Future of Automotive Manufacturing

Trends and Developments within the Automotive Production

Authors

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1. THE DUTCH AUTOMOTIVE INDUSTRY

The Netherlands possesses a serious manufacturing industry of which the automotive industry is an important part. Big OEM's such as DAF Trucks, Scania and NedCar, but also smaller OEM's and subcontractors on SME level are located in the Netherlands. In total these companies have approximately 40.000 employees.

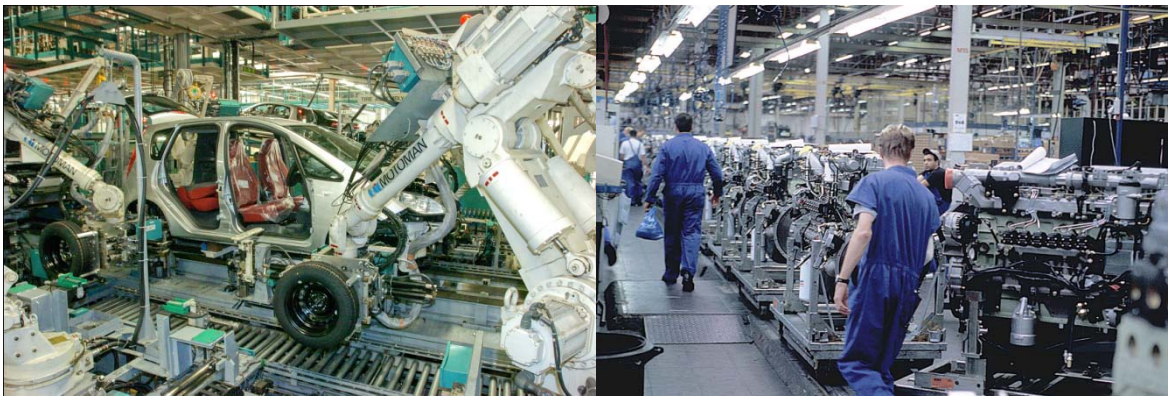
The automotive industry changed during the past 10 years in the Netherlands. The truck industry flourished while the car industry had to cope with deteriorating market conditions. With the disappearance of the by Daimler-Chrysler introduced model, Smart for four at NedCar the total volume of cars produced in the Netherlands dropped significantly.

The Dutch truck industry with companies as Scania , Terberg, Ginaf and DAF trucks experienced a volume growth in production unlike any other period in the past, DAF Trucks even produced the most trucks ever. Direct related subcontractors to these Truck- and Car-companies went through nearly the same tendencies. Next to the OEM's, the subcontractor companies with a more European or even global approach, could also profit from the economical growth of the European and global automotive industry.

If we focus more on the content of manufacturing inside these companies, a lot of items are changed or were introduced during the past 10 years. Although new technologies arrived the general basic contents of the cost quality paradigm (quality up and costs down) remained intact.

- The development of suppliers from component to system supplier or even full-service system supplier.
- The re- or introduction of all variants of the 60 years old Toyota Production System from Taichii Ohno, as fundamental concept of lean manufacturing.
- Fine tuned Six-Sigma methods and combinations with lean.
- Optimization of the in- and outbound logistics.
- Introduction of ICT controlled production lines/plants.
- Decreasing tact-time due to more standardization and optimization.
- Start of having more focus on sustainable production.

There difference between the 'truck' and 'car' industry on various items remains, but if we focus on manufacturing level these two industries seem to approach each other.



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2. CURRENT SITUATION

2.1 Introduction

The current manufacturing industry is already transforming, dictated by the changing social mindset and government aim for sustainable production. This general trend is accompanied by globalization, increasing competition and changing markets, which manufacturing companies need to cope with. Next to these general trends the developments on 'Lean Manufacturing', 'TQM' and 'Logistic innovations' are more and more accepted supported by the ongoing acceptance of ICT. As mentioned this ICT developments are more and more visible in the inbound and outbound logistics of companies. The manufacturing companies of today even cannot function without ICT guided logistics. This chapter describes these themes and thereby the current situation in the manufacturing landscape.

2.2 Manufacturing Strategy

Ask a manager for an optimization strategy and 'Lean manufacturing' is probably the first term that is mentioned. This generally accepted and applied strategy of 'waste' management should lead to a decrease of the costs which eventually contributes to an improvement of the results. In order to implement this strategy companies are more and more improving their total processes from supply until delivery following the Just In Time (JIT) principle. By minimizing lead times, the total logistic efficiency improves and this is beneficial for the results.

Now as far as the cost side 'Lean Manufacturing' is concerned as the leading theory today. However when improving company results, quality is the other key variable to be taken into account. When reviewing total quality management (TQM) nowadays, Six Sigma is the general accepted measurement tool to monitor and control quality. Six Sigma seeks to improve the quality of process outputs by identifying and removing the causes of defects (errors) and minimizing variability in manufacturing and business processes. Besides monitoring quality certifying quality is currently an widely accepted tool in the competitive environment to gain an advantage. The international organization for standardization (ISO) has developed an international accepted certificate to prove quality levels within the organization. ISO TS 16949 for automotive manufacturers is the standard norm in the current manufacturing landscape.

With the implementation of the 'Lean' and 'Six Sigma' philosophies to control costs and quality, technology is now of vital importance to the manufacturing companies.

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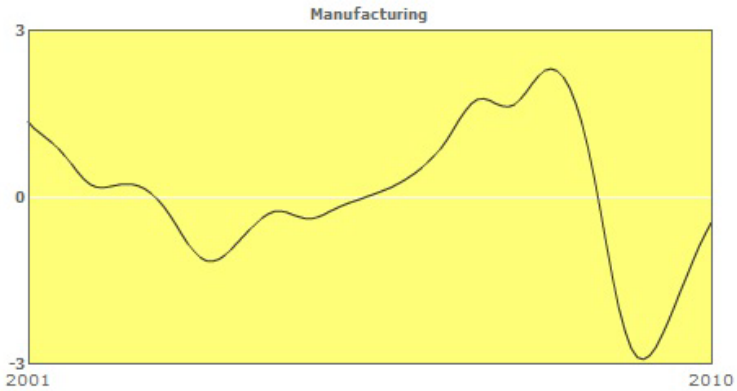
2.3 Current Technologies

Technology plays a major role in manufacturing these days. Advanced automation and ICT supports manufacturing companies in there strive for increased efficiency and quality optimization. A good example of currently applied software is enterprise resource planning (ERP). This integrated computer-based system is used to monitor internal and external processes including tangible assets, financial resources, materials, human resources and logistics. The technology discussion about manufacturing eventually leads to discussing logistics as well as they play an important role in optimizing the manufacturing process. In- and outbound logistics can be planned and monitored with an ERP module or with a dedicated warehouse management system (WMS). In today's tight economy, there is significant pressure to use the warehouse module from the ERP package because its price is usually heavily discounted as part of the original ERP license or the cost of integration is presumed to be lower.

2.4 Regulations

The regulations on sustainability and CO2 reduction policies are about to thoroughly change the industry. To enact this policy the European Union has set up the Strategic Energy Technology Plan (SET-Plan). The plan aims to reduce greenhouse gas emissions by 20%, ensure 20% of the renewable energy sources in the EU, and reduce EU global primary energy use by 20% by 2020. Chapter 3 discusses the effects for the future, but for now the manufacturing industry is already acting upon these changes as the EU proposes minimum efficiency standards and rules by labeling products. It is noteworthy that machine tools are mentioned as one of the top three priorities for the product categories to be regulated in the framework. This is defined in the Ecodesign Directive of the European Parliament and Council of 2009 that the energy efficiency of manufacturing and machine tools will be regulated legally in the future. This directive defines ecodesign as "the integration of environmental aspects into product design with the aim of improving the environmental performance of products throughout their whole life-cycle (LCA)". A signal that current developments on sustainability will affect the manufacturing industry of the future.



2.5 Economic landscape

When describing the current situation one cannot omit the economic crises. With this crisis still in the back of our minds the manufacturing industry now shows positive signals with a recovery towards output levels of before the relapse of late 2008 (figure 1). With the restored growth of economies in BRIC countries (Brazil, Russia, India and China) and the economy of Turkey picking up again mainly exporting companies are experiencing a growing demand again.

Figure 1: Manufacturing output (%), source: CBS

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2.6 Changing industry

The business environment for Dutch manufacturing companies has developed from regional to European and even global over the years. The current playing-field is an international industry where companies need to cope with international competitors, customers and suppliers and their accompanying challenges. In order to produce high volumes for competitive prices the movement of production facilities towards low-cost countries is noticeable. Another issue of today, which continues in the future, is fluctuating demand from a more diverse customer base. This forces companies to become more flexible and adaptive in order to react faster to the demand of the customer. Next to that quality demands are becoming higher every day and regulation forces manufacturing companies to reduce CO2 emissions now and in the future. This leads to a growing awareness of re-thinking strategies in order to stay competitive and underlines that the present paradigm of costs and quality is due for revision. Future perspectives and trends of high performance, sustainable and intelligent manufacturing are discussed as the general trend in the next chapter to provide an overview of what 'factories of the future' could be like.

3. FUTURE PERSPECTIVE

3.1 Introduction

The trend of sustainability is already present in the current industry and changes the future manufacturing landscape. This affects manufacturing companies in a way that they will have to produce quality products against a low price in a sustainable way. Next to the sustainability aspect, three more topics: "ICT", "High performance manufacturing" and "Use of new materials" are identified as key factors to describe future trends.

3.2 Sustainable manufacturing

Not only because of regulations but also because of the social mindset the manufacturing industry is facing the challenge to improve its energy efficiency. With sustainability improvement in manufacturing is meant: energy efficient with minimal impact on environment and society. In this improvement process the focus is laid on carbon dioxide emissions. By overhauling production processes and technologies manufacturers can react to this development of the sustainability trend and stay competitive. As a general term 'ecodesign' is often heard to cover a sustainable design of activities which can also be applied in the manufacturing sector. In order to standardize such a development the International Organization for Standardization (ISO) approved the establishment of a new project committee (PC242- Energy Management) in February 2008. This newly developed management system standard is expected to be released this year (2010). The ISO 50001 is an international framework for industrial plants or entire companies to manage energy, including all aspects of procurement and use. This comes down to a company having: sustainable management systems in place, completed a

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baseline survey of energy use and made a commitment to the continuing improvement of its energy performance. In the short term this 'eco-factory model' should aim for optimized utilization of energy streams, reduction of the environmental impact such as waste to landfill and improvement of resource efficiency.

These aims will address at the same time:

- Environmental friendliness.
- Economic growth.
- Social well-being.

3.2.1 Environmental friendliness

By using technologies for efficient use of resources and cleaner manufacturing the energy intake can be reduced. When trying to optimize environmental friendliness the main objectives are: High efficiency and near-to-zero emissions in manufacturing processes, alternatives to energy-intensive processes based on advanced production and manufacturing systems, improved use of renewable resources at factory level, and using environmental neutral materials in production.

3.2.2 Economic growth

When redesigning processes and technologies towards sustainability the focus will be on solutions that also encounter a decrease of costs. For instance when smart maintenance of equipment is used it may increase the lifetime and energy efficiency of machines and will reduce costs. Also innovative re-use of equipment and smart factory lay-out modular design contribute to both sustainability and cost reduction.

3.2.3 Social well-being

The main objective here is to create new forms of interaction processes as in adaptive and responsive human-machine interfaces. Here solutions have to be developed to provide an optimal match between workplaces and machines. This both affects employee satisfaction and efficiency which eventually results in better achievements.

3.3 ICT-enabled intelligent Manufacturing

In the future the further implementation of ICT services will positively affect efficiency, sustainability and quality of the manufacturing industry. Although integration of ICT can be costly and time consuming it is a key enabler for improving manufacturing systems at three levels:

- Smart factories: agile manufacturing and customization.
- Virtual factories: value creation, global networked manufacturing and logistics.
- Digital factories: Manufacturing design and product life cycle management.

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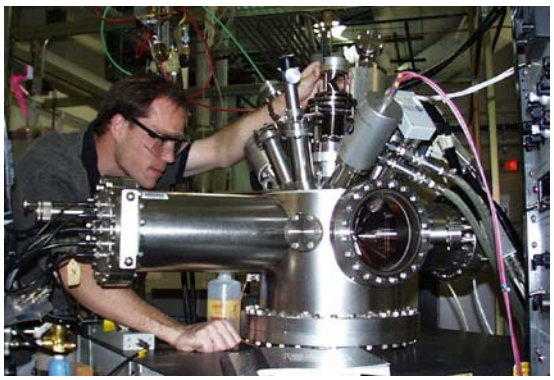
3.3.1 Smart factories: agile manufacturing and customization



Future production sites for a large variety of sophisticated products will offer flexible, short cycle time and variability controlled manufacturing capability. These manufacturing approaches ensure energy-efficient, reliable and cost effective production as well as production set-up/ramp-up with reduced cost and time through lean and simpler ICT. Important developments in automation are foreseen from the increasing convergence of machine, product control and personal computer technology.

3.3.2 Virtual factories: value creation, global networked manufacturing and logistics

ICT, if integrated end-to-end, can provide clear insight and exact and useful knowledge from the relevant data, thereby facilitating or supporting decision making and creating value from global networked operations.

3.3.3 Digital factories: Manufacturing design and product life cycle management

Addressing the front-end stages of manufacturing, in particular early concept modeling, simulation and evaluation, as well as the transformation of the knowledge-time curve, thus ensuring greater acquisition of knowledge earlier so that better informed manufacturing decisions can be taken. The handling of uncertainty is also a crucial area.

3.4 High performance manufacturing and equipment

The economic crisis has a strong effect on new industrial investments in production and process equipment, in particular for SMEs, since the return on investment must be thoroughly justified. Therefore, there is a need for manufacturing systems that are flexible enough and, at the same time, are robust, reliable and cost effective. The aim would be to allow improvements through successive investments in production equipment, as well as an easy reconfiguration from small to large production series, or small to large production capacity using flexible technologies such as modular production units. Furthermore, the new solutions should bring the integration of the necessary ICT support providing simplification and real user friendliness which leads to the following topics:

- Flexible adaptive production equipment, systems and plants.
- High precision micro-manufacturing machines and systems.
- Tools for production planning and adaptive manufacturing systems.
- Zero-defect manufacturing.

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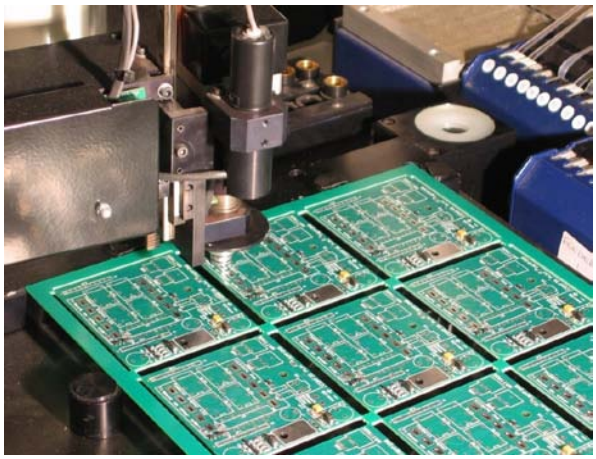
3.4.1 Flexible adaptive production equipment, systems and plants

Compared to the past, customers require higher quality and faster delivery times. This pushes companies towards higher flexibility and permanent adaptation of machines, equipment and production systems. To meet these requirements high performance manufacturing in terms of efficiency and accuracy is the key. New system architectures with self-adaptive modular structures and machines and equipment which require less floor space could contribute to meet these requirements. Also plug and produce components, further automation and improved HMI (human machine interaction) developments will play a significant role.

3.4.2 High precision micro-manufacturing machines and systems



Future manufacturing technologies will move towards the manufacturing of parts with complex internal structures such as conductive or cooling channels and material gradient structures. Miniaturization of products and production appliances and integrated compact systems design will be key issues for this part of future manufacturing. Examples of such miniaturization are: use of rapid micro-manufacturing technologies (e.g. micro-electromechanical systems), 3D micro-parts production, and micro-factory and mini-manufacturing systems taking up small space to assemble and test small parts.

3.4.3 Tools for production planning and adaptive manufacturing systems

New high performance processes, machines and production systems will require new methods and tools for machine design and operation monitoring. Considering the need of production systems to evolve in line with products and processes, new ways to manage initial and ongoing system configuration are needed. For instance Platforms integrated in the information and execution system of factories should be developed for non-linear process planning. By considering local production and outsourcing, these tools will allow the optimization and monitoring of manufacturing processes, wherever in the world these are performed. Finally a further development on the graphical user interface of machines is important, as a user friendly interface helps personnel to work with more complex machines without having running the risk of higher waste.

3.4.4 Zero-defect manufacturing

When it comes down to zero-defect manufacturing innovative solutions are needed in support of customization and "make to order" strategies in automotive and electric and electronic components industries, improving methodologies through quality control and the increase of efficiency in manufacturing. Intelligent measuring systems for accurate and time efficient in-line measurements combined with adaptive automated tool-control are an example of a possible solution to support the zero-defect philosophy.

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3.5 Exploiting new materials through manufacturing

Traditional and new industries in Europe are working with new materials to take advantage of increased functionality, lower weight, lower environmental burden and energy efficiency. This is needed to achieve a sustainable manufacturing base when moving to high added value products and customized production. New materials pose new challenges for cost efficient manufacturing to shape, handle and assemble complex structures that can involve macro-micro-nano scale, multiple material combinations such as sandwich structures and composites and smart materials involving integration of sensing and actuation technologies within a material (e.g. smart textiles). In other cases, there is a need to work with bio-inspired materials to integrate them more effectively with conventional and new materials, to meet the needs of new bio-industries and environmental targets. Recycled materials are also relevant in this domain, due to their large potential both for cost and environmental reasons.

Most industrial sectors of importance to European manufacturing have a requirement for new and improved processes to deal with the need to exploit new materials through manufacturing. In the transport sector key changes are required to achieve a greater use of light weight materials, such as composites, and the efficient use of high value added metals, such as high strength steels and nickel based alloys. New composites are also used by industry in the drive towards renewable energy sources, where components need to be manufactured at volumes and costs not previously anticipated, whilst ensuring that waste is minimized. In the textile and footwear sectors new approaches such as 3D shaping and drapability in new automated factories are needed for mass customization and increased product functionality. Integration of electronics, e.g. using improved sensing and control systems, and customization of smart products, such as in intelligent packaging, also demand new manufacturing methodologies, e.g. an increased use of laser technologies.

The following topics are addressed:

- Net-shape manufacturing for advanced structural and functional materials.
- Product design using sustainable material processing technologies.

3.5.1 Net-shape manufacturing for advanced structural and functional materials

Net-shape manufacturing technologies have gained industrial significance to produce structural parts made of a wide range of materials, namely metals, ceramics and polymers. Transferring traditional low-cost net shape manufacturing processes to novel material classes, such as advanced metallic materials (e.g. intermetallics), functional ceramics (e.g. bioceramics) or structurally reinforced composites (e.g. metal-ceramic or polymer nanocomposite materials) will lead to completely new possibilities in the design of components and to significant savings in materials and processing costs. One can think of complete manufacturing chains for nanophased components as such a possibility. Here the development of high throughput processes (e.g. extrusion, forming, casting, coating and quick sintering) enables production of net-shape or semi-finished products as well as coatings using nanotechnologies and nanomaterials.

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3.5.2 Product design using sustainable material processing technologies

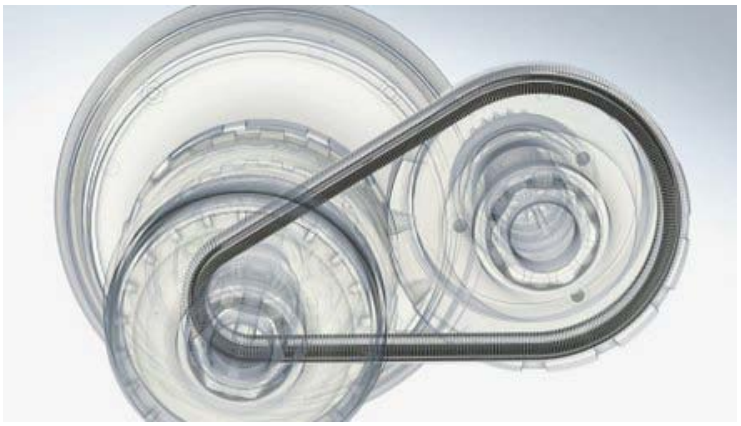
New materials bring new challenges in sustainable manufacturing that require new approaches for low resource consuming processes. These new materials include, among others, “carbon neutral” materials as well as materials for improved product quality, weight saving and improved behavior and functionality. This will then significantly reduce undesirable processing emissions and provide new methods to process micro-nano-materials (minimising the potential impact on the environment and human health). There is also a need for the development of manufacturing technologies for sustainable production and recycling of process residuals that are suitable for new materials. In this direction new technologies to support casting, material removing and forming processes are interesting.

3.6 Trend Overview

We have tried to present an overview of the trends for the coming years that we have indentified. The demands of society for an ever-increasing use of renewable energy sources, higher standards of living, constantly changing markets and highly customized goods, as well as the risks posed by increasing energy costs and depletion of resources are the challenges manufacturing companies face the coming years. These topics are the driving forces behind (technological) innovation in the manufacturing landscape for the coming years.

3.7 What does Future manufacturing mean for the Dutch automotive Industry.

Manufacturing, Production as activity and competence is an important base to develop innovative high quality products and processes, (Design for Excellence). Manufacturing and production as operational activity also has a main social content. Approximately 60 percent of the total employment by this industry is production related, mainly secondary vocational educated. The possible innovations described are enablers for the Dutch automotive and non-automotive industry, to stay a global competitive player. Even to enable to a draft industry for other countries. For education and knowledge institutes it enables study and research possibilities on different levels and when executed in corporation with the entire industry also close to the demands of this industry.



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- European Union
- Intel Corporation
- Bosch Transmission Technology

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