



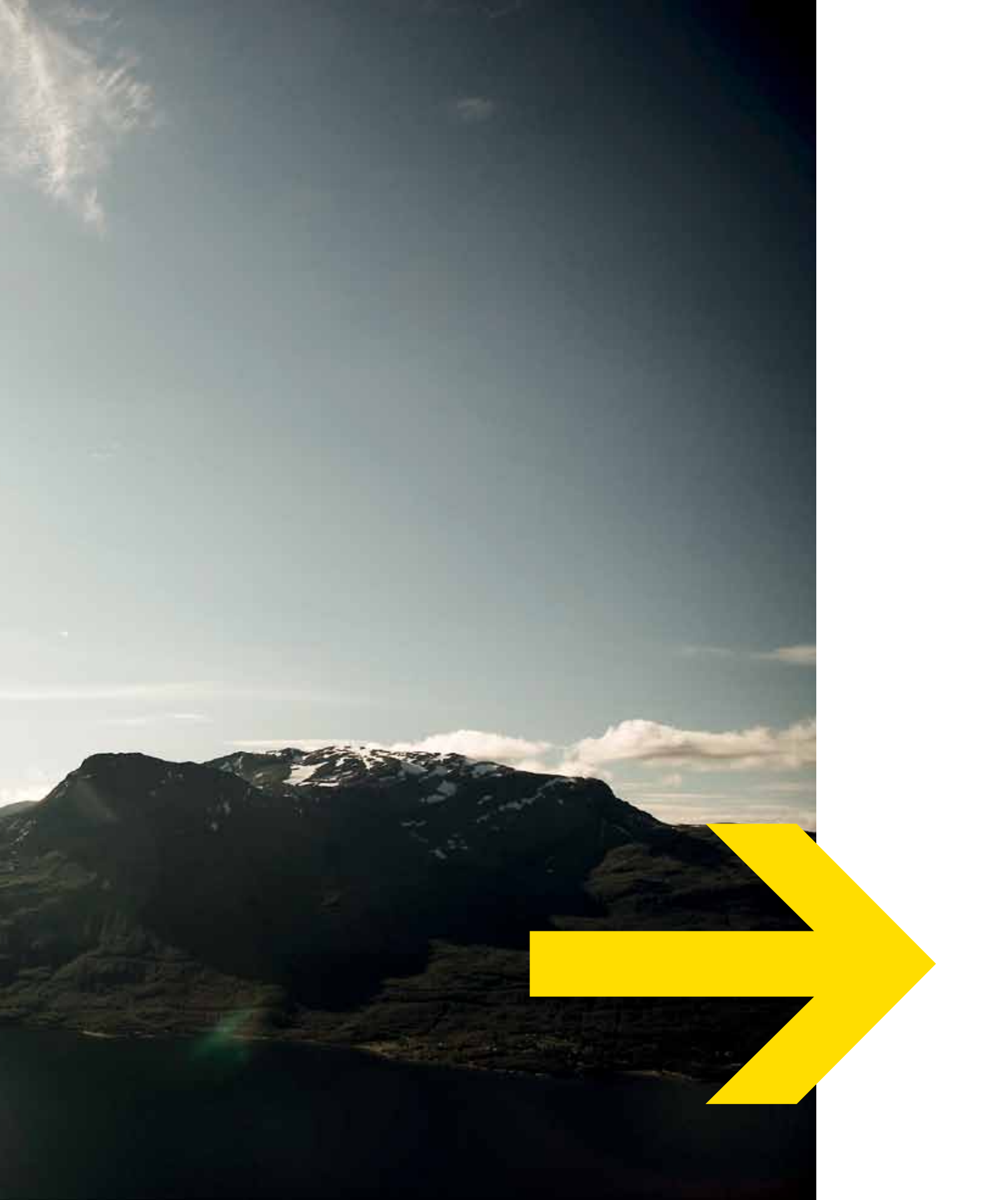
# **MADE IN SWEDEN 2030**

*Strategic Agenda for Innovation in Production*

# CONTENT

<b>Strengthening innovation for production in Sweden</b> .....	3
<b>Production in Sweden – a vision for 2030</b> .....	4
<b>Mega trends and social challenges affecting production in Sweden</b> .....	6
<b>Production in Sweden: strengths and challenges</b> .....	9
Environmentally sustainable production .....	10
Flexible manufacturing processes .....	10
Virtual production development and simulation .....	10
Human-centred production system .....	11
Product- and production-based services .....	11
Integrated product and production development .....	11
<b>Case: Xelmo</b> .....	14
<b>Actions for innovation and development in production</b> .....	15
Research and innovation projects .....	16
Knowledge and technology transfer to SMEs .....	16
Education .....	16
Mobility .....	17
Internationalization .....	17
<b>National resources for research, development and innovation</b> .....	20
Research Institutes .....	20
Strategic national research areas – SPI and XPRES .....	20
<b>APPENDIX</b> .....	22







*This strategic research and innovation agenda is proposing a new vision for production in Sweden 2030 and recommending long term efforts that are necessary to strengthen innovation, development and production of goods and services in Sweden.*

# STRENGTHENING INNOVATION FOR PRODUCTION IN SWEDEN

**S**weden is competitive when it comes to production and the manufacturing industry has successfully shifted focus from mass production to flexible manufacturing of advanced goods and services. Access to skill and a qualified workforce, a leadership in advanced technologies and productivity growth have been key success factors in this transformation. Swedish manufacturing companies are characterized by horizontal, decentralized organizations with a stable relationship between unions and employers. This makes a good foundation for problem solving, collaborations and innovation and is central for producing the knowledge intensive, flexible and customized products that Sweden is known for.

Production is a broad concept which includes every part of the production process required to create a marketable product. It starts with an idea or a customer need, followed by product development, a material strategy, manufacturing, service and re-manufacturing. Sustainable manufacturing with optimal resource efficiency and minimum waste together with a life

cycle perspective and material development are some of the vital areas of development towards a stronger and more competitive manufacturing industry, as well as development in management, organization and expansion of new business models.

Manufacturing and industrial services industries have become increasingly integrated and today services are regarded as part of the value chain in manufacturing. Together, the two sectors employ more than one million people in Sweden, half of which are employed in ICT, R&D and other business services. In summary, manufacturing matters a great deal in securing jobs and welfare in Sweden.

Most of the goods and services produced in Sweden are sold globally. The Swedish manufacturing industry is, however, facing increased competition and is dealing with more challenges today than ever before. Countries like the US, Germany, South Korea, Brazil, India and China are investing heavily in research, innovation and education in manufacturing, a clear sign of tougher competition ahead.

Sweden has a strong base for advanced manufacturing. The investments

in strategic production research in the 2008 R&D bill is providing for excellence in research and will provide for a growing number of engineers and PhD's in this field. But this will not suffice to secure jobs and increase competitiveness long term. Sweden's competitors, including emerging markets, are increasing efforts towards production as well and to remain competitive, Sweden must continue investing in long-term strategic programs that strengthens innovation, research and education in production and industrial services.

This strategic research and innovation agenda is proposing a new vision for production in Sweden 2030 and recommending long term efforts that are necessary to strengthen innovation, development and production of goods and services in Sweden.

The agenda was prepared by Teknikföretagen, in close cooperation with the Swedish Production Academy, Swerea IVE, Chalmers, KTH and IF Metall.

*Stockholm, April 2013*

*Åke Svensson*

*Director General Teknikföretagen*

# PRODUCTION IN SWEDEN – A VISION FOR 2030

IN THE YEAR 2030, Sweden is the primary choice for developing and producing advanced products and services. Manufacturing companies are characterized by innovative product and production system development, as well as by excellent leadership. Swedish manufacturing industry is a forerunner in producing customized, high-end industrial services. Sweden's globally competitive position in 2030 is based on the strategic, long-term efforts that began in the early 2000, leading to increased focus on research, innovation and education in production. In addition, the strong ties between industry, academia and research institutes constitute essential and unique assets to strengthen Sweden's competitiveness.

In 2030, a career or education in manufacturing is a desired choice for

young people and adults looking for a new career. The education system offers manufacturing education opportunities on all academic levels. Swedish operators and manufacturing engineers as well as postgraduate students are internationally recognized, as are students trained in product and production innovation and manufacturing services. These students have close ties to companies, as well as with research and industrial development projects.

Production in Sweden is knowledge-intensive, flexible, efficient, and environmentally sustainable, made with minimal use of resources. Product and production development is a parallel and integrated process, from idea to production of manufactured goods and services. Manufacturing companies are flexible and driven by continuous deve-

lopment, with a management focusing on change and stability.

Production is characterized by complex systems where virtual and real production processes are integrated for optimal flexibility, resource efficiency and customization. Sweden is one of the leading countries when it comes to sustainable production, based on ecological, economic and social perspective. Raw materials, energy and logistics are characterized by efficiency at all levels and the use of lightweight and recyclable materials has risen sharply.

The manufacturing industry, together with academy and research institutes, collaborate to develop ecologically and socially sustainable processes and products and contribute to the sustainable development of society and its supply chains.

---

*In 2030, Sweden is a forerunner  
in sustainable production.*

---



# MEGA TRENDS AND SOCIAL CHALLENGES AFFECTING PRODUCTION IN SWEDEN

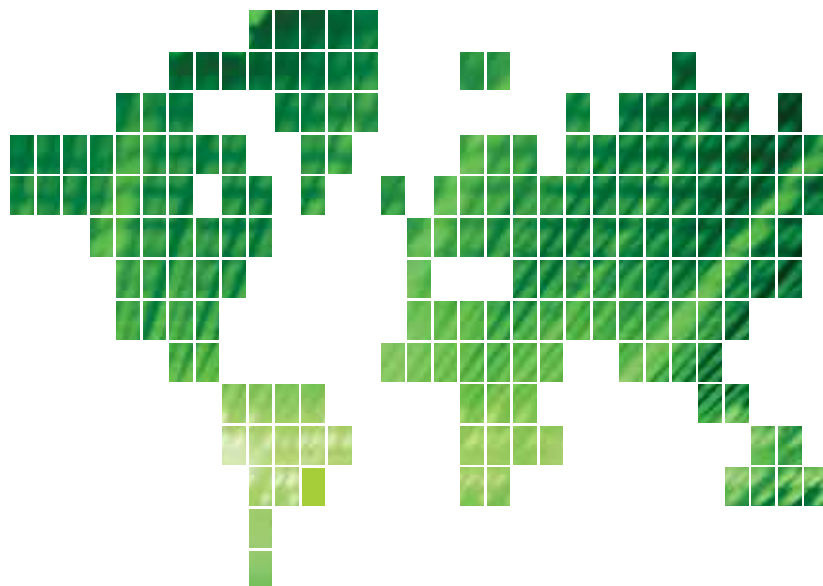
**SWEDISH INDUSTRY** is extensively influenced by international mega-trends, where perhaps the most important factor will be demographics on a global scale. In 2030, China will likely be the world's largest economy, followed by the USA and India. Thirty new multi-million cities will have emerged in Asia and Africa and approximately 60 percent of the world population (4.9 billion people) will live in urban "mega-cities". The middle class will have increased by almost two billion people, compared to 2010. This means that demands for goods and services will have doubled compared to today. The growth will drive technology development and innovation both in advanced economies and in emerging countries.

Production will be affected in all parts of the world by the on-going third industrial revolution. This means that not only people will constantly be connected, but also that products, machines, production systems, transport systems and buildings will be able to communicate with each other. Smart grids will integrate communication flows and energy supply.

Goods and services from the manufacturing industry will be increasingly integrated and business models will be focused on functions rather than physical products. Production will no longer be limited to companies owning machines and production systems. New additive manufacturing technologies, including free form fabrication and 3D printers, will enable

cost-efficient production of customized products to a global customer base.

A rapidly growing middle class will increase demand for products, making the shortage of resources such as raw materials, energy and know-how one of the grand challenges for future generations. In the production area this has meant that far-sighted production companies already in the early 2000s began the transformation of processes and products with the aim to minimize the use of inputs such as materials, energy and water. Reducing waste in all its forms is the basis for lean production, lengthily established in the production industries. Production without waste, including a high proportion of recycled materials, will also become increasingly important.





## GLOBAL TRENDS WITH SIGNIFICANT IMPACT ON THE PRODUCTION AREA

### **Sustainability and efficient use of resources**

Remanufacturing of products is gaining importance. In many industrial sectors the trend toward closed material loops, where raw materials are constantly being recycled and used in new products, is growing and will make new demands on the manufacturing industry.

#### **Challenge for Swedish society and industry**

Creating new business models as well as addressing problems in product development, production systems, logistics and work-environment related to recycling and reuse of materials and resources

### **New types of production**

Future production systems are connected with product development, recycling and re-manufacturing. New materials will require new and improved manufacturing processes, machines and tooling systems. Products such as cars and machinery will become more light-weight and at the same time more complex with more integrated mechanical and ICT-based features and service content.

#### **Challenge for Swedish society and industry**

To take advantage of existing production knowledge, and to develop and utilize new methods of production.

### **Raw material shortages and development of new advanced and exotic materials**

Many industries are looking for new advanced materials to increase value added and sustainability as well as minimizing risks of materials shortages. The applications are particularly interesting in the automotive, energy, healthcare and communications industry. New materials in the supply chain create challenges such as changing systems of production, manufacturing and logistics.

#### **Challenge for Swedish society and industry**

To make better use of raw materials and new technologies for new products and processes in manufacturing, working environment and logistics.

### **Everything communicates**

Information and communication technology (ICT) enables seamless and continuous exchange of information and knowledge between people, machines and systems worldwide.

#### **Challenge for Swedish society and industry**

To manage increasing demands on data management and knowledge needed in industry to be able to utilize and develop with the opportunities in ICT.

### **A challenging demographics development**

Sweden and Europe are facing demographic problems that will be critical around 2020. A large part of the population will be older than 65 and has to be supported by a decreasing part of the population active in the workplace. Manufacturing companies will compete over competence and investments by industry will be often guided by availability of skills and know-how as well as by attractive research and innovation infrastructure. Clever use of ICT and automation can ease the situation and compensate for physical and cognitive limitations.

#### **Challenge for Swedish society and industry**

To develop the research and innovation infrastructure, providing access to a skilled workforce and to manage the development of education at all levels.

### **Components with micro- and nano-structures**

Products ranging from mechanical micro-components to semiconductors and circuit boards are becoming more important for increasing the value added in many products. Micro components are more commonly being used in many industries and nano-materials such as Graphene has many potential applications in the automotive, energy and medical technology. Today the development are led by the US and Asia, but Sweden has a prominent position, not least through the major European strategic focus on the Graphene with a Swedish leadership.

#### **Challenge for Swedish society and industry**

To build knowledge about new micro- and nano-materials, including processes and production systems for the manufacture of products in micro and nano dimensions.

---

*Global megatrends creates pressure on manufacturing companies in general, regardless if they operate in Shanghai, Stuttgart or Borås.*

---



# PRODUCTION IN SWEDEN: STRENGTHS AND CHALLENGES

**MANUFACTURING** and production-related services have been key drivers for Sweden during years of prosperous growth, as well as leveraged the economy out of recession. Manufacturing makes up for a large part of the Swedish GDP growth during the past 20 years. The progress and productivity gains in the production sector have partly been the result of global expansion of Swedish companies and their establishment in emerging markets, often closely connected to subcontractors.

Parallel to international expansion, the national industrial productivity was among the highest in the world during the 1990s, ensuring continued localisation of production in Sweden. Consequently, production is an extremely important base for Swedish employment and economic growth. Looking at employment figures, manufacturing has decreased in the last decades, but the industrial services industry has grown substantially, such as IT, R&D and other supporting services. Overall, the manufacturing industry together with industry-related services employ more than one million people in Sweden.

It should also be emphasized that the level of skills in the manufacturing industry is steadily increasing. The share of employees with higher educa-

tion in engineering doubled from 1993, representing 20 percent of the workforce in 2010. Increasing demand for a well-educated workforce is expected to continue, posing a major challenge for European and Swedish industries. Global megatrends, societal challenges, and global changes creates pressure on manufacturing companies in general, regardless if they operate in Shanghai, Stuttgart, or Borås. But despite increased uncertainty in the global market and a financial crisis in recent memory, many Swedish manufacturing companies are investing in production facilities and for the future. Investments by companies like Volvo, ABB, Scania, Saab Group and SKF strongly suggest that Sweden is a major stakeholder in manufacturing, also in 2030.

This strategic innovation agenda in production proposes six critical areas for production research and innovation where Swedish industry, academy and institutes presently are well positioned. However, mega-trends and social challenges outlined in this agenda are already creating strong pressures for change and innovation. It is therefore clear that substantial public and private investments need to be made in research and innovation programmes to maintain short and long-term competitiveness.

The awareness of production's importance for jobs and GDP has increased during recent years. Public and private investments in long-term interdisciplinary research programs for industry, academy and research institutes have increased. In Europe the Barroso recovery package focused on the Factories of the Future. In Sweden investments in two new (2008) centres for strategic research (SFO) in production creates a strong foundation for research and development excellence. The sites are "Sustainable Production Initiative" (Chalmers University of Technology and Lund Institute of Technology) and "Excellence in Production Research" (Royal Institute of Technology and Mälardalen University). However, these research efforts are aimed towards basic research and lower TRLs and need to be complemented by efforts in research and innovation to enable Swedish industry to be among the global leaders in 2030. Short-term competitiveness requires stable and efficient processes from innovation to industrialization, while long-term success relies on responsiveness to megatrends and societal challenges. We need to invest to build attractive research, innovation, and education in order to secure Swedish industry long-term competitiveness.

## SIX KEY AREAS TO STRENGTHEN PRODUCTION IN SWEDEN 2030

### 1. Environmentally sustainable production

The overall challenges for environmentally sustainable production in Sweden are to minimize resource consumption and environmental impact of production systems and products.

Sweden has acquired a strong international position in development of environmentally sustainable production. Important challenges are for example efficient use of materials, lightweight structures, energy optimization, remanufacturing, and advanced methods for recycling. Virtual engineering methods for advanced product and production system analysis in Sweden are beyond state of the art. This strengthens Swedish competitiveness in industries such as automotive, energy, and electronics.

Industry must cope with the transformation into producing with significantly reduced resources, which is a significant challenge. Production must minimize the use of materials, energy, water, and other resources. Sustainability efforts also include concern for raw materials commodities and needs for alternatives, such as for rare earth metals or materials from politically unstable regions. Products must be designed to be easily dismantled, recycled, and returned into the production system. Modular manufacturing, new tools and tooling systems, life-cycle assessment-based business models, and further development of established manufacturing processes are required to make the transition. Decision support is needed to assess the potential and risks of production-related scenarios, both in terms of environmental impact and economical impact. New technologies such as additive manufacturing processes and technologies like 3D printers need to mature but will increase in importance.

### 2. Flexible manufacturing processes

The overall challenge for flexible manufacturing processes is to develop manufacturing processes for the products of the future.

Successful Swedish companies focus on production of complex and customized products. Factories that once were organized and equipped for high-volume production of one standardized product have evolved into highly specialized production systems. In an automotive example, out of 80 000 trucks built by a Swedish manufacturer less than two vehicles are alike. Flexibility is enabled by all parts of the production and its different ways of machining, assembly, painting, etc. Several products will be produced in the same production system. Success is achieved by coping with an "infinite" range of product variety and high customization, while rapidly introducing new products. Advanced materials with high performance characteristics are enabling a rapidly growing number of innovative products, but manufacturing is still limited by production process capability. Strategic choices of manufacturing processes are needed to meet the requirements of flexibility of materials and batch sizes. New technologies, like additive manufacturing processes enable new capabilities. Speed and flexibility are essential to deal with external changes such as market development, energy and environmental crises, and changes in the availability of raw materials. The flexibility and level of customization of products is determined largely by the capability of the different manufacturing processes and production resources. This includes the competence and capability of people involved in manually assisted process steps.

### 3. Virtual production development and simulation

The overall challenges for virtual production development and simulation are to enable conversion of information and data into knowledge and decision support in virtual and physical production systems.

The use of digital modelling and simulation in development of complex products and production systems is well established in the manufacturing industry, especially in the automotive sector. Sweden is a frontrunner in research and development of virtual factories for optimization and planning of production.

Product development, geometry assurance, materials testing, and production layout planning are examples where product test runs and physical models are increasingly being replaced by simulations in virtual systems. Virtual representations are also frequently used for ergonomics, skills development, and training. Information and communication technology (ICT) and data management is increasingly connecting all resources in manufacturing. ICT tools and advanced visualisations are used by designers and operators to interact with production systems at all levels. Information management is needed to support the processes of product and process development and testing of new materials and industrial development.

Effective management and communication of data and information means that new data management system, new skills and strategies in ICT and simplified interfaces between systems and humans. Swedish manufacturing companies are currently very strong in the use of simulation and virtual technologies in the production area.

#### **4. Human-centred production system**

The core challenges for human-centred production systems is the demographic situation and the new evolving forms and systems of interaction and collaboration between people and advanced automation to achieve high performance.

Future production systems are highly complex and have capability to adapt to changes. Such systems require skilled and trained people to work in new types of adaptive teams. Humans will collaborate directly with robots, automation, technical tools, and cyber-physical systems. This places new demands on work task allocation, safety, cognitive expertise, and advanced communications.

Traditional production work is evolving into sophisticated knowledge work, characterized by collaboration, broad expertise, communication, innovation and effective problem solving. Skills and knowledge of individuals form boundaries for the production system's ability to optimize daily production and the continuous improvement of processes required for global competitiveness. The level of competence is growing and the share of engineering graduate employees has increased by 140 per cent since the mid-1990s. Great responsibility and decentralized decision-making characterizes organizations and involves the entire supply chain. Such qualities are strong in Swedish companies, with a long tradition of knowledge work in systems of production and innovation and in the design of sustainable workplaces.

New ICT tools enable operator teams to plan, program, monitor, and maintain complex production systems. Physical and cognitive support enables workers with restrictions in terms of age, knowledge, language, etc. and thus address the demographic problem Swedish industry is facing.

#### **5. Product- and production-based services**

The major challenges are product and production-based systems based.

Customer value is created both by physical products and by the services and software integrated with the products. Manufacturing industry is presently increasing its efforts to develop product-integrated services and software to attract customers. Similar efforts are made to develop services integrated in production systems. Several Swedish companies shifting towards service-based customer value, for example ABB, Atlas Copco, Alfa Laval, Ericsson, Volvo Corporation, Volvo Cars, and Assa Abloy.

The transition from traditional products to integrated service-based products provides challenges for manufacturing industry in terms of new methods, processes, methods, and development tools. There is an opportunity for cross-disciplinary collaboration between production- and service-oriented research centres. To allow businesses to grow and develop in Sweden, our ability to develop industry-related services needs to be strengthened and developed. The industry already sells mainly services, where the hardware, software and services are highly integrated. With an increasing focus on product-integrated service sales completely new production systems are required.

The transformation is crucial for competitive production in high-cost countries such as Sweden. Innovative products that offer services, functions, emotions, combined with sustainable manufacturing and flexibility require increased innovation in corporate organization, management and production systems with service development goals.

#### **6. Integrated product and production development**

The challenge is to strengthen product development processes, developing processes and tools for innovative product development.

Rapid market introduction of new products is critical for the competitiveness of Swedish manufacturing industries. For companies wanting to remain profitable in intense global competition, the time from innovation to market is crucial. This applies to the entire chain, from product and production systems development, to dismantling, reuse and recycling. Sweden has long tradition of developing technically complex and knowledge-intensive products, which has contributed immensely to our industrial competitiveness. We have strong expertise in product development of both goods and services. Parts of our strength in innovation lies in efficient management and organization of innovation.

In order to streamline the product development process, time and resources must be used efficiently. Among the challenges are new demands on communication, innovation and corporate organization. The ability to develop fully integrated product development processes is critical to long-term competitiveness. Integrated processes requires parallel development of the product, manufacturing and production processes, and marketing systems, aftermarket offerings, and systems for recycling and reuse when the product is finally unusable. All processes must involve life-cycle thinking. The key to success is the utilization of integrated and flexible platforms for the efficient development, customization and configuration of sustainable products, systems and processes. The skill gap between global actors is shrinking and management and organization of product development is becoming increasingly important.

**MEMBER COMPANIES IN  
THE ASSOCIATION OF SWEDISH  
ENGINEERING INDUSTRIES**

**3 600**

**1/3**

**OF THE INVESTMENTS  
IN R&D COMES FROM  
ENGINEERING INDUSTRY**

**SWEDISH ENGINEERING  
INDUSTRY HAS**

**60%**

**WHITE COLLAR**

**SWEDISH ENGINEERING  
INDUSTRY HAS**

**40%**

**BLUE COLLAR**

**300 000**

**EMPLOYEES IN  
ENGINEERING INDUSTRY**

**More than  
50%** OF THOSE EMPLOYED  
IN ENGINEERING INDUSTRY  
HOLDS A UNIVERSITY DEGREE

**3 470**

ENGINEERS GRADUATED 2012

OF SWEDISH EXPORT  
ARISES FROM  
ENGINEERING INDUSTRY

**50%**

**600 000**

EMPLOYEES  
IN THE MANUFACTURING  
INDUSTRY

# XELMO

## *A high-tech manufacturer in the middle of the value chain*

What does Sweden's competitiveness in advanced manufacturing mean for the development and growth for a small company? We took a closer look at Xelmo: a small technology intensive company specializing in embedded systems.

**XELMOS PRODUCTS** and services are important building blocks in the manufacturing industry. Their speciality is building communication systems between machines in a manufacturing system. Their customers are companies with manufacturing in Sweden – a vital factor for a supply company like Xelmo.

Production of goods in Sweden is a fundamental requirement for the emergence of smaller technology companies. The close collaboration of smaller technology suppliers and the larger companies is an important contribution to the competitiveness in the manufacturing industry.

A large number of companies collaborate in the supply chains surrounding the manufacturing industry. These clusters make up an eco-system where innovations are made and where new products and/or companies; and even

new markets, are created. The presence of a strong and competitive manufacturing industry is a prerequisite for these types of clusters and thereby the growth of small and medium sized technology suppliers, which in turn, support the competitiveness of the manufacturing industry.

Research and innovation in the private and public sector is an important part of a knowledge society, like Sweden, and contributes to the knowledge growth in technology SMEs. Equally important for the growth and development of SMEs is the continuous development in the manufacturing industry, which in turn makes new demands on the suppliers like Xelmo, thereby, increasing their competitiveness.

Xelmo stands apart by actively participating in research projects, on a Swedish and European level. It is very

unusual for companies with the size of Xelmo, only a handful of engineers, to be involved in R&D projects. According to David Bauman at Xelmo, the R&D collaborations have resulted in valuable contacts, as well as access to new knowledge and national and international researchers.

–Since the availability of knowledge in embedded systems is limited in Sweden, our small company needs access to a larger network of knowledge and researchers. It's therefore fundamental for Xelmo to participate in research projects, says David Bauman.

There are, however, several thresholds preventing SMEs to collaborate in research and innovation and programs. Extensive administration and fees ought to be removed to facilitate a higher participation from SMEs, says David Bauman, since the time invested into projects is very valuable to a small company with limited resources.

In conclusion, the continuous development of the manufacturing industry in Sweden is a fundamental requirement for the growth of competitive small and large companies in Sweden.



# ACTIONS FOR INNOVATION AND DEVELOPMENT IN PRODUCTION

**PRODUCTION IS** of fundamental economic significance for Sweden and its future growth and welfare. Therefore, it is crucial that Sweden remains an attractive country for production, something that requires development and innovation in the production area as well as close cooperation between industry, academy and institutes. This agenda describes the need of establishing a Strategic Programme for Innovation in Production, covering the entire production chain. An important mission for the Programme is to identify industrial needs and demands in a medium to long-term perspective. Therefore an active collaboration with manufacturing companies is a

fundamental require in all actions within the Programme in order to attain its goals.

Global megatrends that affect production in Sweden have been described. We have also identified six key areas where Swedish companies and researchers have a strong position to continue a leading role. To support this development, national funding has to be directed towards strengthening the innovation capacity and shortening the time from research and development to industrial implementation in these key areas. Thus, national research and innovation funding has to support the development of new technologies, organizations and processes, as well as

the development of production-oriented education at all levels. Strategic innovation initiatives and pre competitive test beds are also needed to demonstrate new ideas for companies and markets.

In order to secure long-term, efficient implementation of research and innovation in the manufacturing industry the Programme for Production is structured around the following five instruments:

1. Research and innovation projects,
2. Knowledge and technology transfer to SMEs,
3. Education,
4. Mobility, and
5. Internationalization.

---

*Investments in the Swedish research and innovation system are necessary to secure long-term competitiveness in production.*

---

### **1. Research and innovation projects**

Research and innovation projects will be the largest instrument and is number of criteria, such as a high TRL; collaborations with several industrial and academic partners; links to education in production as well as to EU-programmes. New technologies in SMEs.

### **2. Knowledge and technology transfer to SMEs**

To secure future growth and innovation, Sweden needs to increase the number of high-tech, small and medium sized companies. Initiatives like Vinnova's program Research and Grow are directed towards SMEs to support them in developing technologies with great commercial potential. However, SMEs need to be more involved in research and innovation, thereby increasing their access to new, innovations, research and opportunities.

### **3. Education**

Access to the right competence and skill is one of the grand challenges that will affect Sweden and many other countries' competitiveness for a long time to come. For manufacturing companies to choose Sweden as site of production requires that many demands be met. One of the most important is access to world-class production expertise at all levels, from operator and product developers to engineers and researchers. This applies large multinational companies and smaller enterprises alike. Vital areas where knowledge needs to be developed is in for example in production technology, product development, leadership, and organization.

To meet the manufacturing industry's needs of competence and skills knowledge transfer has to take place early within educational programs. This can be effectively done by collaboration between education, industry and academy. The focus should be on the key strengths in the Swedish

production: sustainable production, flexibility and the use of ICT in both products and processes must be reflected in the educational programs.

Through stronger collaboration between academy and industry both excellence in education and increased industrial relevance in academy are achieved. Better interaction between students and industry i.e. in industry-related projects, during master thesis's, and through lectures increases student motivation, excellence in education is achieved and industry-related research in academy is strengthened. In order to achieve long-term competitiveness production-oriented programs at all levels needs be developed and renewed and we suggest two types of education programmes to develop education in production:

1. A National Graduate School in Production
2. Implementation of a national training programme for production employees



#### 4. Mobility

Mobility between industry, academy and research institutes is an important prerequisite for an efficient and successful commercialization of research results and for securing industrial perspectives on research and education. This type of personal mobility is low in Sweden compared to many countries in the OECD. The issue has been discussed extensively in recent years and a new approach to academic qualification is necessary, where industrial experience needs to be valued to the same extent as academic research and citation. A more strategic mobility would strengthen the competitiveness of all parties involved.

One example is, associate positions in universities which has a great potential to help industry build competence, increase the research capacity and transfer new knowledge to industrial organizations. Academy need to further enhance corresponding incentives to developed associate positions.

However, this type of collaboration is not used to its full potential in Sweden today and we suggest increased efforts in this area. We suggest opportunities for short exchanges of staff that will enable flexible exchanges for shorter periods. The initiative would be a complement to Vinnova's programme for mobility "VINNMER" and "Innovation-driven mobility," which both allows for longer exchanges.

#### 5. Internationalization

The fifth and final priority area suggested is to further develop international co-operation regarding research and innovation in production. A good foundation for the international efforts is available within the network Manufuture, a European Technology Platform for stakeholders in industry and research to strengthen and develop production within European countries. The Swedish national platform Manufuture-SE includes Swerea IVE, Teknikföretagen, the two Strategic

Research Areas at Chalmers and KTH and Vinnova. Affiliated to Manufuture is EFFRA, an industrial network, and the Public Private Partnership "Factories of the Future", one of several partnerships to strengthen research and development to address global grand challenges. EFFRA's Roadmap for 2020 covers six main areas, which are in line with the Swedish areas of strength described in "Production in Sweden: strengths and challenges".

A strategic innovation programme in production is an important base to develop and strengthen Swedish participation in European production research within Horizon 2020.





"As manager of component manufacturing at ABB, production is about combining flexibility in assembly with almost infinite product variants. My team and I are driven by the challenge to constantly developing our processes and the way we work. It makes our work much more interesting as it strengthens the competitiveness of ABB."

Hans Linder, ABB Components

= G10PLC  
+ M005-U01

# NATIONAL RESOURCES FOR RESEARCH, DEVELOPMENT AND INNOVATION

SWEDISH MANUFACTURING COMPANIES are making substantial investments in research and development; more than one third of national R&D spending comes from the manufacturing industry. ABB, Saab Group, Scania, SKF and Volvo Group are just some examples of industries who are investing today to meet global competition and contributing to securing jobs and future welfare. In addition, Sweden also has strong research and development environments within universities and research institutes.

The Swedish Production Academy was established to manage and develop research, graduate and undergraduate courses in production. It is a unique platform for mobilizing and developing production; a broad and interdisciplinary area. The Academy consists of teachers, graduate students and professors active in the following universities: Chalmers, Halmstad, Jönköping, Linköping, Luleå, Lund, Mälardalen, Karlstad, KTH, Skövde and Trollhättan (University West). The Academy organizes regular conferences, contributes to develop graduate schools and engineering programs and can quickly mobilize and create pilot projects with partners from academy and industry throughout Sweden.

Representatives from universities, institutes, and the Swedish Production Academy have been actively involved

in the preparation of this agenda. This vouches for a fast and effective implementation of a Strategic Research and Innovation Area for Production.

Below are examples of research and development environments in Sweden working with the production of the future. For a more detailed summary, see Appendix 3.

## Research Institutes

An important factor for industrial competitiveness is fast and efficient transfer of new knowledge, innovations and research to industrial applications. Here, the research institutes in Sweden play an important role. The Swerea Group is the main research organization in the area of production and is comprised of five research institutes: Swerea IVF, Swerea KIMAB, Swerea MEFOS, Swerea SICOMP and Swerea SWecast. Swerea covers the entire chain from raw materials to process, with specialized areas such as materials, production processes, work environment and energy efficiency. The 600 senior scientists at Swerea work in close collaboration with industry and academy, and the institute is an important platform for mobility between these environments, contributing to competitiveness. An additional important role for Swerea is to manage and develop a long-term strategic cooperation with the manufacturing industry, thereby identifying and solving future production related challenges.

Swerea is also promoting strong innovation environments, like Open Access Labs, where researchers and companies can cooperate in short-term projects.

## Strategic national research areas – SPI and XPRES

“Sustainable Production Initiative” (SPI) is one of two national Strategic Research Areas (SFO) in production, funded by the Swedish Government. The “Sustainable Production Initiative” is collaboration between Chalmers University of Technology and Lund University. The joint research centre focuses on sustainable manufacturing processes, sustainable production systems, and sustainable product development. Four open innovation laboratories at Chalmers and Lund have been built. SPI is linked to six centres of excellence as well as to undergraduate and postgraduate courses. SPI has close cooperation with industry, academy and institutes in Sweden, EU, and globally e.g. in the US.

“Excellence in Production Research” (XPRES) is the second Strategic Research Area in production, a collaboration between KTH and Mälardalen University. XPRES focuses on virtual factories and new production in collaboration with Swedish industry. Together with Swedish and international partners XPRES is building research and innovation infrastructure, including facilities for simulation and visualization of production processes. XPRES also invests in the development of courses in the field of production. By building an educational environment, which has close collaboration with industry and research, XPRES wants to educate world-class engineers and scientists, which helps to strengthen the industry’s long-term competitiveness.



# APPENDIX

## APPENDIX 1

### Core group for the preparation of the agenda

#### Project manager and editor:

Cecilia Warrol Ersson, Teknikföretagen

#### Co-Project manager and editor:

Elisabeth Sagström, Research manager,  
Swerea IVF

Johan Stahre, Professor, Chalmers

Bengt Lindberg, Professor,

KTH Royal Institute of Technology

Johan Ancker, Teknikföretagen

Peter Johansson, Manager R&D,

Teknikföretagen

Mats Lundin, CEO, Swerea IVF

Jan-Eric Ståhl, Professor, Lund University

Boel Wadman, Research manager,

Swerea IVF

Mats Björkman, Professor,

Linköping University

#### Participating companies and organizations:

ABB

AB Volvo

Electrolux

SAAB Group

Sandvik

SKF

Volvo Cars

Xelmo

Chalmers

University West

KTH Royal Institute of Technology

Linköping University

Lund University

Luleå University of Technology

Mälardalen University

Swerea IVF and

Swerea Swecast

#### Discussions with the following other

#### agendas (selection) have been realized:

Resource smart material use

Aeronautic

NRIA

“Hjärnkraft – Brainpower”

Food

LIGHTer

Metallic materials

ICT Agenda

Innovation Management

Simulation

Forest

Swedish electronics hardware and

Services

## APPENDIX 2

### Selected references

- Atlas of Economic Complexity, [www.mit.media.edu](http://www.mit.media.edu)
- McKinsey Report on Work and Labour, 2012
- ICT for Manufacturing
- The ActionPlanT for Manufacturing 2.0
- MIT ILP Conference, Brussels 2012
- Report of the MIT Taskforce on Innovation and Production
- Report to the President on Ensuring American Leadership in Advanced Manufacturing, PCAST, June 2011
- Tillväxt och förnyelse i den svenska ekonomin, McKinsey Global Institute, Maj 2012
- Visionary Manufacturing Challenges for 2020
- World Economic Forum, 2012
- World Manufacturing Forum, Stuttgart 2012
- Svensk Produktion 2020, 2008
- Svensk Produktion 2025, 2011
- Teknikföretagens policy för högre utbildning, Teknikföretagen 2012
- Kreativitet för konkurrenskraft – näringslivspolitiskt program 2013, Teknikföretagen 2013
- Energieffektivisering i industrin – fördel Sverige, Teknikföretagen 2013
- Ekonomiska förutsättningar för avtalsrörelsen 2013, Teknikföretagen 2013
- Svenska framtidsutmaningar, Slutrapport från Framtidskommissionen, 2013
- Factories of the Future PPP, FoF 2020 Consultation Document



## APPENDIX 3

### A selection of Research Centres within production

**Sustainable Production initiative, SPI**, a cooperation between Chalmers University of Technology and Lund University and one of two Strategic Research Areas for Production.

<http://www.chalmers.se/en/areas-of-advance/production/research/Pages/sustainableproduction.aspx>  
<http://www.chalmers.se/production>

**Excellence in Production Research (XPRES)**, a cooperation between KTH, Mälardalen University and Swerea KIMAB, one of two Strategic Research Areas for Production.

<http://www.kth.se/en/xpres>

**Wingquist Laboratory VINN Excellence Centre** at Chalmers University of Technology focused on effective product development.

<http://www.chalmers.se/ppd/wingquist-en/>

**Centre for design and Management of Manufacturing Systems (DMMS)** at KTH is a competence centre for education and research on advanced machining.

<http://dmms.iip.kth.se/>

**Metal Cutting Research and Development Centre (MCR)** at Chalmers is a national centre for research and development in machining.

<http://www.chalmers.se/mmt/EN/centres/mcr>

**Innofacture** is a graduate research school in cooperation between Mälardalen University, University West and eight of Sweden's largest production companies. Innofacture focuses on innovation and product development to strengthen the competitiveness of companies.

<https://www.mdh.se/idt/forskning/2.1994>

**Production and Materials Engineering (ProMatEn)** is a research centre at Lund University with focus on advanced material processing and economic analysis. The centre has special SME-focus and cooperates with MAX 4 and ESS.

[www.iprod.lth.se](http://www.iprod.lth.se)

**Centre for Electro Magnetic Energy Conversion (CEMEC)** is a research centre at Lund University with focus on electric processes with material processing.

<http://www.lth.se/cemec>

**Rydberg laboratory** at Halmstad University  
<http://www.hh.se/forskning/laboratorier/rydberglaboratoriet.11365.html>

**Produktionstekniskt centrum** at Innovatum in Trollhättan

<http://www.innovatum.se/pages/default.asp?SectionID=3103>

**Helix VINN Excellence Centre** at Linköping University

<http://www.liu.se/helix?l=sv>

**Faste Laboratory** is a VINN Excellence Centre at Luleå University of Technology  
<http://www.ltu.se/centres/Fastelaboratoriet-Vinnexc-Center>





