WORKING IN THE AUTOMOTIVE INDUSTRY

MIND SET, SKILL SET & TOOL SET
FOR PEOPLE WORKING IN THE AUTOMOTIVE INDUSTRY

H. Broekman; D. Ekert; M.I. Kollenhof
A.E. Riel; H.C. Theisens; R. Winter

FIRST EDITION

Lean Six Sigma Academy©
LSSA BV, 2017

Amstelveen, the Netherlands

Title: Working in the Automotive Industry
Mindset, Skill set & Tool set for people working in the automotive industry

Author: H. Broekman; D. Ekert; M.I. Kollenhof; A.E. Riel; H.C. Theisens; R. Winter

Graphics: R. Verreijt

Publisher: Lean Six Sigma Academy
LSSA BV, 2017
Amstelveen, the Netherlands

Contact: Contact us or visit our website for more information, volume discounts, online sales and training material licensing.

www.lssa.eu
info@lssa.eu

1e edition, 2017
ISBN 978-94-92240-15-6
NUR 100

Printed in the Netherlands

Co-funded by the Erasmus+ Programme of the European Union

The "Automotive Engineer" project is financially supported by the European Commission in the Erasmus+ Lifelong Learning Program under the project number 2014-1-NL01-KA200-001189. The project's website and publications reflect the views only of the authors, and the Commission cannot be held responsible for any use which may be made of the information contained therein.

Content

Preface – Working in the Automotive Industry

The automotive industry is a sector that is growing on a worldwide level at different paces. While markets in Europe are stagnating, those of the BRICS countries (Brazil, Russia, India, China and South Africa) are almost exploding and opening up a huge economic potential. However, it is important to keep in mind the countries' differences in culture, infrastructure, legislation, economy and environment. International vehicle manufacturers like Renault, Toyota, BMW or VW should be aware of the impact of these differences when establishing a factory, dealer network, or releasing a new type of vehicle in a new local market.

The automotive industry is changing more rapidly than ever. The first company dedicated to producing vehicles was the French company French Panhard et Levassor, in 1889. Peugeot followed only two years later. Since then, vehicles have changed significantly. This is a result of increasingly stricter legislation and regulation, as well as changing customer demands (behavior). Safety comes first. In the past, a vehicle used to be delivered with a tool case to be used in case of a breakdown. Nowadays, every vehicle released on the market has to be well developed and thoroughly tested during the construction process. This is executed using different methods and analyses. Clearly, this also means that the education of mechanics and engineers needs adaptation. As the automotive industry will continuously innovate, the technical schools are to anticipate on these changes. Self-driving cars and alternative fuel systems influence the way a vehicle is designed and produced. These changes will also affect the infrastructure. For example, think of all the necessary charging stations at parking lots, businesses, homes, etc. Moreover, how will a self-driving vehicle know where it is when it is in a tunnel?

In October 2016 the new standard (IATF 16949:2016 [1]) for the automotive industry was published. This new standard has replaced the ISO/TS 16949:2009. Companies that are certified according to ISO/TS 16949 have time until the 14th September 2018 to complete the transition to IATF 16949. In this book we already address content relevant in the new IATF standard such as: Automotive SPICE®, functional safety, embedded software, leadership and lifecycle management.

Be someone that innovates the industry by knowing the past and changing the future.

About the Authors

Henk Broekman

Henk Broekman has been working since 1995 in the automotive industry and he is one of Symbol's Lead Consultants. For 10 years now as a trainer and consultant specialized in manufacturing companies that supply to the automotive industry. He helps production companies to set up but also optimize quality management systems. His goal is to produce better product quality with the lowest possible cost by controlling processes in an organization. He is also an IATF 16949 1st/2nd party auditor (quality standard for automotive).

Damjan Ekert

Dipl.-Ing. Damjan Ekert has studied Telematics at the University of Technology in Graz (Austria) and finished his studies with distinction. Since 2001 he has been working for ISCN as a SW project manager, ISO 15504 and Automotive SPICE consultant and SW integrator. He is a certified e-Security Manager and European Project Manager Trainer. He is also a certified ISO 15504 Assessor and Automotive SPICE Competent Assessor and he has been acting as consultant and/or trainer for leading companies like ZF Friedrichshafen AG, ZF/BOSCH Lenksysteme, Magna Powertrain, Hidria, T-Systems and many more. Damjan Ekert has many years of experiences as consultant in the range of software process improvement and is member of the group "Model comparison" of the German/Austrian task force SOQRATES. He is also a member of the S2QI Initiative, member of the European Certification and Qualification Association and vice-president of the ISECMA e.V. (International IT Security Management Board).

Monique Kollenhof

Monique Kollenhof MSc/MA has studied Educational Science & Technology at the University of Twente in Enschede (the Netherlands) and is specialized in "Research Methodology, Measurement & Data Analysis" and "Curriculum Design & Educational Innovation". She is one of Symbol's Lean Six Sigma Black Belt consultants improving your (company's) competitiveness and efficiency by providing consultancy and training concerning business and process improvement, and quality and change management, for industry as well as for service and health organizations. She also guides Master Black Belts in "Training Design and Delivery" and is Symbol's Program Manager for international innovative projects, like the Automotive Engineer project. She manages multiple complex international and multidisciplinary EU projects –like Lean Six Sigma for Healthcare, several automotive projects, and Lean New Product Development– with a focus on innovation and training development, for over 20 years. Her strength is being able to level with all those involved.

Andreas Riel

Dr. Andreas Riel has studied at the University of Technology in Graz (Austria). Andreas is Innovation Manager of EMIRAcle, as well as a habilitated researcher and lecturer at Grenoble Alpes University, both based in Grenoble, France. He is also a consultant, coach and trainer to industry with a strong focus on automotive, where he collected professional experience over more than 15 years. His areas of expertise include several topics around innovation and creativity, technology planning, integrated systems engineering methods, processes and organizations, as well as quality engineering and assessment.

Andreas Riel is an experienced teacher at Grenoble INP and EMIRAcle. For both organizations he was the project manager of many educational (development) projects. Andreas Riel is specialized in Automotive Engineering and Production Processes; Virtual Automotive Product Development (model-driven and simulation-based); Integrated Automotive Systems Engineering; Functional Safety in Automotive according to ISO 26262; Automotive Mechatronics Process Quality according to Automotive SPICE and Innovation Management in Automotive. Andreas Riel also acts as a consultant in the above mentioned areas of knowledge and expertise.

Dick Theisens

Dick Theisens has graduated at the University of Twente in Enschede (the Netherlands), Theisens developed his experience of process improvement as a consultant in the automotive and high-tech industry over a period of 20 years. Theisens executed and coached around 50 Six Sigma breakthrough projects. Currently Theisens is Director and Master Black Belt of Symbol B.V., a consultancy and training company in the Netherlands that is specialized in 'Business Improvement'. Theisens is also founder of the LSSA – Lean Six Sigma Academy©, which is scheme owner of the world wide Lean Six Sigma certification program of the APMG (APM Group Limited), iSQI (International Software Quality Institute), ECQA (European Certification and Qualification Association) and University of Twente.

Richard Winter

Richard Winter is a Lean Six Sigma Black Belt trainer and consultant who is specialized in Lean Six Sigma and Automotive Quality Management. He has over 15 years of experience in training, consulting and coaching in automotive quality management and (implementing) advanced automotive quality tools and techniques (IATF 16949, APQP/PPAP, FMEA, SPC, MSA, VDA 6.3, 8D). He is also an IATF 16949 1st/2nd party auditor and has worked as an interim Quality Manager and SQE/CQE for many automotive firms, such as Power-Packer, Voestalpine, Mitsubishi Turbocharger Europe, WABCO Vehicle Control Systems. He also is a trainer at Dutch automotive cluster (AutomotiveNL) and a visiting lecturer at Windesheim University of applied sciences.

1. Introduction

Imagine that you are graduating from an automotive engineering school: do you know what kind of jobs are waiting for you? What kind of jobs are there besides creating a vehicle? Is automotive engineering only about vehicles, speed limits, and traffic lights? What does the automotive industry mean, and how has it evolved during the past few decades?

Can I develop and build any vehicle I like and drive away? Are there rules that I should take into account while developing and building a vehicle? Are the rules worldwide the same, or do they differ in different countries? What is an OEM? What is a Tier?

Maybe you do not like to develop a vehicle, but you are very interested in the developing process. Do you know what the automotive process landscape looks like? What role do end users play in the development of a vehicle? What about modern technology?

So many questions to ask and so little time to study. This chapter will give you a good overview of the past of the automobile industry and some of the innovations of the past, as knowing the past is always essential to change the future! Innovation is not always extreme; sometimes, the innovative ideas of the past can be taken at the “right time” to be improved to become useful in the future. For this, you have to be aware of the past and its regulations, as well as know the present regulations and perhaps regulations that will be introduced and that might change. For example, will I reinvent the combustion engine, knowing that oil (limited resource) might be very expensive in the future? Additionally, automotive engineers today need to be aware of a number of standards, not only of their country, but also those of the countries the car will be sold to. While designing the car, you need to understand the need of the customers, as well as their culture, because even the best car will not be sold if it doesn´t meet the needs and culture of the customer. Quality standards as well as legislation are additional topics that you need to be aware of. Legislative topics can become very expensive if they are ignored or implemented incorrectly.

Taking a look at other industries and branches is always good, as it is important to understand what drives and influences those that work for you or that you are dependent on. Will shortage in oil influence the production of your cars? Of course! Will shortage of cotton or rubber influence the production of your car? Perhaps, depending on the amount of material you need and if there is an alternative way or a replacement that you are aware of.

1.1 Automotive Industry

Learning Objectives

1. Recall the most important moments in automotive history.
2. Recall the main developments within the automotive industry.
3. Recall the most commonly used definitions, terms and abbreviations.
4. Describe the automotive supply chain and its important players.
5. Understand the key challenges in the automotive industry.
6. Understand the differences between the automotive industry and other branches, such as production companies, medical, aerospace, etc.
7. Describe what the future of the automotive industry could be like.

1.1.1 History and Evolution

The history of the automobile and automotive industry begins a long time ago. Many people and companies have contributed to today's car, and more people today are concerned with the development of the car of tomorrow.

Before the automobile existed, people moved by horse and cart. The first vehicle that could be driven by engine was developed by the French officer Nicolas-Joseph Cugnot at the end of the 18th century. In the second part of the 19th century, the first vehicles with petrol engine were built simultaneously by several inventors working independently. In 1885, Gottlieb Daimler patented the first successful high-speed internal combustion engine.

In 1889, the French company Panhard et Levassor was the first company that exclusively concentrated on the production of vehicles. The Benz Velo and the Duryea Motor Wagon were seen as the first standardized cars.

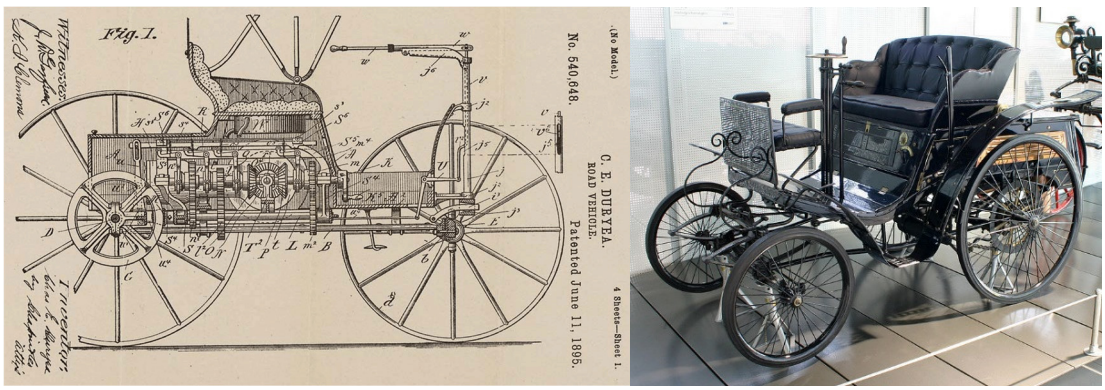

Figure 1: The first standardized cars: Duryea Motor Wagon and Benz Velo (source: Wikipedia)

With this, the automotive industry was born. In a few years, hundreds of producers were established. They built steam vehicles, electric vehicles and fuel vehicles.

Steam and electricity were initially the most widely used power sources for vehicles. Later, the steam engines competed with the combustion engine. By 1910, most vehicle manufacturers switched to gasoline and the interest in steam technology disappeared.

Standard Car Design

Due to a large number of producers in the market, the development of vehicles was rapid in those days. All the experiments with different vehicle designs resulted in a standard design. This standard was developed by Panhard and first used on a Panhard automobile in 1895. This design is known as 'Système Panhard' and quickly became licensed worldwide, and became the standard car. What was novel about the standard car was the internal combustion engine placed at the front and the steering drive situated on the rear wheels. Other main innovations of the era were the ignition and electric starter.

In 1913, Ford Motor Company sold 189,088 units of its Model T. This was the first year in history when more vehicles than horse carriages were built.

Figure 2: Ford Model T

After World War I

After World War I, the European automotive industry restored rapidly. The demand for vehicles was great. The production of certain components was more and more outsourced to specialized suppliers. The vehicle became much more practical and comfortable. The car heater became standard and the radio was introduced. In addition, antifreeze was introduced, which allowed water-cooled engines to remain usable throughout the year. One pedal for the brakes on all four wheels was introduced as was the power steering.

After World War II

The postwar era began in 1949, towards at the end of World War II. During this period, the assembly on the assembly line became in general use. New technological developments followed each other more rapidly. In the first half of the 40s, the development of the vehicle in Europe and the United States was halted because of World War II. Important developments in the postwar era are the fuel injection system, which was built in luxury passenger vehicles since the end of the 50s, the use of independent suspensions, and an increasing focus on safety in automotive design.

Safety

Before World War II there was no attention to safety. Vehicles were to be reliable and robust. It was possible that after a collision, a vehicle could only have paint damage, but the occupants killed. In the 60s, under pressure from a number of activists for example the publication *Unsafe at Any Speed* [2] by Ralph Nader, the first security legislation was adopted. Important issues for safety were the safety cage and the seat belt.

In addition, the introduction of the airbag in 1973, third brake light in 1974, and the development of crash tests were important milestones for safety in the automotive industry.

Oil Crisis

The oil crisis in 1973 set emission standards and the fuel consumption of a vehicle became important. Japanese vehicle manufacturers began to play a big role in worldwide vehicle manufacturing. The American automotive industry still had serious problems after the oil crisis. Fuel consumption of an automobile was an important selling point. The American automotive industry didn't focus on this point. Therefore, Japanese and European automotive companies also established plants in the US. Around the year 2000, Japan became the world leader of vehicle production.

Software

Computer Aided Design (CAD) software used in the design and development of products was introduced in the early 80s in the automotive industry. CAD made it possible for vehicle engines to become much more efficient. This was highly desirable after the oil crises. The ability of motors could be maintained and even increased, but still be more environmentally friendly.

The 90s were characterized by the strong globalization of national economies. Automotive concerns focused on joint ventures and established new markets. There were also significant mergers and acquisitions. Important developments in the 90s were the navigation system, Electronic Stability Program (ESP), and the hybrid car. The Toyota Prius was the first commercial hybrid car in mass production. This hybrid has a combustion engine and an electric motor, and is therefore more environmentally friendly than most other vehicles [see also 1.1.6].

The Rise of Software and Electronics in the Vehicle

Software was not only important in the development of the vehicle. Nowadays, the vehicle itself consists, to a large extent, of software and electronics. Also, most of the developments in the vehicle are focused on Advance Driver Assistance Systems (ADAS). Advanced driver assistance systems are developed to improve the systems for safety and better driving. Examples of ADAS are:

- Intelligent cruise control: a system that is capable of controlling the speed and distance of another vehicle.
- Automatic parking: autonomous car-maneuvering system that moves a vehicle from a traffic lane into a parking spot.
- Lane departure warning system: system to warn the driver when the vehicle begins to move out of its lane (unless a turn signal is on in that direction).
- Traffic sign recognition: technology by which a vehicle is able to recognize the traffic signs put on the road.
- Driver monitoring system: the system used to monitor driver attentiveness. If the driver is not paying attention to the road and a dangerous situation is detected, the system will warn the driver by flashing lights and warning sounds. If no action is taken, the vehicle will apply the brakes.

In the near future, more developments will be implemented in the area of communication systems and autonomous vehicles, leading towards the self-driving car. Until recently, a vehicle consisted mainly of mechanical parts. Nowadays, electronics and software control up to 70% of the functionality of a modern vehicle. In the near future, this will be 90% or more [see 1.1.6]. Figure 3 shows an overview of the most important technologies in modern vehicles.

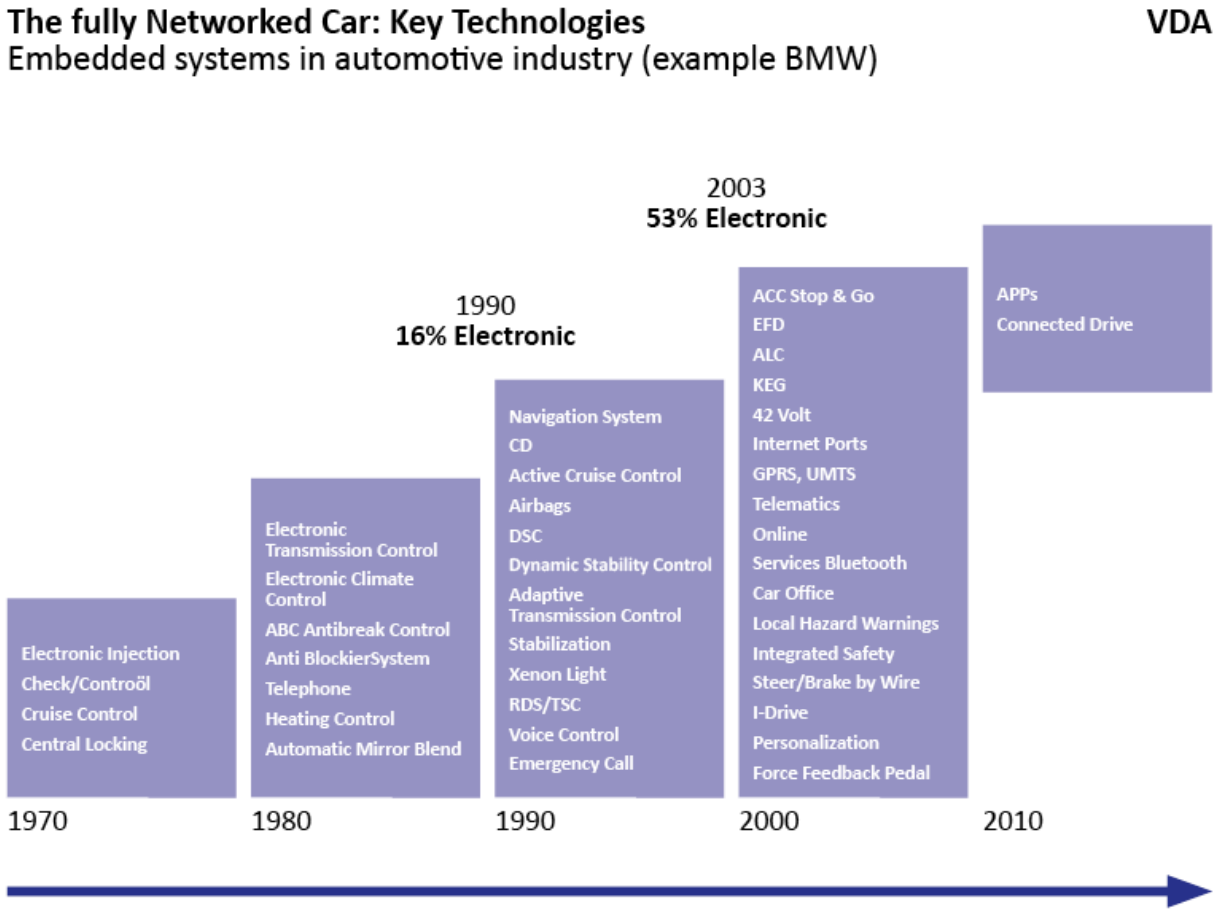

Figure 3: Development of embedded systems in a vehicle

1.1.2 Definitions, Terms and Abbreviations

The automotive industry is a wide range of companies and organizations involved in the design, development, manufacturing, marketing, and selling of motor vehicles. It is one of the world's most important economic sectors. The automotive industry also includes industries dedicated to the maintenance of automobiles following delivery to the end user, such as automobile repair shops and motor fuel filling stations.

The term automotive is derived from the Greek autos (self), and Latin motivus (of motion) to represent any form of self-powered vehicle. This term was proposed by the Society of Automotive Engineers (SAE).