localisation of manufacturing a specific mode of knowledge generation has emerged. Some of these elements seem to point towards the radically new modes of knowledge generation demanded by the challenges arising from the demand perspective as outlined in this report.

4.2.3 Sustainable high performance working patterns

More social dialogue at the local level has allowed for a less rapid uptake of the "instrumental" labour approach. There is a high diversity of approaches towards new forms of living and working patterns. A "slow down movement" has started with people aiming to reduce their workload in favour of taking over other responsibilities outside work, not only caring for family members but also participating in local initiatives etc. Many people aim at pursuing a multitude of activities instead of highly demanding full time jobs. New working arrangements such as job sharing, part time jobs, are increasingly implemented as employees pursue their interests through "collective bargaining" on a local level.

However, as these initiatives are not supported by strong policy measures on a national or even European level, they are often struggling to accomplish their objectives. In some locations where there is ample supply of skilled workforce, new forms of work-life patterns are significantly less present than in others were collective bargaining was stronger due to scarce supply of skilled personnel. In a similar way the role of unions is differing from region to region. In some areas they have been actively mediating the development of new working patterns while in others they have not been able to negotiate. Accordingly, working and living patterns alter from region to region. In some places such as big cities local initiatives have formed advanced collective arrangements such as neighbourhood office.

In this scenario there is a patchwork of diverse solutions towards sustainable living and working patterns coexisting with each other. The chances for people to realise their preferred living and working patterns differ widely among regions.

4.3 Scenario Focus Europe

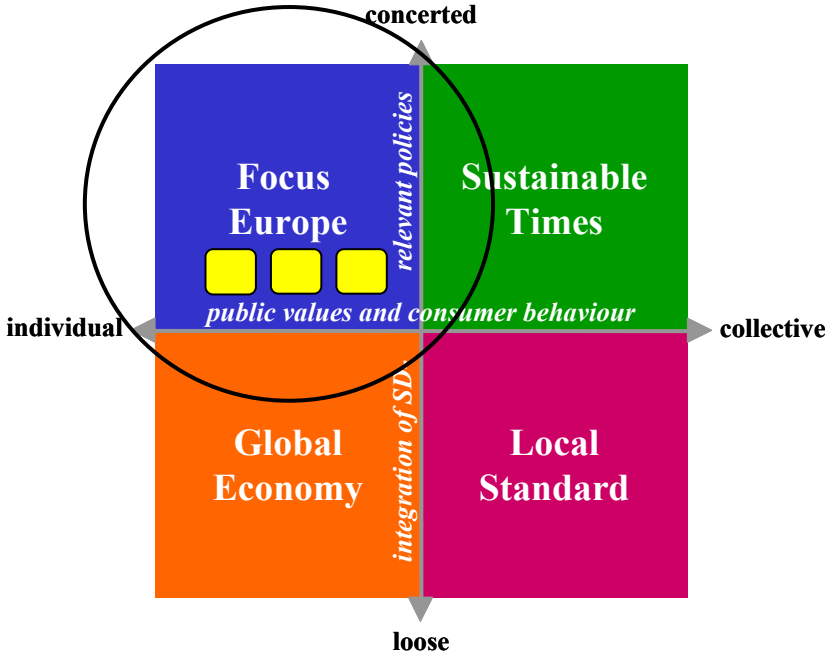

Figure 5: The Focus Europe Scenario

The Scenario is characterised by a strong integration of European politics and prevailing of individualistic values.

4.3.1 User centred innovation system

In this scenario demands of individual consumers have been served in much the same way as in the GE scenario. Substantial technological progress has been achieved along existing lines of development such as customisation and personalisation approaches. Consumers have a significant degree of influence on the design of products meeting their individual needs. Radical innovation towards new forms of product service systems is facing difficulties of socio-technical lock-in particularly a lack of interest from consumers to engage into joint learning processes on a collective level. However, as in this scenario manufacturing is facing a strong coherent legislation enforcing sustainable manufacturing concepts a higher degree of innovation is required than in the GE scenario to serve diverse customers demands on the one hand and comply with regulation on the other. In some cases where regulation is acceptable to the majority of stakeholders there are initiatives towards social innovation involving new types of product service systems. Due to the strong integration of European policy some progress has been achieved to include societal demands beyond individual product demand in

the manufacturing innovation progress. Usability of products for groups with special needs will have been enforced by regulation and supported by targeted public procurement strategies. Product information will be widely available due to strong consumer protection legislation.

In the Focus Europe scenario manufacturing is struggling to serve individual customer demands while at the same time complying with strong regulations. There are only a few joint learning processes between customers and manufacturers characterising a user driven innovation system. Progress towards sustainability is enforced by legislation.

4.3.2 New modes of knowledge generation and competence building

Within Focus Europe the integration of tacit knowledge into innovation will be the subject of negotiation with the individual holders of this knowledge and they can be expected to drive hard bargains. However, (just as in the GE scenario) with the rapid redundancy of knowledge elements and improvements in automation and associated information and control systems tacit knowledge has been lessening in importance.

In this scenario the higher education is placing “Strong emphasis on scientific excellence in education and training schemes, cross-cutting science discipline boundaries.” Therefore, the ability to cross established lines of thinking and to link different realms of knowledge is prevalent among manufacturing companies personnel.

Training programmes in companies will be continuous and individual learning will be a negotiated mix of company defined competence building and individual self-development specified by the employee. Retention of key employees will require imaginative strategies and high rewards, involving a range of processes for financial participation in results.

Because firms have to cater to niche markets their demands on universities, as the providers of new knowledge, are diverse. They have as many interactions with business schools and humanities departments as with science departments. It is not unusual for collaborators from universities to attend regular management meetings in companies to ensure that local decision-making is informed on innovative thinking being developed for the firm. As labour policy and education policy is strongly coordinated on EU level, the danger of exclusion from learning is limited.

4.3.3 Sustainable high performance working patterns

In this scenario there is a strong tension between companies striving to reduce work cost and to maximize labour turnover and government's strong emphasis on the social pillar of sustainability. European policy initiatives on qualification and certification have counteracted social tension due to a widening gap between insiders and outsiders of the knowledge economy. Also, policy intervention helped to promote family friendly employment schemes and prevent health problems due to work overload and excessive demand. There are a number of fixed recreation times and other legislation in protection of quality of working life. Targeted R&D projects on IST mobile work have lead to a variety of work arrangements that are possible some of them especially suited for work from home that is compatible with family demands. However, employees are continuously struggling with companies to be able to make use of such arrangements and for the compliance to quality of work regulation.

The three step model (education, work, retirement) is dissolved into a continuous model with fluctuating pieces. One important element of the new type of work life arrangements are phases of learning. Legislation is supporting employees to pursue learning phases above immediate job interests. There is government support for companies adopting long term training schemes improving their employee's employability.

In this scenario there is a certain progress towards the establishment of sustainable high performance working patterns. However, as this progress has been initiated by governments and legislation there is a continuous struggle on its implementation.

4.4 Scenario Sustainable Times

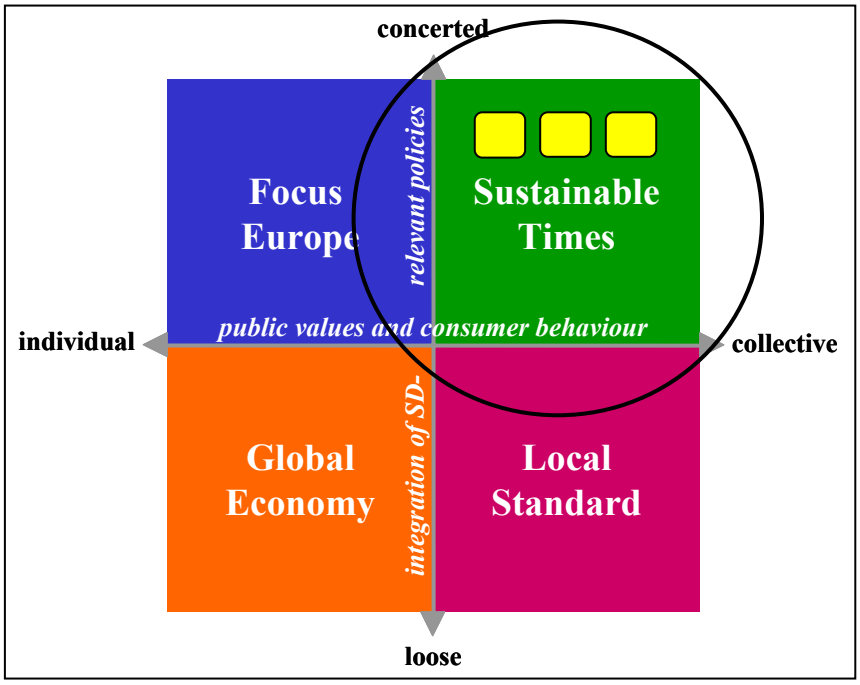

Figure 6: The Sustainable Times Scenario

The Sustainable Times scenario features highly collective values along with strong concerted policy action towards sustainability and a well established global governance system.

4.4.1 User centred innovation system

In this scenario the establishment of sustainable patterns of production and consumption is highly advanced. Supported by public sector initiatives manufacturing has realised radical innovation towards sustainability. New ways of fulfilling needs with minimum environmental burden have been developed. The design of product service systems to fulfil functions in a sustainable way is at the core of manufacturing activity. This transformation has been and still is actively supported by public policy. Industry and other stakeholders are closely cooperating with policy to achieve sustainability goals. Thus social innovation is taking place at a large scale but it is primarily initiated by public bodies like e.g. a city aiming to establish new modes of transport. Citizens do actively engage in policy but they pursue their interests largely through NGOs on a global level. The dialogue between users and producers tends to be conducted through consumer groups with individual interaction confined to the final product selection and con-

figuration stage. Thus direct interaction between manufacturers and user groups to fulfil needs is not often taking place. However, due to the strong shift towards product service systems the knowledge flow between customers and producers is key in this scenario: Extensive knowledge on product and service content and operating knowledge is needed by consumers, and is provided in adequately certified databases to command the consumers confidence. Consumers look to government to ensure this level of accurate knowledge from industry and business.

The provision of products for users with special needs is fostered by public procurement and enforced by legislation. Industry is actively trying to embrace societal interests in their innovation strategies. So e.g. accessibility is the main guiding principle for the transport system.

In the Sustainable Times scenario societal demands are incorporated to a large extent in manufacturing. Through concerted efforts from all stakeholders interests of consumers and users are taken care of. Large scale socio-technical transformations are achieved on a central level. A user driven innovation system is not particularly prominent.

4.4.2 New modes of knowledge generation and competence building

In this scenario a new type of organizational knowledge is required to manage cooperation within extended supply chain. The shift of manufacturing from selling products to provision of services has caused a need for integrating different kinds of knowledge within manufacturing. This has not only affected the modes of knowledge generation in relation to external knowledge sources and the interaction with users and customers. Also, within the companies there has been a strong shift towards open forms of innovation involving people from workplaces all over the company. This has unlocked the high degree creativity that is needed by companies to provide tailored solutions to its customers. Teams with people from different professional backgrounds and different types of workplaces are collaborating to develop solutions for fulfilling customer needs through tailored product service systems. As in this scenario there is a relatively high degree of social security and collective values prevail people will be in a position to share knowledge freely. There is a strong emphasis on tacit knowledge, real-life learning and soft skills within companies. Centres of applied creativity are established where people can asses, experiment and implement alternative solutions for real life problems. In this way tacit and formal knowledge is simultaneously acquired in the right mix through real life learning. Formalisation of knowledge is less emphasised. Real life entrepreneurial projects are carried out in cooperation between universities and compa-

nies as well as within companies. This is supported by the education system that places “strong emphasis on interdisciplinary training, soft-skills, and problem solving capabilities”. Human resource management and long term competence building is seen as high priority in companies which is supported by the education system that is focusing on life-long-learning and re-training. Companies seek especially to integrate aged workers in knowledge generation processes.

The scenario features a high labour cost economy with decreasing demand for unskilled labour. The danger of social disintegration is actively counteracted by policy placing “strong emphasis on strengthening the knowledge base and further education in Europe”. The challenge of attracting and keeping the right people is met by active measures from companies to provide attractive workplaces in manufacturing.

The transition of European manufacturing towards knowledge based and sustainable approaches that has been achieved in the ST scenario has required the adoption of radically new modes of knowledge generation and competence building.

4.4.3 Sustainable high performance working patterns

In this scenario manufacturing companies have restructured their organisational structures to achieve a balance between high performance and sustainable working patterns. This has been achieved through a number of workplace innovation initiatives carried out jointly by employee’s representatives and employees with a high degree of participation from personnel on all levels of the companies. These initiatives have also been fostered and supported by government. At the core of the new organisational solutions is the implementation of “management by objective” using realistic objectives and providing the persons with adequate resources to achieve these goals. At the same time people are systematically involved into companies decision making process so De-stress and En-stress are balancing each other as high performance also means a high degree of influence on the nature of the tasks. Another core element of the sustainable high performance working patterns is a collaborative working arrangement as outlined above.

At the same time a societal process of change has lead to the establishment of new patterns of working and living. There are a number of different arrangements available to combine different elements in a working carrier. Life working time models are generally applied. Arrangements like job sharing and various forms of reduced working hours are widely used even at high management level. Both men and women make use of these models for arranging working patterns in a flexible way to be able to take over responsibility outside work like childcare etc and preserve a proper work-life balance.

The three step model (education, work, retirement) has been dissolved into a continuous model with fluctuating pieces. One important element of the new type of work life arrangements are phases of learning. Legislation supports employees to pursue learning phases above immediate job interests. There is government support for companies adopting long term training schemes improving their employee's employability.

Technological change has shifted most work from being instrumental to being facilitative. As a result attendance patterns can be made more flexible and appropriate to individual's needs and preferences. Most responsibilities can be shared in terms of attendance and attention.

In the Sustainable Times scenario a shift towards sustainable patterns of working and living has been achieved through a number of transitions in different realms of manufacturing industry by joint stakeholder initiatives that were supported by concerted policy action.

5 Summary and Policy Conclusions

The emerging of a manufacturing system that is providing highly customised products and product service systems targeted to customer's individual needs is clearly a core element in all four scenarios. Industry will strive to develop and implement the technological and organisational concepts needed to enable this regardless of the framework conditions. The uptake of wider societal demands in manufacturing innovation approaches such as reduction of environmental impact, provision of products for groups with special needs or transparent provision of product information will not be automatically part of this development but can be triggered through strong policy intervention (ST, FE).

However, the establishment of a **user driven manufacturing innovation approach** as it was outlined by the analysis in the ManVis demand strand is not equally well realised in all scenarios. Such an approach is calling for radical socio-technical innovation. This implies on the one hand the development and uptake of a number of technological innovations but at the same time the establishment of continuous joint learning processes between users and producers. Both aspects can strongly be fostered by public policy through legislation, targeted R&D support or public procurement. Without such a support technological innovation will proceed without social innovation such as outlined in the GE scenario. However, this means missing the potential of user centred innovation for establishing a manufacturing industry that is located on a number of locations within Europe to keep up close interaction with customers and users. Especially the development of high value added product service systems is likely to be hampered

without enabling structures for close user producer interaction. On the other hand such learning processes are heavily relying on the initiative of users and consumers that are willing to develop new patterns of fulfilling functions on a more collective level. Without this, socio-technical innovation will be confined to a few exceptional areas as it is described in the FE scenario. Finally it is striking that in the ST scenario large scale socio-technical transformations are achieved on a central level and less through “grass root” initiatives such as in the LS scenario. Clearly, in the Local Standard scenario user driven manufacturing innovation concepts are most strongly present. In this scenario the uptake of user driven manufacturing approaches has been enforced by a diversity of framework conditions and pursued by active creative communities in different regions. Accordingly in this scenario there is no one best way of user centred manufacturing but a diversity of approaches tailored to a diversity of conditions. However, some of the societal demands on future production patterns are not sufficiently solved due to lacking consistent large scale infrastructure innovation.

All four scenarios embrace **new forms of knowledge generation**. In all scenarios knowledge has become the most critical factor for manufacturing industries. However, the way the “knowledge economy” is realised and embedded into society is differing. Within the Global Economy scenario the emphasis is on highly formalised knowledge that is transmitted worldwide through advanced ICT tools. Knowledge generation for manufacturing industry is largely performed by specialised experts within each field.

Tacit knowledge and experience is less emphasised. The picture is quite similar in the Focus Europe Scenario. However, in this scenario concerted policy action has introduced some elements such as strong orientation on interdisciplinary that have helped to foster knowledge generation in Europe. Also the exclusive effect is less prevalent as targeted government initiatives have enabled a wide range of societal groups to be part of the knowledge generation process. Within the Local Standard scenario knowledge generation is much more localised. As the access to local knowledge sources is important for manufacturing industry there is less emphasis on formalisation and worldwide exchange of knowledge but more on integration of different types of knowledge. More societal groups are participating in the knowledge generation process. However modes of knowledge generation within Europe differ widely from region to region. Finally within the Sustainable Times scenario the open innovation mode outlined by the stakeholders in the ManVis scenario report has been adopted by manufacturing industry. The focus of knowledge learning is on real life learning integration of knowledge types and the inclusion of a wide diversity of knowledge sources.

Workplace innovation is a feature of all four scenarios. In each scenario companies have adopted measures to optimise work organisation in such a way as to maximise the performance. Nevertheless, the way this has been done is differing. In GE the fo-

cus of workplace innovation has been an increase of labour turnover. Extremely high workload for a limited number of people is causing health problems and social tensions. Labour is considered a product that has to be delivered at the right time and right place.

In the FE scenario the pressure on employees is limited a bit through strong legislation. Due to a number of regulations most companies have offered flexible life-working time arrangements. However, people encounter difficulties to realise their right. In the ST scenario industry, supported by policy initiatives, has carried out radical workplace innovation enabling learning and contribution towards innovation from all workplaces. In the LS scenario this has been achieved only in some regions were conditions have been favourable.

In all four scenarios **new patterns of work** have emerged as the classical linear model (education, work, and retirement) has dissolved into a continuous model with fluctuating pieces. However the integration of these pieces is on different level. While in the GE scenario the employers struggle to integrate learning phases often on the cost of spare time, in the ST scenario the integration is helped by companies themselves supported by strong legislation. In the LS scenario a number of local initiatives on new models of working and living have been initiated by local groups.

Highlighting message to policy

There are three major challenges to manufacturing arising from the demand side:

- Adoption of a user driven innovation approach
- Adoption of open forms of knowledge generation
- Adoption of sustainable high performance working patterns

To cope with these challenges manufacturing industry needs to undergo a major transformation. This transformation embraces a number of technological and organisational innovations. The main challenge of the transformation is the integration of technical and organisational innovations into new socio-technical patterns of production and consumption. Central elements of these new patterns are joint learning processes between different actors of the value chain as well as workplace innovation enabling contributions to innovation from all workplaces.

Research policy can support the necessary transition of manufacturing industry by targeted funding of the technological elements and even more by adjusting the way it designs its funding activities (cf. in depth the policy conclusions outlined in Chapter 8 of the ManVis Delphi interpretation report).

However, the radical transition process that is needed to keep manufacturing competitive within Europe embraces elements from completely different realms. Therefore, it cannot be achieved by research policy alone. It needs to be pushed by a strong concerted alignment of policies from different realms. Just as research itself has to adopt more open approaches, research policy will have to join efforts with other actors in the political arena. To coordinate these concerted measures guiding visions such as they were developed within the scenario exercise or by the Manufuture high level group can play a vital role. Further foresight activities can serve to orient the various stakeholders towards these visions.

Finally, from the scenario analysis it became clear that the issues at stake are not only relevant for the manufacturing industry but for society as whole. On the one hand, many of the challenges manufacturing industry is facing involve major societal transformation. On the other hand, failure to address challenges like inclusion of societal groups into learning processes, provision of customised products for groups with special needs or establishment of sustainable working patterns fitting societal needs may lead to major social tensions and affect quality of life for European citizens.

The scenario analysis furthermore indicates that in many respects advanced solutions are likely to emerge from a local level where the framework conditions are favourable. For policy making this implies that it could be useful to support such local “model” approaches to then be able to systematically foster their transfer and adaptation to other conditions.

Figures