Roman Mildner
Thomas Ziller
Franco Baiocchi

Car IT Reloaded

Disruption in the Car Industry

Springer Vieweg

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Roman Mildner
Bergisch Gladbach, Nordrhein-Westfalen,
Germany

Thomas Ziller
Besigheim, Germany

Franco Baiocchi
Dudelange, Luxembourg

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Preface

Since our first issue of *Car IT Compact* in 2015, the automotive industry has developed at a breathtaking pace. Electrification has become a technological driver of progress that seems unstoppable. Once seen as a crazy idea and often mocked, it has reached a dimension that hardly anyone could imagine. The unexpected success of Tesla Motors, a company once the subject of ridicule, has now made electric cars a serious contender in the automotive industry.

Since then, established car manufacturers have found themselves in a partly latent, partly open crisis: the sales figures for their EVs have been sobering. It seems as if the traditional car manufacturers have been caught on the wrong foot. Since then, we are still in a state of shock. How do we get out of it? We know there can be no patent concepts: the socio-political and economic situation is too complicated for that on both sides of the Atlantic. Therefore, we aim to offer a few suggestions that make a meaningful and constructive contribution to the global strategy debate.

Another reason for our book's innovative approach is the realization that new technologies, especially artificial intelligence (AI), have rendered books that offer simple inventories increasingly obsolete. In Car IT Reloaded, we have focused on findings and ideas that are innovative, unusual, or uncommon in the field, aiming to stimulate discussion and provide suggestions for the automotive industry's future.

Car IT Reloaded was born out of the realization that the automotive industry is changing so rapidly that we—who have grown up in this business—often struggle to keep up. We want to offer a view of the car industry that considers this rapid pace. As the automotive industry continues to open up new areas of technology—as is the case with artificial intelligence, for example—our book has grown considerably. While the previous book, *Car IT Compact*, presented a concise overview of the then-current manifestations of the increasingly digitalized world of the automotive industry, *Car IT Reloaded*, therefore, offers a more detailed perspective, not only of the vehicle industry but also of innovative ideas and some (self-)critical voices that expand this context.

However, even though *Car IT Reloaded* has grown significantly in volume compared to its predecessor, this book is not a comprehensive compendium but a synthesis of findings and advanced ideas to better understand and tackle current

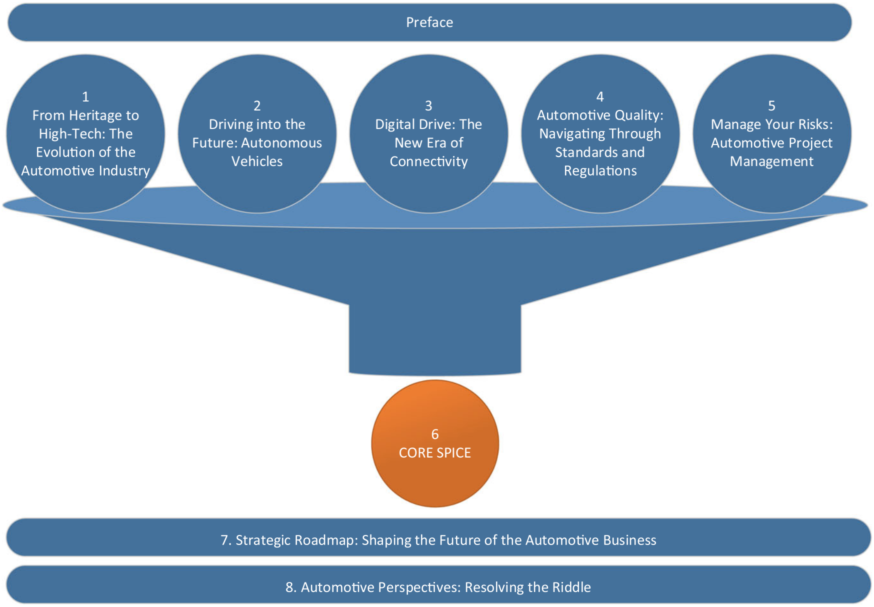

Fig. 1 Book concept of *Car IT Reloaded*

and future challenges in the car industry. We focus on practical ideas that can be applied in the short term, such as CORE SPICE.

Our book is based on a concept illustrated in Fig. 1.

The basic idea is based on a broader range of highly relevant topics in the vehicle industry. Starting with a historical outline covering particularly interesting subjects such as car propulsion technologies, electrification, vehicle safety, and autonomous driving, through to the historically outlined process improvement topics, the extensive Chap. 6 on CORE SPICE plays a special role. CORE SPICE supplements Automotive SPICE, widely used in the vehicle industry, with a practice-oriented, pragmatic component. While Automotive SPICE is an assessment model, CORE SPICE offers a pragmatic and practical project coaching approach. The benefits of systematic project implementation can be realized with less effort and in less time. This is particularly advantageous around safety-relevant projects (especially in functional safety). The book is rounded off in the concluding Chaps. 7 and 8, in which strategic topics relevant to the vehicle industry are discussed.

We are holding back on long-term forecasts this time. While electric vehicles continue to celebrate new successes, the situation with autonomous driving is more nuanced. The complexity of AI-based systems is significantly higher than anticipated. While we are looking forward to a fully autonomous car, no such vehicle is commercially available. Although we are convinced that self-driving cars are only a matter of time—the first vehicles, which still enable quite limited autonomous driving, are gradually becoming more popular—we realize it will be years before the automobile is so advanced that a steering wheel becomes superfluous.

Car IT Reloaded offers a wide-ranging outline of topics that affect today's vehicle industry. We focus on the critical issues we encounter daily as automotive project managers and technology advisors. However, the book is designed for a wide audience and will interest anyone working in the automotive industry or looking to broaden their horizons: project managers, consultants specializing in the automotive industry, quality managers, engineers, and anyone interested in automotive mass mobility. The result is a selection of topics that are both practical and entertaining. We hope you enjoy the book and find inspiration in it to utilize the solutions included and apply them to your practice.

Bergisch Gladbach, Germany — Roman Mildner
Besigheim, Germany — Thomas Ziller
Dudelange, Luxembourg — Franco Baiocchi

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A special thank you goes to Volker Johanning, whose groundbreaking work on the previous book, *Car IT*, inspired the creation of *Car IT Reloaded* and gave us the courage to tackle this new project.

We thank Alison Thompson of The Proof Fairy for her meticulous proofreading and editing. Her exceptional attention to detail and unwavering dedication have greatly enhanced the quality of this book.

We would also like to thank Springer-Verlag for supporting the formal design and encouraging us to conclude the manuscript successfully.

Lastly, we thank everyone who permitted us to use their sources and illustrations. Their contributions have greatly enriched this book.

We hope *Car IT Reloaded* will meaningfully contribute to the continued success of the car industry and to driving digital innovation. This work is dedicated to all who have been with us throughout this journey.

Cologne-Besigheim-Luxembourg
December 2024

Roman Mildner
Thomas Ziller
Franco Baiocchi

Competing Interests The authors have no competing interests to declare that are relevant to the content of this manuscript.

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About the Authors

Roman Mildner is a project manager, automotive SPICE consultant, strategy consultant, leadership coach, and book author with over 25 years of experience in the software and systems industry. He holds a degree in computer science from RWTH Aachen University. He has made a name for himself through his work in the automotive industry. He is also successful and recognized in other industries, such as telecommunications, logistics, software houses, and life sciences. His international projects, which he has implemented in Germany, the USA, Australia, and Japan, demonstrate his global presence in the industry. His numerous clients include IBM Deutschland GmbH, Deutsche Telekom AG, Telefónica Germany GmbH & Co. OHG, T-Systems International GmbH, Harman International, Robert Bosch GmbH, Seeing Machines Limited, Aptiv Services Deutschland GmbH, Hitachi Astemo Ltd., ZF Friedrichshafen AG, Olympus Deutschland GmbH, CARIAD SE, Schaeffler AG, and many more. His practice-oriented approaches to project management and process improvement are particularly valued, especially concerning Automotive SPICE and safety-related projects. He has worked across the entire spectrum of the system development world, not only as a consultant but also as a practitioner, successfully fulfilling these roles as a project manager, quality manager, software architect, software developer, and test manager. This practical experience is the basis of his successful consulting work. His main goals are to establish effective project management and help clients overcome inefficient practices to achieve optimal results. His systemic approach leads to high customer satisfaction and timely project results, which he can proudly point out.

Thomas Ziller M.Sc. Dipl.-Ing. (FH), is self-employed and has over 20 years of professional experience in the automotive industry. He is the founder of martozi consulting and engineering. He supports companies in sales, business development, and engineering services in his consulting work. His focus is on team and strategy development as well as project management. He began his professional career with an apprenticeship as a communications electronics technician. After studying electronics and information technology, supplemented by a master's degree in signal processing and control, he first encountered the automotive industry at Valeo in the radar division. There, he worked in several areas, from engineering to sales and project management. He later moved to Carmeq (now CARIAD) as a team leader within the VW Group. He worked there for many years, successfully implementing challenging projects and building successful teams. Ziller found a new challenge at ASAP Engineering, where, using his technical expertise, he developed optimal solutions for established companies in complex projects. Today, in addition to project management and sales, he offers creative solutions for start-ups as a freelancer. As a Heilbronn University of Applied Sciences lecturer, he shares his knowledge to ensure that the next generation of engineers benefits from his insights—successes and failures—with practical "lessons learned."

Franco Baiocchi is an Intacs™-certified Competent Assessor and Project Management Professional (PMP) with over 30 years of experience in the automotive sector. He has been working as an independent consultant and freelancer since 2021. After his studies (FH Electrical Engineering), he started at Siemens in telecommunications sales and, after a short time, moved to Robert Bosch GmbH, where he held various positions in the development and application of gasoline injection systems, project management, sales, quality management, process management and consulting across multiple product areas. He led the piloting of a process management tool and developed the definition and introduction of a quality database application, including the interface to the project management tool to enable measurable quality reporting. In the consulting field, he has managed and completed a project in production to reduce zero-km failures for a product and advised on product areas in CMMI and ASPICE to achieve the corresponding maturity levels. He has also been leading assessments for almost 10 years.

1 From Heritage to High-Tech: The Evolution of the Automotive Industry

Abstract

This chapter traces the automotive industry's evolution from its early beginnings to today's high-tech era. The narrative covers key moments in automotive history, including the initial competition between electric, steam, and gasoline-powered vehicles, the eventual dominance of the internal combustion engine, and the industry's major safety and quality challenges. The chapter explores how the "Dieselgate" scandal contributed to the current electric vehicle renaissance and discusses Tesla's disruptive role in transforming the industry. It concludes with an analysis of current challenges in electrification, including battery technology, charging infrastructure, and the changing dynamics of the automotive market.

We do not intend this to be a comprehensive compendium on the world history of the automobile. Others have already done this in detail, and such an undertaking would go far beyond the scope of this book. However, we would like to place the following chapters in the automotive industry context, as it is a topic of great interest and importance. Our main aim is to provide a deeper understanding of this industry's current challenges. In recent years, the automotive industry has made enormous technical progress. This development has been multifaceted and so profound that many details have already been overlooked or forgotten. We will first outline the historical background—the beginning, significant highlights, and setbacks, as well as the current status—in order to deal with topics relevant to the future in later chapters. We can only shed light on a section of automotive history, but our examples represent the entire dynamic since the invention of the automobile. American and European history, especially German history, is, of course, close to our hearts. While we do not emphasize some important events from other countries, such as France, because of our geographical focus, our intent is to speak for the entire industry.

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We will now embark on a brief journey through time to look at aspects of automotive history.

1.1 The Dawn of the Automotive Industry

We know from general history that the wheel was invented in Mesopotamia around 3500 BC. It was invented simultaneously in other places, but no written records exist. It took around 300–500 years for the first carts to be developed. Horse-drawn carts were invented around 1900 BC. The situation mostly stayed the same until James Watt patented his practical steam engine in 1769. The new era of mobility began with the invention of the steam locomotive in 1804, which, for the first time, traveled without human or animal propulsion. In the following chapters of this book, we will outline how individual mechanical mobility developed in the years that followed.

Today, we take the automobile for granted. Many even feel tempted to grumble about what is sometimes called the "endless stream" of cars on our roads. We also like to use the argument that cars fundamentally harm the environment. Of course, it cannot be denied that cars hurt the environment; mass mobility has considerable consequences for nature. However, the environment is actually better with motor vehicles. Just imagine if we still had only horses as a means of transportation. Horses are beautiful animals, but their excrement is anything but harmless. In 1890, it was estimated that London's inhabitants would live almost three meters deep in horse excrement by 1950. Americans even feared that, by 1930, horse excrement in Manhattan would reach up to the third floor [RM-092]. One can smile at such extrapolations, but the global population has increased fivefold, from around 1.6 billion in 1900 to 8 billion today. If there were proportionally as many horses on our roads, our everyday life would smell very unpleasant and the environmental impact would be enormous.

In this sense, the automobile was a blessing; we didn't see it coming, but we wouldn't want to be without it today—and probably shouldn't.

1.1.1 Early Automobiles

As early as the fifteenth century, Leonardo da Vinci pursued the vision of a powered neither by humans nor animals. Over time, various and sometimes adventurous attempts were made to develop alternative methods, such as propulsion by air pressure. However, the steam engine was the first successful propulsion system. In 1769, the French Army captain Nicolas Cugnot developed the first verifiably functioning steam vehicle: a tricycle that could reach up to 3.6 km per hour.

The potential of these new machines was quickly recognized. Steam buses were already in operation in Paris at the beginning of the nineteenth century. Such buses were also experimented with in the USA and England, but the operation of these vehicles was inefficient, and most roads were unsuitable for them.

Moreover, mechanical vehicles also had an image problem at the time: they were generally regarded as strange, smelly, dangerous machines. For this reason, restrictive laws were passed in England. For example, a steam vehicle could only be operated if someone ran in front of it with a red flag to warn other road users. These restrictions were not lifted until the end of the nineteenth century, and such draconian laws hindered the progress of steam-powered mobility. Nevertheless, steam-powered vehicles became increasingly popular in Germany, the USA, France, and other countries at the beginning of the twentieth century. Some of these vehicles could also travel quite quickly. In 1906, the Stanley brothers, known for their steam-powered car races, reached the incredible speed of 205 km per hour with their *Locomobile*.

Progress—by its very nature—often encounters resistance—a common aspect of human nature. When early automobiles became popular, whole sections of society and some professions worried about the impact the new devices might have. Would horse-drawn coachmen now be out of work? What would happen to the whole "horse infrastructure": the stables, horse breeders, carriage manufacturers, farriers, horse feed suppliers, and so on? In the meantime, the new machines were by no means generally touted as "the future of mobility" at the time. Until 1914, automobiles were regarded as toys for the rich [RM-080]. They were status symbols—a thorn in the side of society, proof of modern decadence and rampant social injustice.

It was only when mass production of cars lowered the price to such an extent that "normal" people could afford them that this stigma disappeared and doubts about cars' usefulness fell silent.

Doubts about progress are inevitable. The latest developments in mobility, such as autonomous driving, are also under scrutiny. Self-driving cars have yet to become a reality, and the timeline for their widespread adoption remains uncertain. Nonetheless, we are confident that autonomous driving is simply a matter of time.

One thing seems certain: the automobile brought the masses prosperity, freedom, and joy. Despite environmental concerns and the many accident victims, the desire for individual mobility remains. The only question is: what will this mobility look like in the future?

The following chapters will revisit the automotive past to answer this question.

1.1.2 The First Electric Cars

Remarkably, one of the first electric vehicles was built as early as 1835 by Thomas Davenport, a blacksmith from Vermont, USA. He had already developed the first electric motor a year earlier. However, his patented electric vehicle did not bring him the hoped-for commercial success. Instead, his dream of electrically powered cars ruined him financially. When he died in 1851, electric driving was still far from being practical or popular. At that time, the steam engine was already widespread, diminishing interest in the new and still rather unreliable electric vehicles.

In 1884, Briton Thomas Parker developed and marketed one of the first commercially successful electric vehicles. Parker also developed various innovative solutions for the automobile, including a hydraulic all-wheel brake.

At the end of the nineteenth century, many manufacturers produced prototypes of electric vehicles. In 1899, Ludwig Lohner and Ferdinand Porsche (then employed by Lohner) developed the Porsche-Lohner "Toujours Contente" electric car, which was exhibited at the 1900 World Exhibition in Paris [RM-039].

Lohner was an environmentally conscious engineer.

> Leave us "world villagers" the last remnants of oxygen and clean air our wonderful society has given us. This air is ruthlessly polluted by the combustion products of the growing number of gasoline engines [RM-039].

Interest in electromobility also grew on the other side of the Atlantic. While most early electric vehicles used lead-acid batteries, the famous inventor Thomas Edison developed the nickel-ion battery used in Detroit Electric vehicles, for example. Henry Ford bought an electric vehicle from Detroit Electric for his wife Clara and gave Edison such a car for Christmas. Ford, who considered Edison's battery technology to be potentially revolutionary, thought about producing electric vehicles on a large scale. As early as 1914, he expressed the conviction that electric cars would be the next big thing; he was already planning a factory to manufacture them.

Electric vehicles became increasingly popular towards the end of the 19th and early twentieth centuries. By 1910, around 20 vehicle manufacturers were already vying for the favor of customers. The advantages included simple operation, uncomplicated maintenance, and low noise levels. However, like today, they suffered from an inadequate infrastructure. Charging stations where batteries could be changed were rare, and charging took many hours. In addition, electricity was not available everywhere at the time. By the 1920s, these obstacles seemed to have been overcome—at least in larger cities in the United States. The race to develop the best propulsion system was wide open.

1.1.3 The Triumph of the Internal Combustion Engine (ICE)

At the beginning of the twentieth century, three different types of driving were equally popular: steam-powered, electric, and petrol-powered vehicles. The latter were considered particularly unreliable and noisy. However, the first two engine types also had considerable disadvantages. Steam-powered vehicles required a cumbersome starting process and a longer preheating time before they were ready for operation. On the other hand, electric cars were slower and plagued by their limited range.

Like other types of propulsion, the gas engine was developed independently by various inventors. Frenchman Étienne Lenoir was already working on a petrol engine in 1862, and the Austrian Siegfried Marcus did the same in 1864. The German Nikolaus August Otto invented a fully developed four-cylinder engine in 1876; however, Frenchman Alphonse Beau de Rochas developed the underlying principle two years earlier. Otto founded an engine factory in Cologne, where he further perfected his internal combustion engines. One of his later employees was a certain Gottlieb Daimler.

Carl Benz patented the first gasoline-powered vehicle in 1886. It was a two-stroke engine on three wheels, marketed commercially for the first time.

After Gottlieb Daimler left his former boss, Otto, in 1885, he designed a vehicle with a four-cylinder engine. To this day, this type of engine remains very successful in automotive engineering worldwide.

However, the vehicles of the time were more like mechanical carriages than the cars we know today. Some terms in the automotive world, such as the "mudguard," first used on carriages and resembling a wing, come from this era when mobility was a rather dirty business. It was not until 1901 that a vehicle was designed and commercially produced that was more like today's cars in its essential features: the Mercedes 35 PS, developed by Wilhelm Maybach. Its 35-horsepower engine could reach up to 85 km/h [RM-040].

For more than a century, the gas engine has been predominant. Still, given the rapid pace of technological progress, it might appear surprising that the internal combustion engine was overshadowed by steam and electric vehicles for so long. The disadvantages of combustion engines continued to exist. Their costly maintenance and high noise level made them unpopular, especially among female drivers. Although gas engines offered clear advantages because of their higher energy density (and therefore greater range), there was a bigger problem: starting the engine required considerable physical effort. This obstacle was eventually solved through the invention of the electric engine starter by Cadillac engineer Charles Franklin Kettering in 1912. And thus, Kettering, a talented inventor with over 300 patents, paved the way for the dominance of the gas engine.

Coincidently, the discovery of abundant and inexpensive oil wells in Texas at the beginning of the twentieth century made oil increasingly cheaper. In the 1920s, petrol was an absolute bargain, costing only around 5 cents per liter. This price trend and the constant further development of combustion engine technology meant other engine types were pushed into the background. Finally, the introduction of the assembly line by Henry Ford in 1914 drastically reduced the production costs of gasoline-powered cars, marking the end of the dominance of other car propulsion systems.

Since then, Ford models have rolled off the production line ever faster. Between 1908 and 1927, 15 million Model T cars were produced and delivered. The technology race seemed decided, and the internal combustion engine—often referred to in modern parlance as ICE, for *Internal Combustion Engine*—dominated the market. Electric cars gradually disappeared from the streets; by the mid-1930s, they were rarely seen. One of the last manufacturers of electric cars was Detroit

Electric. An interesting connection between Detroit Electric and the famous inventor Thomas Edison was that Edison, who owned a Detroit Electric automobile, was working on electric powertrains before the success of Ford's Model T overtook all other engine types. However, by the end of the 1930s, that time was only a vague memory. Detroit Electric had to file for bankruptcy during the Great Depression in 1929. It was bought out, and electric vehicles continued to be produced, but the race for a better powertrain had already been decided. In 1939, the factory closed its doors for good [RM-039].

It should be noted that the rapid demise of car brands did not only affect e-cars. Hundreds of new car manufacturers had been founded, particularly in the turbulent start-up phase of the early twentieth century. Over time, most of them went bankrupt or were taken over by successful competitors. The defunct American car manufacturers list includes over 1,600 names [RM-041]. Worldwide, the number could be around 3,000. With recent bankruptcies of electric car manufacturers such as Fisker, the list continues to grow. The automotive dream has always come at a high price.

1.2 Era of Automotive Turmoil

The automotive industry has experienced ups and downs over the decades, leaving deep scars on both the industry and motorists' minds. Growing safety concerns have led to technological advances and stricter standards. At the same time, the car part supplier industry and the entire supply chain have faced challenges. The "Diesel Gate" scandal shook confidence in the industry and accelerated its electrification.

This section addresses these challenges.

1.2.1 "Unsafe at Any Speed"

While post-war Europe lay in ruins, the 1950s was an exciting time of change for America, and industry experienced an impressive rise. Technological breakthroughs and earth-shattering inventions were announced at every turn: the transistor and integrated circuits and microprocessors, nuclear reactors, color television, the polio vaccine, new antibiotics, the commercial success of the Boeing 707, and much more—all unleashed on a society that, after the horror of the Great Depression, the shock of Pearl Harbor and the subsequent Second World War, was finally able to look to the future with confidence. It felt as if five decades had been compressed into fifteen years. America became an unprecedented consumer society—and the car became a cult object, celebrated above all in Detroit. The Detroit "Big Three" (General Motors, Chrysler, and Ford) dominated the global automotive industry. Detroit grew into a cosmopolitan, vibrant city, the equivalent of Silicon Valley at the turn of the millennium.

Belief in technology was the dominant spirit of the time, and no one dared oppose it. In the dawning era of space travel, the exterior design of vehicles often resembled rockets. Modern cars were often changed, like cell phones today: a new vehicle had to be bought every other year to avoid being ridiculed as outdated. In the 50s and 60s, car design became an expression of personality and individuality. Owning a modern car was a statement. The car had become an object of fashion, a way of expressing oneself.

The triumph of the Detroit carmakers seemed unstoppable: they dominated 90% of the global car market. Among the "Big Three," quality did not play a decisive role; the design was the driving force. Today, it is hard to imagine that defective cars used to be the norm. If it broke down, you just bought a new one. Looking back, it's clear this approach was unsustainable. Indeed, a scandal was only a matter of time.

In 1965, the book *Unsafe at Any Speed* [RM-036], written by a young lawyer from Washington, DC, became a bestseller. In his book, the then 31-year-old Ralph Nader described precarious safety problems that occurred in some cars popular at the time. He focused on the then-successful Chevrolet Corvair (General Motors) as a prime example of poor vehicle safety. The Corvair, advertised as a "compact" modern car, was equipped with a rear-engine drive that could produce up to 180 hp (special edition with a turbocharger). This allowed the six-cylinder engine to reach a top speed of 230 km per hour (there was no speed limit in the USA then). The Corvair was innovative in many respects; for example, it had independent suspension on all wheels, which increased ride comfort. Like the VW Beetle, which it was intended to compete with, it was air-cooled, had rear-wheel drive, and was quite affordable at around 2,000 US dollars.

Overall, the Corvair was a successful car that earned the "Car of the Year" award from the influential magazine *Motor Trend* in 1960.

But then problems and complaints began to accumulate. One of these problems was that the Corvair required significant differences in front versus rear tyre air pressure due to its different weighting. If this was not considered and the wheels were pumped up evenly, the vehicle could easily oversteer and roll over, becoming a death trap. Vehicle stability in sharp bends at high speed was poor; a Corvair would probably never pass today's "moose test." Additional stabilizers could be ordered to alleviate these problems, but they were not advertised and thus usually not ordered.

What followed reads like a thriller. While these problems could have been dismissed as driver error and 'not unusual at the time, 'GM management, unfortunately, chose to address the crisis with the character assassination and blackmail of Ralph Nader. His phone was tapped, and prostitutes were hired in an attempt to seduce the young lawyer and ruin his reputation. However, GM's efforts backfired. Ralph Nader sued them—and won. For GM's highly questionable "risk management" campaign, they had to pay Nader nearly half a million US dollars (around $4.5 million in today's dollars). Ralph Nader emerged as a champion of consumer rights.

As a result of the scandal, the NHTSA—the US National Highway Traffic Safety Administration, founded in 1970—launched a multi-year investigation into the Corvair incidents. In 1972, they announced that the Corvair was no less safe than other vehicles in its class. But it was too late—by 1969, GM had already discontinued production of the Corvair [RM-037].

The PR lessons learned from the Corvair debacle were more significant than the technical criticisms of an unqualified journalist with no engineering background. Instead of denying everything and taking dubious countermeasures, admitting the alleged problem and moving on would have been more effective. A well-thought-out PR strategy is crucial when a crisis occurs. In Chap. 7, we will take a closer look at the phenomenon of PR in the context of our industry.

While Ralph Nader's book startled the American industry, it was not its last scandal. At the end of the 1960s, Ford Motors developed the Pinto as a small, compact car to counter the increasingly successful competition from Japan and Europe, such as the Toyota Corolla and Volkswagen Beetle. Costing 2,000 US dollars, the Ford Pinto rolled off the production line for the first time in 1971. It was a successful compact car that was particularly popular with younger customers. One day in 1978, following a rear-end collision with another car, a Pinto exploded, and all three occupants were burned to death [RM-038]. Following this horrible accident, US authorities launched a large-scale investigation, which revealed that the Pinto had already been known to explode a year earlier. The Pinto's fuel tank was mounted too close to the rear bumper. It was particularly embarrassing that Ford engineers were already aware of the tank's design weakness at the time of the vehicle's development, including its tendency to explode. But nothing was done about it for years for cost reasons.

Fortunately for Ford's management, the driver who crashed into the Pinto was already known to the police for his careless driving. Therefore, the cause of the terrible accident lay with the driver and, at least from a formal point of view, not with Ford.

Such disasters—both human and in terms of public relations—caused the American car industry to lose favor with consumers. Japanese and European car manufacturers gradually became a threat to the "Big Three."

While European manufacturers, especially VW and its Beetle, were making waves, Japanese car manufacturers saw their chance to conquer the US market. However, although manufacturers such as Toyota and Nissan tried to gain a foothold in the USA in the 1960s, their success initially remained modest. Although they were able to improve quality steadily and at the same time offer their cars at comparatively low prices, the Detroit brands continued to dominate the American market thanks to their characteristic design. However, this changed abruptly with the first global oil crisis in 1973.

The problem with American cars was not solely related to the PR disasters. The decisive factor was that those brands earned the reputation of being less reliable, and the public eventually realized there were alternatives to poor-quality US cars. During the oil crisis, American cars' fuel consumption suddenly became another important purchasing factor. Gradually, smaller, cheaper, higher-quality cars became more in demand. As the first oil crisis slowly faded into oblivion and Detroit carmakers hoped for a return to the "good old automotive days," the second oil crisis began in 1979, leaving a lasting mark. The American consumer no longer wanted unreliable "rocket cars" with astronomical fuel consumption. As a result, buying "Made in America" cars became less importantl. Americans now wanted to drive from A to B as reliably and cheaply as possible.

In addition, Detroit carmakers faced increasing cost pressures due to growing scrutiny from the US trade union UAW (United Auto Workers).

Meanwhile, foreign manufacturers began to set up their plants in the USA. In 1978, Volkswagen AG, among others, opened its first American plant in Pennsylvania, with 2,500 employees assembling the Volkswagen Golf. Japanese manufacturers also continued to expand in the US. Honda opened its first plant in Ohio in 1982. In contrast to the German factories, however, the Honda plant represented a challenge of a different dimension to the "Big Three." Volkswagen opened the plant in Pennsylvania under the patronage of the UAW, and as a result, the quality of the VW Golf suffered from the same issues that Detroit manufacturers encountered. However, Honda chose a different path: the newly hired young American workers were sent to Japan, where they were taught the Japanese ways of quality manufacturing, such as *Total Quality Management* (TQM) and *Kaizen*.

This was one of many differences between Japanese and German working methods. German and American mentalities clashed sharply at the VW plant in Pennsylvania. The UAW employees also brought bad habits to the VW plant, similar to those of their Detroit colleagues: arrogance, unequal treatment at different employee levels, and a different way of dealing with mistakes and suggestions for improvement. VW finally capitulated to these problems and closed the plant in Pennsylvania in 1988 [RM-039].

While the VW managers failed with the help of the UAW, the Honda managers got off to a successful start with their efficiently functioning Japanese production methods. Initially, many feared that the cars produced in Ohio would be of poorer quality than the same vehicle types built in Japan. However, these concerns proved to be unfounded. Apparently, when treated with respect and led by effective managers, American employees could deliver the same quality as Japanese employees in Japan [RM-039]. The real triumph lay not only in the superior leadership of the Japanese management but, above all, in the UAW's inability to unionize the workers at the Honda plant. In a secret ballot conducted in 1986, the Honda plant workers—referred to as "*associates*" rather than "*employees*"—rejected membership of the UAW. Despite the UAW's subsequent attempt to force an open vote, which might have changed the outcome, Honda management stood firm. Thus, the Honda plant remained independent.

There is an interesting parallel here to the current situation in Tesla factories. There, too, the management has successfully resisted the spread of unions. There are other similarities, such as Honda's ability to build the first plant in Ohio in a record time of 18 months. The first Tesla plant in Germany was built in a similar time scale: it was completed in March 2022 after just 22 months of construction, despite political, bureaucratic, and environmental pressure.

Encouraged by Honda's success, other Japanese manufacturers, such as Toyota and Nissan, followed suit. The monopoly of the "Big Three" was soon broken. With 44 million vehicles sold worldwide, the Toyota Corolla became the most successful car ever, followed by the Volkswagen Beetle, while the Ford Model T was tantamount to a sentimental obituary.

Meanwhile, US car manufacturers were increasingly experiencing economic difficulties. As a result of the second oil crisis in 1979, Chrysler was the first of the "Big Three" to file for bankruptcy. It was the beginning of a long ordeal that reached its temporary climax with the insolvency of General Motors in 2009. One of the most successful and largest American companies, often inseparable from the "American Dream" and a jewel of America, was on its knees 101 years after it was founded. Although the company was "reanimated" after bankruptcy, it has remained a shadow of its former self. That same year, Chrysler also joined the ranks of bankrupt automakers. It was a frustrating time for American industry.

Germany, known as Europe's automotive stronghold, has experienced a roller-coaster ride of ups and downs over the decades. The 1990s, in particular, were a difficult period for the German automotive sector. The massive success of the VW Beetle was followed by a less clamorous period. Increasingly, front engines replaced rear engines, and competition in the global automotive market became ever more fierce.

With German reunification in 1990, German car manufacturers expected a boom in sales. They assumed the East Germans' newfound desire for freedom would be achieved primarily with German cars. But these high expectations were disappointing. Many people in East Germany and Eastern Europe did not have the necessary "small change" for such purchases. The resulting overproduction led to such an oversupply that, in 1992, there was even speculation about the possible insolvency of Volkswagen AG [RM-072]. The following year, Ferdinand Piëch succeeded Carl Hahn as Chairman of Volkswagen AG. At Audi, he had been known as a ruthless reorganizer. As the new CEO, he undertook several restructuring measures.

Firstly, he invited Japanese experts to teach VW the *Kaizen* strategy. The Japanese ideas of *lean management* and *just-in-time* were also copied. Secondly, he hired the notorious cost-cutter Ignacio López, about whom we write in Sect. 1.2.3 in the context of the supplier issues. Furthermore, Piëch consequently implemented the modular principle. This involved sharing vehicle components from several brands throughout the Group. In addition, under Piëch, the column dimension became a fetish: he knew the appearance of quality brands was essential to buyers and that this quality radiated to other, externally invisible aspects of a vehicle. Volkswagen also developed new, economical vehicles, some with unprecedented fuel efficiency. For example, the VW Lupo became famous for consuming 3 L of diesel per 100 km. Under Piëch, Volkswagen successfully negotiated a four-day week, which meant jobs were saved despite the slump in sales. The four-day week was accompanied by a 10% reduction in income for Volkswagen employees—a measure still in place today. The situation was different for top management in the Volkswagen Group; Piëch replaced almost all the members of the Board of Management [RM-072]. All these measures brought about a turnaround at Europe's largest car company: Volkswagen was able to return to a growth trajectory and later, in 2015, finally became the largest car company in the world.

Learning from each other is an essential skill for car manufacturers. Volkswagen adopted Ford's assembly line production methods in the 1930s and the *Kaizen* strategy from the Japanese in the 1990s. The Japanese, in turn, learned the TQM methodology from the Americans (in particular, from the famous quality expert William Deming).

Our industry's ability to learn is critical. This includes strategies known everywhere today, such as *lean management*, *just-in-time delivery*, *total quality management*, employee empowerment, continuous improvement (*Kaizen*), and much more.

The belief that Americans can always bounce back from devastating defeats is often considered a myth. But this vitality is by no means unique in the world. In fact, German and Japanese companies were also seemingly destroyed after the Second World War—and yet, amazingly, they returned to fame and fortune. This vitality of our industry gives us hope that other similar challenges can also be overcome.

In our industry, technological brilliance is not the only goal we have pursued. Vehicle safety has also steadily improved. Despite the PR and safety issues discussed in this chapter, the industry continues to learn from its mistakes and prioritize vehicle safety. In the next chapter, we will examine these efforts more closely.

1.2.2 Safety First

While vehicle design and the "coolness" of cars were often the main focus in the past, customer expectations have increasingly shifted towards safety in recent decades. The problem with the driving stability of the Audi TT at the end of the 1990s may serve as an example. The vehicle could oversteer dangerously at high speeds. Among the reasons experts gave for the car's behavior was a considerable aerodynamic lift at speed. In 1999, the German magazine *Der Spiegel* scrutinized a fatal accident involving an Audi TT. The issue was broadly discussed in German media [RM-035]. In the meantime, the physics of the sports car was admitted as a risk factor, and the cost pressure and vehicle design were questioned. The TT was meant to be an affordable, fast lifestyle car. The engineers' concerns about the vehicle were ignored. Audi chief engineer Werner Mischke is said to have said: 'We *wanted* this car to be *exactly* like this.' [RM-035] Many TT drivers accepted the technical risks. When driving such an unpredictable sports car, such risks were part of the fun for them.

But eventually, even many die-hard amateur racing car enthusiasts recognized that life holds a greater value than they might have acknowledged decades earlier. So, besides various safety improvements such as a new wishbone, the Audi TT also received a spoiler, although it was often criticized as "ugly."

8.1.8 Paradigm Shift 8: Prioritizing Projects Over Matrix

Insight

The traditional matrix organization in the automotive industry, rooted in functional hierarchies and rigid departmental boundaries, is increasingly at odds with the agility demanded by modern, software-defined car manufacturers. Once viewed as a mere nuisance, the matrix structure is now struggling to keep pace with the growing complexity of vehicle functions, ultimately hindering the speed and effectiveness of development. In contrast, the project-based approach has become essential for meeting these challenges and accelerating innovation.

Consequence

Car manufacturers must become more project-oriented, and this must also be reflected in role understanding, such as that of the project manager (or Project Lead, in the case of CORE SPICE). Strong project leadership is a recipe for more personal responsibility and safer, faster feature implementation. A clear understanding of roles and a strong focus on objectives are proven strategies for avoiding unproductive debates over methods.

To become effective, the project approach must be replicated across the organization. At the same time, overarching work must be bundled and coordinated via systematic program management.

A professional and effective career ladder must be established to ensure that working on projects is not a career dead end. In the evolving automotive industry, it's not practical for managerial roles to be the only path to higher salaries. A technical career ladder with levels such as software developer, software architect, software lead architect, system developer, and system architect must be established at the highest company level (see [RM-143]) and supported by attractive compensation.

Project Orientation and an Expert Career Path Must Be Established as Equivalent Alternatives to a Management Career to Retain Top Talent in Our Industry.

8.1.9 Paradigm Shift 9: Embedding Sustainability into the Core Business Model

Insight

Sustainability is no longer just a PR term, or a side note in corporate policy but a key factor for long-term competitiveness in the automotive industry. Customers, investors, and legislators increasingly demand ecological responsibility and transparency along the entire value chain.

Consequence
Vehicle manufacturers and suppliers must integrate sustainability into every level of their business activities. This ranges from using environmentally friendly materials to using renewable energy in production and developing circular economic concepts for the end of a vehicle's life. It requires all stakeholders to work closely to minimize environmental impact while ensuring efficiency and profitability. Sustainable innovations can help open up new markets and strengthen brand loyalty.

8.2 Car Manufacturers in a Constant State of Change

Transforming a 130-year-old industry into a collection of "T-Rex" companies (see [RM-143]) isn't something that can happen at the push of a button. The strategic elements outlined in Chap. 7 and the necessary paradigm shifts demand a true *tour de force*. This transformation requires a united effort from the entire company—from the boardroom to every employee. These changes must not only be supported but actively championed and driven forward.

Such a significant, strategic change requires careful planning. The groundbreaking book *Leading Change* by John P. Kotter, a renowned expert in leadership and change management [BF-016], presents a proven process for corporate transformation:

1. **Create a sense of urgency**: Build awareness of the need for change.
2. **From a powerful coalition**: Bring influential and committed team members together.
3. **Develop a vision and strategy**: Craft a clear vision of the future and actionable strategies.
4. **Communicate the vision**: Clearly and convincingly share the vision of change.
5. **Empower broad-based action**: Enable employees to act and remove obstacles to change.
6. **Generate short-term wins**: Achieve and celebrate quick, visible successes.
7. **Consolidate gains and produce more change**: Use early successes to drive further change.
8. **Anchor new approaches in the culture**: Integrate changes into the corporate culture.

This straightforward "change process" provides a framework for a car company to plan and achieve measurable results. It is particularly relevant for the company's shareholders that the difficult transition phase, likely to extend over several years, is communicated appropriately.

This all-encompassing change can be supported in a targeted manner, for example:

Seek expert support with expertise guiding similar transformations to a software-focused organization. Prioritize those with hands-on experience in the software industry.

Implement education and training programs focused on “software”. Contrary to common belief, software is not as hard to grasp as it might seem. Successful training relies on motivation, curiosity, and effective communication of software concepts. These elements can encourage interest in software and lead to professional fulfillment. However, to ensure lasting impact, employees should receive ongoing support after the training to prevent these gains from becoming short-lived.

Actively utilize AI-powered tools. With modern AI-supported tools, teams can be highly effective. Process improvement, documentation, searching for new ideas, and even root cause analysis of tricky defects—AI-supported development tools and planning tools – make the list of AI solutions endless. AI can offer and implement training measures, act as a virtual consultant (for example, for Automotive SPICE or ISO 26262 issues), and even provide emotional support in crises, such as during extreme escalations, which are common in our industry. However, appropriate support must be offered to use these tools successfully. This is an opportunity for older, experienced employees who can, for example, develop the right “prompts” [RM-146]. This will be necessary until a general AI understands the context and can take the initiative.

Persuasion. Resistance to change is natural. Examples of the right mindset are worth their weight in gold for easing this resistance. Imagine a visionary industry leader of the caliber of Steve Jobs giving an inspiring motivational speech.

Utilize cross-functional teams. Bring teams from different company areas to generate and implement ideas and solutions. This promotes collaboration and helps to overcome silo thinking.

Maintain open communication channels and an ongoing dialog between management and employees to gather feedback, address concerns, and keep the workforce informed.

Support champions. Identify and empower critical individuals within the organization to serve as change champions who lead by example and inspire others.

Establish rewards and recognition for teams and individuals to ensure that innovative “inner leadership” is cultivated and spread throughout the organization. This approach aligns closely with John Kotter’s second step of management change.

Promote flexibility and adaptability. Encourage employees to take on new challenges and introduce them to the new world of software.

Pilot projects. Test new approaches and ideas on a small scale before implementing them company-wide. This idea correlates with the sixth step of John Kotter’s change process.

Implement change sustainably, not just in the short term but also in the long term, integrating it into the corporate culture. This correlates with the eighth step of the Kotter process.

In all these observations and implementation ideas, the role of company management is crucial. Top management must identify and implement suitable support measures that fit the management style and the (new) corporate culture. Credible, inspiring leadership is essential for such profound change.

Such changes are currently occurring worldwide. The pace of change in the automotive sector is nothing short of breathtaking. At least in our industry, the saying ‘Nothing is more constant than change’ has been proven true.

8.3 Closing Words

This book has explored a wide range of topics that shape the future of the automotive industry, from the industry’s early days to the challenges and innovations of autonomous driving and connected cars. It has also addressed the role of quality, effective project management, and strategic considerations.

From groundbreaking technological advances in automobiles to the revolutionary approaches to business management, the true greatness of our industry is evident.

Car IT Reloaded has taken us on a journey that reflects on the past and looks forward confidently to a future where new technologies are increasingly ubiquitous. Its topics are so diverse and captivating that we had to focus on the essentials. While we covered a narrower spectrum in our previous book, *Car IT*, and only briefly touched on many of the critical topics of digital mobility, this book has become a quasi-compendium. Each sub-chapter could easily warrant its dedicated, comprehensive book, as the automotive industry has evolved into a highly diverse field, increasingly integrating the fast-paced advancements of automotive digitalization.

Car manufacturers are profoundly transforming their brands, platforms, and corporate cultures to navigate the new era of rapid mobility change. This challenging task deserves recognition, as corporate culture is critical in determining a company’s success or failure. Now is the time for vision, courage, and creativity to shape the future of mobility. We firmly believe the key to success lies in striking the right balance between honoring tradition and embracing the adaptability needed to thrive in our industry’s new dynamics.

The pace of change in our industry is nothing short of astonishing. What was once a leisurely automotive Sunday stroll has become a digital race. So, let’s race together into a future defined by mobile innovation and the seamless connection between man and machine. One thing is sure: we will win this race. Together, we will all emerge as winners.

May our journey through *Car IT Reloaded* inspire you to explore the new mobile world with enthusiasm and curiosity. Change remains the only constant, and the most exciting automobile innovations and adventures lie ahead.