Automated Driving in Its Social, Historical and Cultural Contexts

3

Fabian Kröger

3.1 Introduction

The fascination with the promise of automotive autonomy has historically rested primarily on human drivers' control of the gas pedal, steering wheel and brakes. Steering a car is the only area where the love of power and imagination still has free rein, observed the semiologist Roland Barthes in 1963 [3, p. 241]. The sociologist Henri Lefebvre also emphasized that the automobile was the last refuge of chance and risk in an increasingly controlled and managed society [23, p. 192].

Concealed in this risk, however, is not only freedom: there is also the threat of fatal accidents. In this sense, the car both runs with and against the grain of "the utopia of modernity," as emphasized by cultural scientist Käte Meyer-Drawe [27, p. 111f].

The vision of man driving himself was therefore accompanied early on by the dream of self-steering cars bringing us safely to our desired destination. It is astonishing that the fulfillment of this wish has always remained 20 years away for almost the last 100 years [50, p. 14]. Between an automobile controlled by a driver and one that transports passengers, there is evidently not only a technological break, but above all a cultural one. Driverless vehicles have played a prime role in our imaginings of technology, their history is largely a pictorial one.

The following article traces some of the central elements in the almost hundred-year-long pictorial and technological history of driverless cars from a cultural science perspective (see also [22]). The central interest is the relationship of technological and pictorial designs from industrial research projects and the cultural imagination. We

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will see how the logic of automatic automobiles unfolds as a fantastical object between the weird and the wonderful.[1]

3.2 Early Aviation and Radio Technology Lays the Foundation

The story of the driverless car begins in the USA in the first half of the twentieth century. At this time, the sharp rise in fatal traffic accidents was becoming a social problem. Mass motorization had begun in the USA as early as the 1920s—three decades earlier than in Europe. More Americans were killed in auto accidents in the first four years after the First World War alone than in total in France up to that point [32, p. 25]. Overall, motorized road transport led to the accidental deaths of around 200,000 US citizens in the 1920s; by far the greatest number of these were pedestrians (ibid., p. 21).

Driver error was seen as being the prime cause of accidents. That infrastructure and vehicle design are also critical factors in accidents' form and severity was at first little acknowledged. The idea of substituting error-prone humans with technology thus practically suggested itself.

Two new technological developments from the fields of aviation and radio engineering belonged to the material conditions that an accident-free, self-driving automobile first made conceivable:

Firstly, in Bezons near Paris, France in June 1914, Lawrence B. Sperry (1892–1923) introduced the first gyroscopic *Airplane Stabilizer*, which today is seen as the first autopilot. Before the eyes of astonished spectators, his mechanic climbed out onto the right wing during the flight, while in the cockpit Sperry stood up and raised his hands above his head. The system was based on the gyrocompass, which his father Elmer A. Sperry (1860–1930) had invented [6, p. 183]. It automatically equilibrated the aircraft, although it did not fully relieve the pilot of steering duties. John Hays Hammond (1888–1965) introduced a system for automatic course stabilization at around the same time. The inventions of Sperry and Hammond paved the way for the commercialization of autopilots [11, p. 1253 ff; 17, p. 1258 ff].

Secondly, radio technology was one of the technical requirements needed to be able to create a self-driving car. The new science of radio guidance was engaged with the remote control of moving mechanisms by means of radio waves [16, p. 171]. This technology was developed, amongst others, by the US military, which was experimenting with remote-controlled torpedos, ships and aircraft.

[1]Note: The terms self-steering, automatic and autonomous vehicles are used here interchangeably.

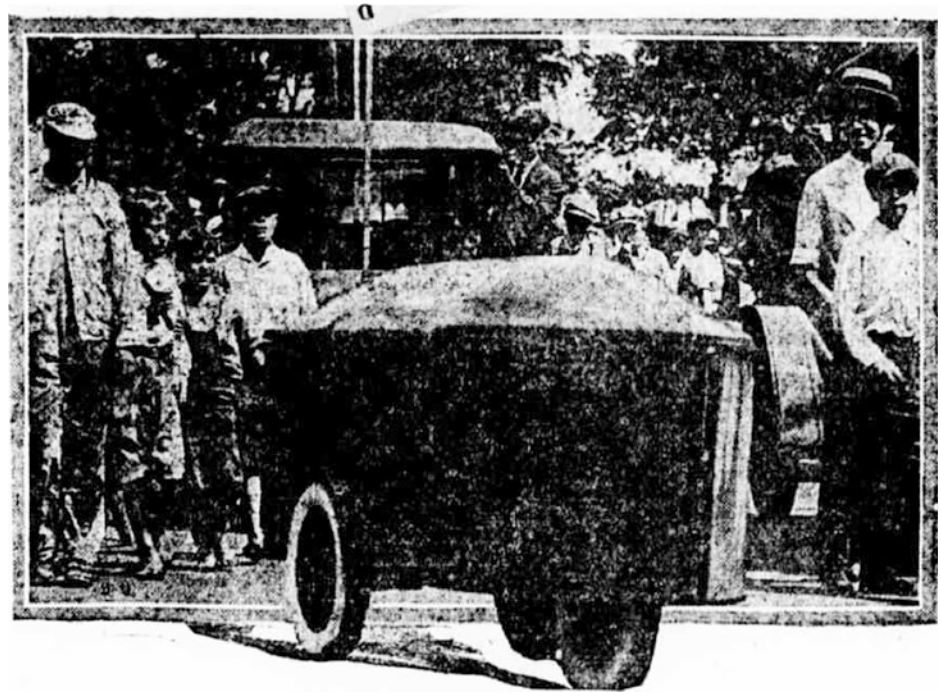

Fig. 3.1 The first remote-controlled vehicle (USA 1921)—The Daily Ardmoreite, 12 August, 1921, p. 5 [38]. Image rights: copyright by the Author

3.3 Technical Beginnings: Driverless, but not Self-steering

These pioneering works led to the first driverless car, which engineers of the Radio Air Service introduced to the public on the McCook air force test base in Dayton, Ohio on 5 August, 1921.

The 2.5 m-long car (Fig. 3.1) was controlled via radio from an army truck driving 30 m behind. Technically speaking this, then, was not an autonomously self-driving vehicle, but rather a remote-controlled one—just that the driver was outside the car. What is noteworthy here is that the history of driverless cars is linked to the military, and was a media story right from the beginning—the press reported on it and published photos of the prototype [33].

In 1925 another remote controlled auto named *American Wonder* caused a sensation as it drove on Broadway in New York [37].[2] It was developed by the Houdina Radio Control Company. Military know-how also played a role here: Francis P. Houdina had worked as

[2]Note: Due to a defective OCR scan of the TIME article, the name American Wonder was incorrectly recorded as Linnrican Wonder. This was carried over to numerous articles.

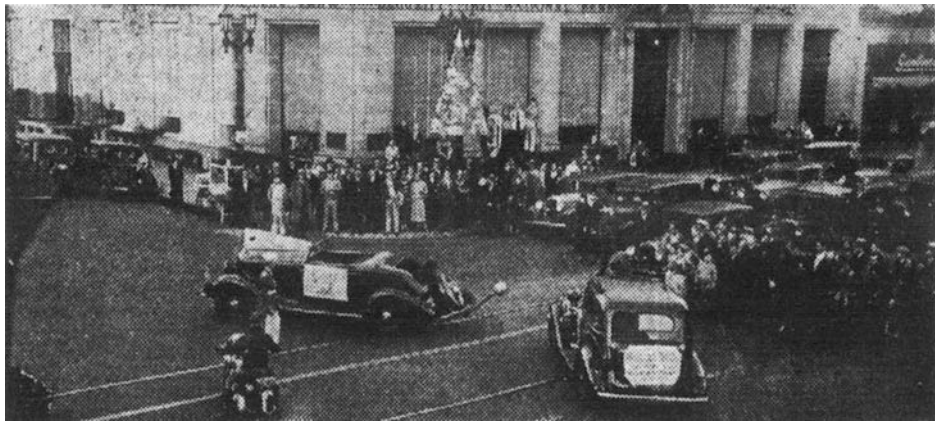

Fig. 3.2 Remote-controlled vehicle in a safety parade (USA, 1930s)—magic car to demonstrate safety, in: The Herald Statesman, 28 July, 1936, p. 1. Image rights: copyright by the Author

an electrical engineer in the US Army. *American Wonder* was also steered by remote control from a second vehicle.

In the 1930s, various offshoots of these remote-controlled automobiles appeared in public. At the one hand it was to be used as a commercial advertising vehicle, due to its notable qualities in terms of an attention economy. At the other hand it was taking a leading role in the so-called *Safety Parades* (Fig. 3.2) for road transport safety under the management of Captain J.J. Lynch.

From 1931 to 1949, Lynch gave demonstrations of the remote-controlled vehicle in 37 of the 48 US states. In 1934 he even demonstrated it in Australia. He manipulated the brakes, steering wheel and horn of the vehicle driving in front of him with the aid of a morse key. A spherical antenna received the code, although there are also reports of a wire between the vehicles. In Buffalo and at Utica Airport in 1933, the car was even controlled from an airplane.

The driverless vehicle was almost perfectly suited to transport safety campaigns. On the occasion of a driving-safety campaign, Lynch stressed that modern automobiles' safety depended on the driver. Because the driverless automobile obeyed all traffic rules, it would serve as an example for car drivers.

3.4 Between the Weird and the Wonderful

The press announced the remote-controlled automobile as the *phantom auto* [34], robot car [36] or *magic car* [35]. These metaphors show that the driverless car was perceived as a fantastical object from early on. To this day, it takes precisely that place between the weird and the wonderful that Tzvetan Todorov ascribes to fantasy literature [44].

"We sped off with no-one holding the steering wheel, whizzed round corners, dodged other equally fine powered carriages, nobody honked their horn" [20, p. 7f]. In his early automation utopia *Utopolis* (1930), the German writer Werner Illing describes the wonder of "secretly self-steering autos" (ibid., p. 37). We are moving into a society where "the automatic machine" has replaced "work done by hand" (ibid., p. 19)—and also steering done by hand. "The most wonderfullest (sic) thing about it was that the car (…) behaved as if it had learnt all possible traffic rules by heart." (ibid., p. 38). As in Lynch's Safety Shows in the USA, the particular attraction of the driverless car here consists in keeping to social norms.

The technical side of this literary utopia is also explained. Each car has a small prism eye at the front, which communicates with the traffic lights that are "embedded inconspicuously in house walls." "These mechanical eyes regulate speed and steering via alternating reflected images" (ibid.). There is even a navigation system that is reminiscent of today's GPS devices:

> In place of the steering wheel I found a metal plate in which the map of the city was very finely and clearly etched. Above this a pin-sharp pointer. I had hardly begun to move this before the car started up and ran down streets I had never been down before. (ibid., p. 38).

The description of wonderful self-steering automobiles is followed by the literary embellishment of its weird potential. In his short story *The Living Machine* (1935), the US science fiction author David H. Keller describes the invention of a self-driving car that can be navigated with spoken instructions [21]. At first, the benefits are spelled out. The "living machine" has contributed to a drop in the rate of accidents and opened up the car to new classes of users (ibid., p. 1467):

> Old people began to cross the continent in their own cars. Young people found the driverless car admirable for petting. The blind for the first time were safe. Parents found they could more safely send their children to school in the new car than in the old cars with a chauffeur. (ibid., p. 1470).

The story turns when a mechanic notices that the cars have come to life. "Cars, without control, coursed the public highways, chasing pedestrians, killing little children, smashing fences." (ibid., p. 1473). This imaginary phantasm of loss of control to driverless machines was to be the dominant template for the rest of the century.

3.5 Only a Driverless Car is a Safe Car

The driverless car received its first screen appearance in the American road safety education film *The Safest Place* (1935). Commissioned by General Motors (GM) and produced by Jam Handy (1886–1983), this short film shows a car with no driver sticking to the traffic regulations in exemplary fashion. The vehicle always stays in its lane, never forgets to signal when turning, obeys all stop signs and never overtakes on dangerous

corners. Lynch had given similar reasons for campaigning for safety with driverless vehicles.

The Safest Place does not portray a vision of the self-driving car as a technically achievable possibility, but rather as a moral model for further thought. Only drivers are held responsible for accidents in this film. They were shown as far more important for safety than technology—which is precisely why they should behave like automatons.

The film's blind spot is the machine: it is not seen as a risk factor. The fact that accidents also happen when the driver has made no mistake goes unmentioned. This is not surprising, as the car industry at that time was not yet convinced of the need for carrying out safety research [42, p. 161]. Visually, the film sums up this paradox of the infallible machine impressively. The camera films the car's interior from the back seat and, as if by a ghost's hand, the steering wheel turns. The front seats are empty.

This approach is noteworthy, as the self-steering car appears to have disposed of all its occupants. Their bodies have been taken out of the car and out of the picture. They are now sitting outside the car in the movie theatre, in front of the screen. Only their gaze permits the audience to visually put itself back in the position of a traveler in the car. In ironic fashion, the film points here to the contradiction between safety and freedom: Is the car only safe when empty?

3.6 Guide Wires Become Utopian Guiding Principles

It is not only literary and filmic fantasies that surround the driverless car. At around the same time—the mid-1930s—the American oil and auto industries began working on ultramodern designs for the highways of the future together with urban planners, industrial designers, architects, transport researchers, and policy makers [50, p. 2]. At this time, automatic driving moved away from the early attempts at remote control, and was upgraded to a guiding principle of an automated transport system. The concept of the automated street was projected onto real landscapes, though immediate implementation was not planned. It was rather to act as a beacon in rebuilding trust in capitalism. Many US citizens had lost their faith in technological progress as a result of the Great Depression. The planning elite were thus drawn to propaganda boosters that were designed to return the luster to technological promises of salvation.

Popular science magazines such as *Popular Science* and *Popular Mechanics* played an important role in this. They were heavily illustrated, which makes them valuable sources for studying pictorial history. In May 1938, *Popular Science* reported on the automatic transport of the future for the first time [31]. The author introduced the so-called guide-wire vision, which was to remain a cultural guiding principle up to the 1970s. All vehicles were to follow an electromagnetic wire sunk into the road surface whose impulse regulated speed and steering (ibid., p. 28). The justification for the design was the need to end the "slaughter" caused by human driving error and bad roads (ibid., p. 118).

Astonishingly, this early guide-wire vision foresaw the switch from manual to automatic control (ibid., p. 27).

Of particular interest here is the accompanying drawing by the illustrator Benjamin Goodwin Seielstad (1866–1960), which develops a utopian pictorial language that was to crop up in connection with automatic driving again and again over the decades (Fig. 3.3).

Firstly, we look with a bird's-eye view onto the freeway of the future, which leads arrow-straight to a vanishing point on the skyline. The shining white roadways merge as they head across the panorama's horizon. The perspective emphatically signposts the path of progress to a better tomorrow. The strategically deployed vanishing point emphasizes the picture's message. In the way it moves with the viewer, and thus unattainably leads to nowhere, it has an affinity with the utopian.

Secondly, the exceedingly high viewpoint underscores the panorama's meaning. The view onto the freeway appears to be the perspective from a hot-air balloon. The visual distance underlines that the vision is only in draft form, which we, along with Ernst Bloch, may name as a "landscape of desire" [5, p. 935].

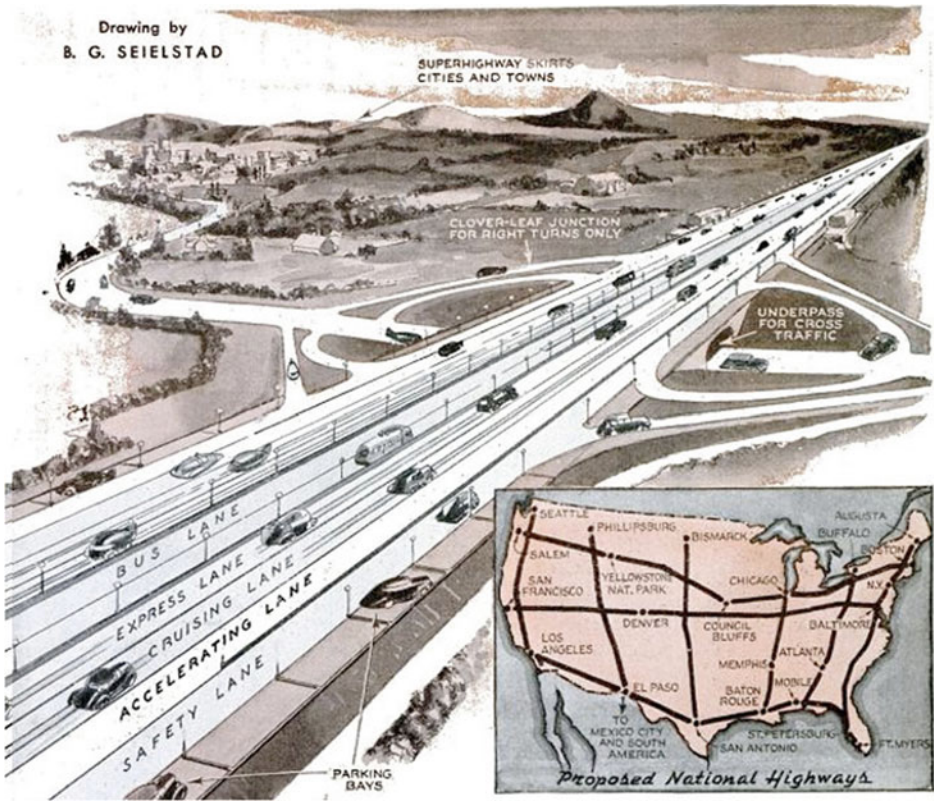

Fig. 3.3 One of the first illustrations of an automatic freeway (detail)—*Drawing* B.G. Seielstad; Popular Science, May 1938, p. 28. Image rights: copyright by the Author

Popular Science explained the vision illustrated in the article by calling on Miller McClintock (1894–1960), Director of the Bureau for Street Traffic Research at Harvard University. McClintock was one of the most important masterminds of US transport planning [32]. In his doctoral thesis, he had analyzed the causes of traffic jams and accidents as early as 1925, and developed new traffic regulations and road construction works [26].

Significant impetus for automatic driving was provided by a large oil company. In the spring of 1937, Shell brought McClintock together with Bel Geddes, a pioneer of streamlining. For a Shell advertisement, they were to design a model of the *City of Tomorrow* [32, p. 249]. Bel Geddes [4] had already written about urbanism and car design in his book *Horizons* in 1932, but it was the Shell job that first had him developing the vision of automatic highways. In May 1938, he managed to convince GM to further develop the Shell model for the 1939 New York World's Fair.

3.7 Self-driving Transport in General Motors' Futurama

"Strange? Fantastic? Unbelievable? Remember, this is the world of 1960!" [13, p. 8]. At the World's Fair, the utopia of driverless cars was given its first big stage. *Building the World of Tomorrow* proclaimed the fair's motto, promising a technologically improved future while daily life was marked by economic depression and forebodings of imminent war. The most popular show at the World's Fair was GM's still-legendary *Futurama*, with its model of future transport systems. The term Futurama is derived from the Greek *horama* (En.: sight). In order to be able to see into the future, visitors to the fair had to enter the streamlined building designed by architect Albert Kahn (1869–1942) across curved ramps, whose esthetic was reminiscent of future superhighways as well as the above-mentioned utopian path of progress.

Inside awaited 552 plush armchairs mounted on a conveyor. Visitors floated on it for 16 min over a gigantic 3000 m^2 model landscape designed by Bel Geddes. The seven-million-dollar diorama encompassed half a million houses, a million trees and 50,000 toy cars [25, p. 110; 30, p. 74]. Visitors were provided with a commentary over loudspeakers about what they could see beneath them: 10,000 animated model cars, dashing along a fourteen-lane highway, embodied the automatic traffic of tomorrow, kept in lane by radio waves. Only gas stations were missing, they would have reminded the visitor of the vision's dependence on oil. The viewer also sought churches in vain, for the whole Futurama was already a place of worship, a tribute to a technological promise of transcendence.

Similarly to *Popular Science*, Bel Geddes, who had worked in the theater until 1927, staked all on the primacy of the visual in this production: "One of the best ways to make a solution understandable to everybody is to make it visual, to dramatize it" (quoted in [50, p. 24]). The aim was to shape viewers' desires and underscore industry's claims to cultural hegemony over the future. For this, images were needed, not technical designs.

Futurama's task was not to enlighten viewers, but to allow them into a realm of imagination. *How* the public saw the future here was just as important as *what* it saw. They imitated "the aviator's godlike gaze," shared by modernist planners viewing the chaotic cities in the hope of controlling them [30, p. 77f]. At the same time, the ideas of Futurama came along in the era of superheroes (the first *Superman* comic appeared in 1938), whose earthly ascendency can be read as an allegory of rescue from the Depression. How the automatic highways were technically supposed to function remained, in contrast to the highly developed pictorial landscape, hazy. This imbalance is typical of all techno-utopias. GM would only disclose that vaguely described "experts" would direct car drivers when changing lanes from control towers [13, pp. 6, 8]. Clearly, the driver was supposed to stay at the controls, but simultaneously listen to a human instructor, who transmitted his orders via radio. Actually, according to James Wetmore, there are no indications that Bel Geddes' highways were ever developed beyond the model [50, p. 5].

Nevertheless, Futurama had an enormous cultural impact which is still being felt today. Two years after the show, science fiction author Robert A. Heinlein was already integrating the automated highways made famous in Futurama into his novel *Methusala's Children* (1941) [18, pp. 5, 27; 39, p. 27]. His book made plain the supervision of automated traffic from control centers.

Beyond this, Heinlein presciently addressed a topic that would crop up in numerous films at the end of the twentieth century: With total road surveillance, a getaway is not possible in a car. The protagonists in Heinlein's novel can only turn off the automatic lanes onto uncontrolled, normal roads by driving through a fence using manual control [18, p. 27f].

3.8 Estheticizing the Guide-Wire Principle

"Why Don't We Have… CRASH-PROOF HIGHWAYS", asked the popular scientific magazine *Mechanix Illustrated* in 1953 [15, pp. 58ff, 184]. The Second World War had interrupted the dream of automatic driving. The automobile industry concentrated on military vehicle production in the 1940s. In the post-war period, the utopia of the driverless automobile sprang back to life. New technologies developed in the war were now to be used for civilian purposes. The guide-wire principle became more concrete in technical terms. Automatic driving was supposed to be achieved with magnet detectors as they had been used in the Second World War to detect landmines. Radar technology—also a military invention—was to regulate the distance to the car ahead.

With its bird's-eye panoramic view of a freeway, the illustration accompanying the article (Fig. 3.4) stunningly resembles the drawing from 1938 mentioned above. The viewpoint has now dropped down, however, as if the viewer has a sightline from a building right next to the road. The picture here suggests that automatic driving has moved closer. The vehicles are now also markedly more detailed, the bodywork drawn somewhat more futuristically than in the 1938 drawing.

Fig. 3.4 Further developed panorama, USA 1953—Mechanix Illustrated, June 1953, p. 58. Image rights: copyright by the Author

The picture shows automatic driving in a transitional phase between old and new mobility concepts. The driver has indeed let go of the steering wheel and turned to the rear passengers, but the front passenger has to strain her arm to be able to speak with her friends on the back seat. The illustrator was evidently not free to leave out the steering wheel altogether and turn the front seats around. Moreover, the picture highlights that the system can be manually overridden to exit the magnetic lane. The public was evidently not yet ready for a fully automatic vehicle.

3.9 Setting the Family in Self-driving Vehicles

Americas Independent Electric Light and Power Companies [1] placed an ad in LIFE magazine in 1956 (Fig. 3.5) which to this day gives one of the most detailed and estheticized depictions of autonomous driving.

In the foreground we see a large sedan rolling along the middle lane of a ribbon of freeway stretching to the horizon. As well as the central perspective, the further-sunken viewpoint is very significant. While the viewer was given a high and distant perspective in

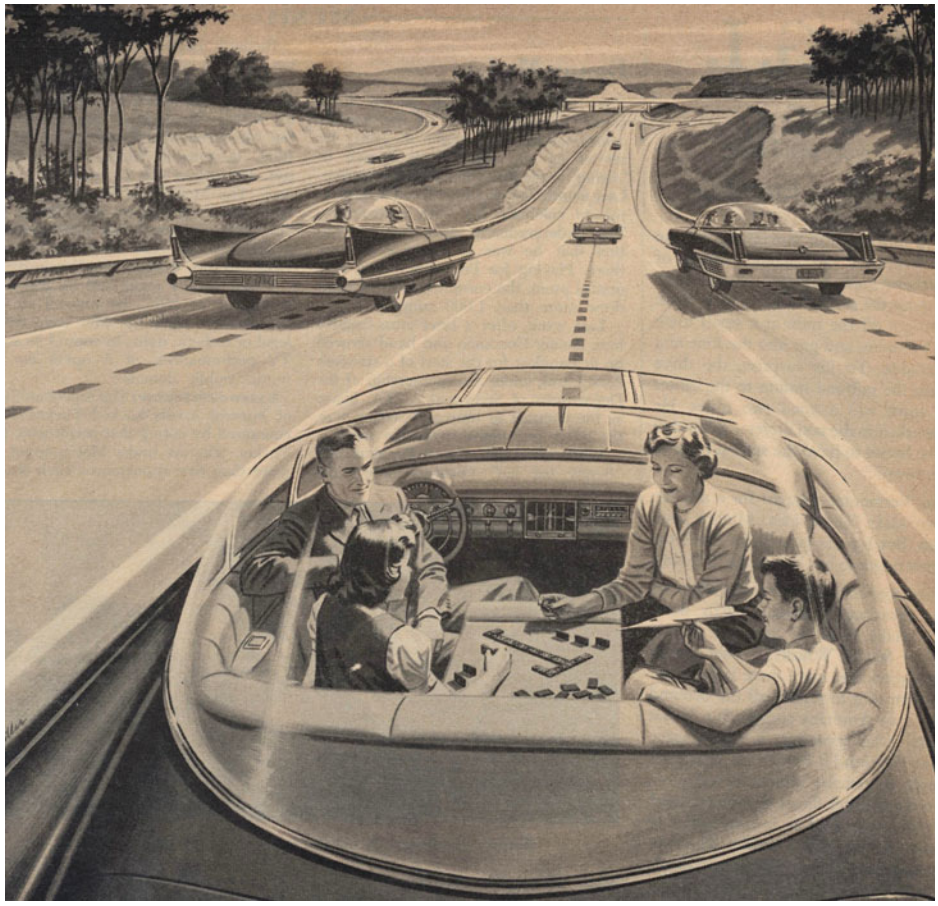

Fig. 3.5 Detailed version of the panorama—Magazine vol. 40, Nr. 5, 30. January 1956, p. 8. Image rights: copyright by the Author

the above-mentioned illustrations, here we find ourselves close behind the car, which takes on a dramatically real appearance in this vision.

The large glass roof is significant, taking up more than half of the picture. It directs our gaze into the car's interior. A family of four is sitting around a table, as if the car were a substitute living room. All family members are portrayed conforming to contemporary social conventions. The father is in the driver's seat, although he has abandoned the steering wheel. Mother and daughter are playing dominos, while the son is looking at his model airplane. Nobody appears to have his or her seatbelts fastened as the car follows a dashed line on the hardly-driven route.

This motif shows that pictures of automatic vehicles were first and foremost an ideal stage for setting the harmonious nuclear family. The popular women's magazine *McCalls*, for instance, defined the ideal family in 1954 through being together and sharing common

experiences [28, p. 180]. This "family togetherness" quickly evolved into a national ideal. The 1950s may be termed as a "golden age" for the family, especially visible in the young age of marriage and low divorce rate. This can be interpreted as a reaction to the times of war and the Depression, with families forming a counterbalance to the increasingly anonymized working environment under which personal relationships suffered (ibid., p. 177ff). The advertisement derives its attractractiveness from these socio-historical conditions, by demonstrating a utopian counterpoint to the world of work. In fact, one of the most important promises of autonomous driving to this day is that of transforming time spent driving into leisure time spent with the family.

3.10 The Interstate System and the Dream of the Magic Highway

A decade after the Second World War, the USA went through a time of dramatic changes with the end of the Korean War. The mass consumer society began to fully blossom. The expansion of automobilism, an indispensable part of the American lifestyle as far back as the 1920s, now led to an accelerated transformation of the landscape.

Of prime significance was the construction of the supra-regional Interstate Highway System in 1956. Walt Disney's film *Magic Highway U.S.A.* (1958) by Ward Kimball placed this gigantic freeway project in a linear history of progress. In a mix of documentary archive recordings and fictional cartoon animations, the film tells the story of the American road [43, p. 112f; 48]. The negative consequences of mass motorization—breakdowns, accidents and jams—are set against the shining figure of the "highway engineer." He will build roads to cure all ills.

This also included automatic driving that was linked, as in the LIFE advertisement, to the conservative ideal image of the American family (Magic Highway U.S.A., from 39′ 00″). The crux of the matter here is a patriarchal society, full employment and consumption. An animated sequence shows a family getting into a futuristic car. After the father has entered the destination on a console, he holds a business conference call on a videophone and is afterwards dropped off at the office. Mother and son are driven to the mall.

The promise of automatic driving addressed itself to long car journeys from the suburbs to the urban centers. Of the 13 million homes built in the USA from 1948 to 1958, 85 % were in suburbs [28, p. 183]. For families, this meant precisely the opposite of "family togetherness". Due to having to commute to work, most fathers had hardly any time left over for attending to their families (ibid., p. 184). Their wives drove their children to school, music lessons and the doctor. They lacked social contact, their lives played out in isolation and boredom. In this respect, the film gives a distorted picture of the division of labor between the sexes, as it omits showing reproductive work.

Magic Highway U.S.A. ends with an automatic vehicle on a centrally framed highway driving towards a glowing red sunset. We thus again come across the utopian esthetic

running through popular culture since the 1930s. Walt Disney summed up this attitude with words to the effect that roads connect all nations, "and help create a better understanding among the peoples of the world" (Magic Highway U.S.A., 47′05″–47′25″). Automatic driving would lead, like a "magic carpet to new hopes, new dreams," right up to a better life in future. It has seldom been clearer that future technologies are part of a promise of salvation.

3.11 The Technical Realization of the Guide-Wire Vision and Its Illustration

So far, we have seen how literature, film and print media portrayed the driverless car as being part of a utopian dream landscape from the 1930s onwards. In the 1950s, these literary and visual techno-fantasies acquired a new dynamic, as technologies were developed in the car industry that were supposed to make automatic driving possible.

In 1953, GM started testing a miniature model of the automatic road together with the electronics manufacturer Radio Company of America (RCA) [50, p. 6]. Autonomous driving was then popularized in 1956 with the help of the Firebird II concept car as part of the travelling promotional show Motorama. The accompanying film *Key to the Future* by Michael Kidd, for instance, shows a family stuck in a traffic jam singing and dreaming of travelling in a Firebird II, which would get them there so much more comfortably. From a control tower, a uniformed man directs the car into an automatic express lane. The car then follows the guide wire and the father can push the control column (Yoke), as seen in aircraft, into the dashboard. At this time, though, the system did not technically function [50, p. 7].

On 14 February 1958, the first "automatically guided automobile" completed a test route of one mile at GM's Technical Center in Warren (Michigan) [14]. The engineers had fitted the front area of a 1958 Chevrolet with two electronic sensors that followed a wire laid in the road and adjusted the steering wheel accordingly [24, p. 76]. In this project, GM drew on the research of the television pioneer Vladimir Zworykin (1888–1982).

Popular science magazines picked up on these experiments with a multi-pronged pictorial strategy, whose rhetoric distanced itself clearly from the drawings of a technological utopia. In 1958, for example, *Popular Science* reported on a test drive at the GM test track (ibid., pp. 75 ff, 227). The first photo shows a young girl laughing as she lets go of the wheel on an automatic car and puts her hands in the air like a "new human" (Fig. 3.6).

By using this iconic motif, which references Sperry's hands-free presentation of autopilots in June 1914, and to this day crops up again and again in the context of driverless cars, the photo clearly belongs to the class of the wonderful. The upward-pointing hands are reminiscent of the orans gesture, with which those at prayer plea for divine grace.

Fig. 3.6 Automatic driving on a GM test track in 1958—Popular Science, May 1958, p. 75. Image rights: copyright by the Author

This pictorial relationship to the numinous is brought down to Earth with two photographs associated with the profane. The first shows construction workers laying a guide wire in a road, the second the picture of a control computer. The photographs are there to verify self-driving cars' actual existence, thus distancing themselves from the utopian pictorial esthetic.

In the same year (1958), GM introduced the Firebird III prototype, which had no steering wheel. In the central console was a joystick (*Unicontrol*) that unified all driving functions—accelerating, braking, steering. The guide-wire vision was adopted unchanged.

3.12 Cruise Control as a Byproduct of Technological Utopia

In the mid-1950s, real practical applications were added to the utopian visions imagined in film, pictures and words, and the experimental technology systems portrayed in illustrations and photographs.

Popular Science reported in 1954 on an "Educated Gas Pedal," the *Speed-o-Stat*, developed by Ralph Teetor (1890–1982). This automatic speed regulator and limiter soon came to enjoy great popularity under the names *Tempomat* or *Cruise Control*. The magazine presented the system as a milestone on the way to automatic driving, setting it among a larger movement of progress [40, pp. 166ff, 264; 50, p. 34]. But in fact, this movement was heading in another direction. With the development of the Tempomat, the car, driven automatically in more reduced and individualized form, detached itself from the grand vision of automatic highways. The Tempomat thus constituted a model for driver-assistance systems that automatic driving is now on the point of realizing.

A *Popular Science* article from 1958 states that Chrysler has developed a new "supergadget," an "autopilot" for the price of 86 dollars [41, pp. 105 ff, 248, 250]. There is no longer any talk of automatic transport, the utopian vision has shrunk and condensed into a product that is immediately available.

This new logic of immediacy manifests itself in the accompanying photo (Fig. 3.7), which shows a chrome knob installed alongside the speedometer on the dashboard and serves to set the speed. Furthermore, we see a hand; thumb and forefinger are in the process of turning the dial.

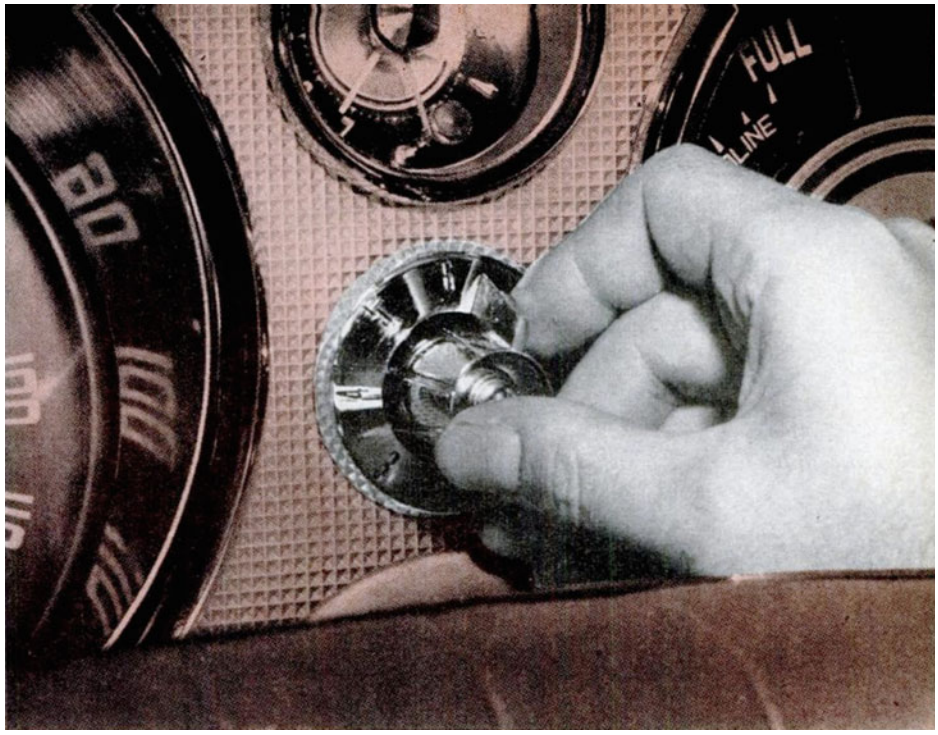

Fig. 3.7 Autopilot dial, Chrysler 1958—Popular Science, April 1958, p. 105. Image rights: copyright by the Author

This close-up stands at the end of a long pictorial history that, starting from the initial distant landscape panoramas, has approached the technological object ever-more closely. This allows us to identify historically successive pictorial levels, running from the abstract to the concrete, from the drawing to the photograph, from exterior to interior, from complete overview to detail, from the collective to the individual.

3.13 Weirdly Bringing the Machine to Life

While press, film, and advertising images in the 1950s are still in awe of this vision, and give the limelight to images of dominant social desires, literature has the question of how strongly our cars of the future will resemble humans on its mind. It warns of future technology taking over and gives vent to unconscious fears.

Isaac Asimov's short story *Sally* (1953) was published in the same year as the *Popular Science* article discussed above. Asimov presents us with humanized "automatomobiles," whose positronic motor assures that "there'd never been a human being behind her wheel" [2]. "You got in, punched your destination and let it go its own way" (ibid., p. 13). Autonomous driving was only difficult to implement in the beginning, then it abolished all accidents and "stopped the killing" (ibid.).

The special quality of the story lies in Asimov's portrayal of the *increased* anthropomorphism bound up in this vision. The "automatics" are vividly brought to life, they are described as "hard-working and affectionate" (ibid., p. 15). They "can talk to one another" (ibid., p. 34). Their emotions can be heard in the sound of the engine (ibid., p. 31). The convertibles in particular are "very vain" (ibid., p. 16). The automatomobile can also be switched to "manual" (ibid., p. 19), but one is not allowed to turn the motor off, as this causes the car pain (ibid., p. 20).

This anthropomorphism then suddenly changes, as in Keller's short story from 1935, into something strange and threatening. The cars develop their own will, they stop opening their doors (ibid., p. 18), roll up to opponents (ibid., p. 25) and finally begin to kill: "they found tire marks on his arms and body" (ibid., p. 32). We later find the same pattern again in John Carpenter's film *Christine* (1981), which is based on a book of Stephen King.

3.14 The Driverless Automobile in Film

A shift can be seen in the sphere of self-driving cars' pictorial history at the end of the 1960s. Until that point, popular science magazines had carried the torch in catering for the public sensation with utopian pictorial concepts. But now cinema took over this role. This finally made the driverless car an important element of the entertainment industry, as James Wetmore confirms [50, p. 26].

In intensity of pictorial language, the cinematic representations of autonomous driving extend far beyond the print media's horizons. Their image worlds are not only indicators of societal hopes, but above all of certain fears. The pattern of weird and wonderful seen in literature is developed further. In doing so, film provides insights into a part of the collective imagination, into unconscious factors that contribute decisively to new technology's acceptance or refusal. Moreover, we see in them the transformation in the self-driving car's public perception. The view of various human-machine interfaces is particularly interesting.

3.15 From Friendly Helpers to Killer Machines

The self-driving car makes its first appearance in film at the end of the 1960s: Robert Stevenson's *Herbie, The Love Bug* (1968) wowed the public as a friendly, if willful, helper in Disney's comedy. The small anthropomorphic racing Beetle has a life of his own. He moves by himself, falls in love with another car, wants to commit suicide out of jealousy, careens around drunkenly, shakes with rage, whimpers like a dog, runs a fever. As Herbie cannot speak, all of his feelings are illustrated by the comments of his mechanic, who appears to understand him. The self-driving car is shown as a brought-to-life, mechanical double of man, and serves as a metaphor for the strange, intense and intimate relationship between people and cars.

Herbie falls into the category of the "purely fantastical," as defined by Todorov [44], for the film never delivers a mechanical explanation for the car's behavior. The driverless car is still completely attributable to the wonderful, as in Illings 1930 novel, and has nothing weird about it.

This would soon fundamentally change. Two years before the energy crisis of 1973, a huge tanker truck hunted an unimposing salesman through the mountains of the Californian desert in Steven Spielberg's first film, *Duel*. The truck sounds its horn infernally down the victim's neck, the rumbling drone of its engine drowns out the radio. All attempts at escape fail. Although the truck is driven by a human, we never catch sight of the driver's face. The machine, with its blank headlights for eyes, thus becomes an actual hunter.

With *Herbie* and *Duel*, two archetypes of the driverless automobile were created which would go on to be embellished throughout the seventies. Herbie was given three sequels by 1980. *Dudu* (1971–1978), the German-Swiss B-movie series, depicts a vehicle with artificial intelligence in *Ein Käfer auf Extratour* (1973), which is said to be where the American producer Glen A. Larson found inspiration for the *Knight Rider* series, which we shall return to later.

Parallel to this, horror films exploited the potential threat posed by driverless cars. *The Car* (1977) takes Spielberg's *Duel* one stage further. A diabolical black sedan terrorizes the inhabitants of a small town. With darkened windows, close-together, piercing

headlights, chrome fenders in the form of a ram's head, and the motor growling like a predator, the driverless car becomes a personification of evil.

With *Christine* (1983), the self-driven car reached its horror-movie, anti-Herbie zenith. John Carpenter's adaptation of Stephen King's novel describes how the car come-to-life disposes of its driver. The radio that turns itself on, hints from the beginning that this Plymouth has a will of its own. The radio is not only a receiver, but mainly a subtle transmitter, it is the driverless car's voice and soul. In contrast to *The Car,* however, Christine has an owner, the pubescent Arnie, who transforms himself through her, and is soon practically sexually obsessed by her. In the day, he drives, at night Christine goes hunting to kill. The windows are darkened like those in *The Car.* Christine is also invulnerable like a zombie, being able to heal herself after the worst accidents. The film's particular appeal lies in the way it remains unclear until the end if it is actually Arnie driving Christine.

These films show the automobile becoming autonomous, which was being reflected in reality. The negative consequences of mass motorization—a high number of vehicle deaths, ever-longer traffic jams and considerable smog pollution—became fully visible in the 1970s. The oil crisis of 1973 led, for instance, to stricter emissions rules, and the era of muscle cars was soon consigned to history. Both in Europe and the USA, this decade symbolized the end of the golden age of the automobile.

Driverless cars were practically made for allegorical depictions of this trend in the cinema.

3.16 The Rise of Microelectronics and the Fall of the Guide-Wire Concept

While the weirdness of self-motion was being conjured up in the cinema, academic and industrial research began to distance itself from the concept of automatic highways. The gaps between technical and economic feasibility became too large, explains one of the engineers involved [50, p. 10]. In addition, the automobile industry had to adjust itself to stricter environmental regulations and safety standards. This required heavy investment.

There was a trend towards research into autonomous vehicles that are not dependent on infrastructure such as guide wires. In the 1970s, Japan and the USA made great progress in attempting to provide cars with sight.

In 1977 Sadayuki Tsugawa's team from the Mechanical Engineering Laboratory in Tsukuba, Japan, presented the first visually guided autonomous vehicle that could record and process (on-board) pictures of lateral guide rails on the road via two cameras. The car was able to move with a speed of 10 km/h [46]. It had no function of lane marking detection.

Hans Moravec from the Artificial Intelligence Lab at Stanford University in the USA researched robot navigation from 1973 to 1981, for which he employed the *Stanford Cart*, an experimental vehicle with four bicycle tires constructed as far back as 1960. Its original

purpose was to learn how to control a moon rover from Earth. In October 1979, with the help of the TV camera on-board (not the computers needed), the cart managed to move through a chair-filled room without human intervention. "The system was reliable for short runs, but slow. The cart moved 1 m every 10–15 min, in lurches. After rolling a meter it stopped, took some pictures, and thought about them for a long time. Then it planned a new path, executed a little of it, and paused again. It successfully drove the cart through several 20-m courses (each taking about 5 h) complex enough to necessitate three or four avoiding swerves; it failed in other trials in revealing ways" [29, p. 407].

At the same time, the rise of microelectronics led, moreover, to increasing use of electronics in vehicle technology (fuel injection, ignition), through to the launch of the first on-board computer (Check Control) in the 7-series BMW (E23). The era of active driver-assistance systems that directly intervene in the driving process began with the introduction of ABS in 1978.

In the 1980s, the research on autonomous vehicles became a serious research topic for academic and industrial research in many countries. It would exceed the frame of this article to give a representative picture of all these efforts. Therefore we will concentrate on the most important pioneering works. Ernst Dickmanns from the University of the Federal Armed Forces in Munich (Germany) developed for the first time visually guided autonomous cars with digital processors onboard, based on the perception of multiple edge elements. In 1984, his team conceptualized the first vehicle that used dynamical models for visual autonomous guidance: The VaMoRs (Versuchsfahrzeug für autonome Mobilität und Rechnersehen) was a 5-ton van (Mercedes 508 D), that was able to carry the big sized computers and cameras of this time. In summer 1987, the VaMoRs drove autonomously —only with the help of cameras, without radar and GPS—20 km with a speed up to 96 km/h (60 mph). The technology was based on a spatiotemporal dynamic model called 4-D approach, which added to the three dimensions of space the category of time and integrated a feedback of prediction errors. It was only after this success, that the automotive industry (Daimler-Benz AG) became more seriously interested in the research of Dickmanns.

The concept of vision-based autonomous driving gained momentum with the EUREKA-PROgraMme for a European Traffic of Highest Efficiency and Unprecedented Safety (PROMETHEUS) of the European Union (1987–1994). At first, the industry had a preference for lateral guidance of cars using electromagnetic fields generated by cables in the road, as known since the 1930s. But the team of Dickmanns successfully convinced the industry to privilege the concept of machine vision that would allow the detection of obstacles and avoid additional costs in infrastructure [7]. Today, this can be seen as a significant paradigm shift in the history of the driverless car.

In the context of the PROMETHEUS-Project, the team of Dickmanns then developed with Mercedes Benz two S-Class (W 140) robotic vehicles: VaMP (UniBw Munich) and VITA-2 (DBAG) [8, 45, 47]. During the final event in October 1994 in France, the twin-robot vehicles drove more than 1000 km autonomously on three-lane highways around Paris, in the middle of heavy traffic and with speeds up to 130 km/h. The system

was based on real time evaluation of image sequences caught by four cameras. Steering, throttle and brakes were controlled automatically through computer commands. For "the first time, a machine vision system has been able to demonstrate its capability of deriving autonomously the decision for lane changing and passing" [9, p. 400]. This system was a major milestone for autonomous driving and a precursor of modern assistance systems such as Pre-Safe and Distronic Plus.

In 1995, members of the NavLab of the Carnegie Mellon University in the USA presented a partially autonomous vehicle that drove from Pittsburgh to San Diego ("No Hands across America"). They also used a vision-based approach: Steering was based on camera images of the road. But a human driver had to control brakes and acceleration. In reaction, the UniBwM decided to demonstrate the capability of its VaMP in a fully autonomous long distance run from Neubiberg near Munich to Odense in Denmark. The car drove 95 % (1.678 km) of the trajectory autonomously, with speeds up to 180 km/h [10, p. 287]. The automated longitudinal and lateral control of the car was based only on video image processing from the front hemisphere. In the following years, other projects continued to develop the visual approach: In the context of the ARGO-project, which followed after Prometheus, the University of Parma in Italy used 1998 a Lancia Thema to drive 2000 km in Italy only camera based.

The success of all these projects accelerated the shift from automatic lanes to autonomous vehicles.

3.17 Knight Rider and On-board Electronics

These technological developments also influenced cultural products. Cinema turned its back on the animistic demonization of driverless cars and began to take an interest in on-board electronics.

A speaking car by the name of KITT (Knight Industries Two Thousand) assumed the lead role in the television series *Knight Rider* (1982–1986). The black Pontiac Firebird Trans Am with the red strip of lights in the radiator grill could both be manually controlled (normal mode) and drive automatically (auto mode). The driving robot supported the ex-policeman Michael Knight in chasing down criminals.

KITT is thus Fully Automated with Extended Availability Through Driver (see Use Case Chap. 2). A part of its circuitry was developed at Stanford University, reported KITT, in an allusion to the development of the driverless Stanford Cart (Knight Rider, Season one, Episode Just my bill, 24:49).

Knight Rider updates the anthropomorphic dimensions of the *Herbie* series into the information society. The series is centered around dialog and communication between humans and machines. Michael Knight calls up KITT on his wristwatch (ComLink).[3]

[3] *Knight Rider* is said to have been inspired from a computer-aided vehicle in the series *B.J. and the Bear* (1979), Episode: *Cains Cruiser* [19, p. 1].

These images not only dream of autonomous driving, but also of a car we can talk with, a car that answers. Michael always calls KITT "pal." The machine is a partner to humans: Even in manual mode—with a gullwing steering wheel—it gives advice. Language functions smoothly as a human-machine interface here, in contrast to how it is portrayed as more problematic in films of the 1990s.

Knight Rider also negotiates the axis of the weird and wonderful we are familiar with from history. In recourse to the stock of images from 1970s horror films, KITT duels with his automobile nemesis KARR, a vehicle programmed for self-preservation.

But the potential to rebel against the driver also lurks in KITT, who does not normally act on its own accord. For one thing, it can overrule him in exceptional cases, for instance when his life is put in danger by his driving: "I cannot allow you to jeopardize your life. I am assuming control" (Knight Rider, Season one, Episode: *Trust Doesn't Rust*, 41:53). We see here that the HAL 9000 computer struggling for autonomy in Stanley Kubrick's film *2001: A Space Odyssey* (1968) serves as the model for the conception of KITT [19, p. 2].

For another, the possibility of a third party reprogramming the vehicle is addressed, which is then a threat to its owner. These variations on the loss of control also appear in the current debates surrounding hacker attacks on autonomous vehicles.

3.18 Autonomous Vehicles in Science Fiction Films

In 1990, autonomous vehicles in science fiction films embarked on a boom that would last fifteen years. In ambivalent dystopias, cinema showed how man appropriates the beautiful new world of automatic driving, or how he is driven from it.

In the conflict between humans and machines, the central question is: Who is in control? The possibility of manual override seen in *Knight Rider* is no longer present in some of these films. Getaway situations in particular became test cases for the degree of freedom of the automatic vehicle. Another matter addressed is how error-prone the human-machine interfaces are. It should be stressed that most films reflect research into autonomous driving here less than the development of active assistance systems. Three milestones are relevant at this point: Electronic Stability Program (ESP), which prevents a vehicle skidding, has been available since 1995; semi-automatic driving became possible with the introduction of Mercedes' Distronic system in 1998; and the Dutch manufacturer TomTom put the first mobile navigation device on the market in 2004. This latter development was of crucial importance in popularizing machine-aided driving, as the driver then began to get used to obeying directions given by a computer.

3.19 The Getaway Car's Demise in Fully Automated Vehicles with No Interface

In science fiction films, we see self-driving cars developed in two different ways. First, there is a totalitarian version, exhibiting fully autonomous vehicles without any manual interface.

Paul Verhoeven's film *Total Recall* (1990) gives the first depiction of the getaway-car crisis in automatic autos of the future. With his pursuers approaching in a manually driven car, the worker Douglas Quaid, played by Arnold Schwarzenegger, tries to escape in an automatic taxi (Johnny Cab). The android does not understand the order to step on it at once, however, and instead asks for an address (*Total Recall*, 00:34:00). As a human-machine interface, language is more of a hindrance than a help, as the driving robot cannot simulate the complexity of human communication. Only after ripping out the mechanical chauffeur from his mounting and controlling the vehicle himself with a joystick does Quaid succeed in getting away.

The surveillance utopia of Steven Spielberg's *Minority Report* (2002) paints a considerably more dystopian picture. Here there is no way out, even by vandalizing the automatic vehicle to take manual control. The film shows self-driving vehicles as an element of a *society of control* where crimes can be prevented before they happen. When a police officer is himself charged with committing murder in the future, he tries to escape in an automatic maglev (magnetic levitation) vehicle. But a female voice soon rings out: "Security lockdown enabled: Revised destination: Office." (Minority Report, 00:41:49). The car is automatically directed into the opposite lane and drives back to headquarters. The car has become fully automated (see Chap. 2), the authorities have special rights to take over the controls. The fugitive is as good as caught. The only option for him is to leave the car by jumping out of the window.

This sequence shows one of the essential reservations regarding autonomous driving. One of the cultural attractions of the car historically lay in the suggestion of an identity with a self. Here, the vehicle slips not only the control of this self, it becomes a real trap because it can be remotely controlled from outside. It thus represents exactly the opposite of the anthropologically dominant, unconscious desire for escape that the automobile historically promised to fulfill.

3.20 Selecting the Control Mode by Voice or the Touch of a Button

A second group of films shows a "more democratic" version of automatic driving—the driver can choose between automatic and manual control via a human-machine interface.

In Marco Brambilla's futuristic thriller *Demolition Man* (1993), autonomous driving is part of a perfect world with no dangers, in which swear words, meat, chocolate, corporeal sex, petrol and spicy food have been outlawed. The film shows a futuristic police car that

can be controlled both manually and automatically. At the spoken command "self-drive on!" the car answers with a female voice and the steering wheel unfolds (Demolition Man 12:42).

As in *Total Recall*, language's suitability as an interface is here deemed unreliable. The on-board computer signals a software error, and switching to self-drive mode is suddenly no longer possible. The car speeds into a bend and even screaming "brake!" cannot prevent the accident, as the vehicle has stopped responding (*Demolition Man*, 01:30:20). In this sequence, cinema reminds us how every new technology brings with it new types of accidents.

Two further films stress that we can only escape if the autonomous vehicle can be switched to manual control. Luc Besson's *The Fifth Element* (1997) tells the story of taxi driver Korben Dallas (Bruce Willis), who lives in a fully automated apartment and has a flying taxicab. As in many films, automation is here equated with total surveillance.

At the same time, the film portrays physically pressing buttons as guaranteeing a last modicum of freedom. In order to evade a police check, Dallas deactivates his taxi's automatic mode (*The Fifth Element*, 34:20). He does this by pressing a button, not by voice command.

The whole setting of Alex Proyas' film *I, Robot* (2004) is predicated on ambivalence towards the weirdness and wonder of modern machines. Commissioner Spooner (Will Smith) has a fully automated Audi RSQ that can also be manually controlled. The steering wheel, open on top with joysticks on the side, is extendable like that in the Firebird II. It is button-activated.

Although the vehicle is driving through a tunnel at high speed, Spooner suddenly decides to take the controls himself (Fig. 9). "Manual driving," confirms the car with a female voice (*I, Robot* 21:23). His passenger, appalled, asks if he really wants to drive manually. Shortly afterwards they almost have an accident. At high speed, then, automatic control is safer than manual. What is meant by safety, however, depends on the context. In order to be able to reach safety in the face of attackers, the car must be driven manually (*I, Robot*, 50:46). Again we can find the contradiction between autonomous driving and the getaway car.

I, Robot is the most recent film to date depicting autonomous driving. This may be seen in the context of the US military's robot races, which started in the same year. With the aim of having one third of American military vehicles drive autonomously in future, the Defense Advanced Research Projects Agency (DARPA) held the first *Grand Challenge* in 2004, a desert race of autonomous vehicles. A VW Touareg named Stanley emerged as the winner of the second race in 2005. It had been developed at the Artificial Intelligence Laboratory at Stanford University under the supervision of Sebastian Thrun, who established the well-known fleet of autonomous vehicles at Google in 2008.

The driverless car had thus arrived in reality. For a long time, research inspired film; now it appears to be the other way around. Film serves as a reference for research teams: one of the participants in the 2007 *Urban Challenge* was a vehicle from the Team University of Central Florida that went by the name *Knight Rider*.

3.21 Why Remote Control is Less Scary?

We finish near where we started, with remote control, which is portrayed in film as the least problematic solution. *Batman* (1989) summons his vehicle via a radio device (*Batman* 01:08:55), James Bond controls his car in *Tomorrow Never Dies* (1997) via a touchpad on an early smartphone (*Tomorrow Never Dies*, 51:24, 57:26).

Neither car is really driverless, the driver is merely outside the vehicle. The driver workspace is delocalized, but control is not fully handed over to the machine. For this reason, both cars are good as getaway vehicles. To be driven by a car is evidently incompatible with the status of a superhero. Physical contact with a material object to control—here the remote control—guarantees that the driver-subject's bargaining power is preserved.

3.22 Outlook

This look into automatic driving's pictorial and technological history has shown that innovations in technology and iconographic imagery have evolved in mutual interplay. Technological prototypes, literary metaphors and pictorial imaginings spark off each other, but never evolve in step.

Remote control technology brought the first remote-controlled car onto the streets. The first truly autonomous vehicle emerged, however, in the literary imagination. From 1935–1955, the history of images is one step ahead of that of technology, and stimulates with its utopian highway panoramas. At the end of the 1960s, a strand of film history evolves that is relatively autonomous of technological development, but which then, from the 1980s onwards, directly comments on the increased use of electronics in driving. From 2005 on, autonomous driving appears to become cinematically unattractive as it approaches the threshold of the present.

For the entire time, the cultural logic of the self-driving automobile develops in the space between the weird and the wonderful.

We are concluding—to venture an overview—by returning to the opposition between driver-controlled and self-driving vehicles. The transition from a culture centered on driving ourselves around, to one of allowing ourselves to be driven, represents a huge challenge. How does *Sheer Driving Pleasure* (BMW) turn into the pleasure of *Being Driven*?

The automobile's automation is not comparable with the automation of other objects from twentieth century industrial culture. One important effect of automation is relieving physically strenuous activities (escalators, elevators, washing machines). Even if these technical transformations required a shift in perception, the logic of the activity affected was not diametrically reversed.

Steering a car, on the other hand, is not only a laborious, boring, tiring and dangerous activity. Driving is also fun. It is precisely its risk and danger that has been driving's central appeal for drivers old and new. The transition to driverless automobiles therefore represents a cultural leap; it practically necessitates a reinvention of the car. It is worth remembering that, etymologically and historically, the term *automobile* combines the Greek *autos* (self) and the Latin *mobilis* (moveable). To be auto-mobile therefore means to be able to move oneself, to be self-mobile. Whether self here means that of the driver, or the car's, thus essentially remains an open question. It may therefore be said with some justice that the auto only truly becomes automobile with the advent of autonomous driving.

3.22.1 Is Siri Paving the Way for Iris?

The success of future autonomous vehicles depends on a key element: the human-machine interface. Around the turn of the century, cinema assessed linguistic communication between man and machine with some skepticism. Acoustic exchanges were portrayed as more prone to breaking down and more open for ambiguities than haptic contact.

Disposing of the steering wheel continues to be a taboo. It may be the case, however, that SIRI, the speech recognition software introduced into smartphones in 2011, is paving the way for linguistic interfaces in cars. A recently published study [49] made it clear that autonomous vehicles are met with greater trust if they are given a name, voice and gender. The car was given the name IRIS and a female voice that told the user how the vehicle worked.

On the one hand, driverless cars break with all the historical rituals associated with control; on the other, they are practically predestined to render automobiles ever-more anthropomorphized. Today, we already treat our cars as living beings, and find nothing strange about it, to paraphrase Sigmund Freud's remarks on children playing with dolls [12]. This bringing-to-life need not play out only in the weirdness of cinema, then, but may also be compatible with the wonderful. A tamed yet brought-to-life car could even reclaim something of the fairy tale [3] that the automobile lost in the course of mass motorization.

Filmography

The Safest Place	(1935)	Prod.: Jam Handy
Magic Highway U.S.A.	(1958)	R.: Ward Kimball
Key to the Future	(1956)	R.: Michael Kidd
The Love Bug	(1968)	R.: Robert Stevenson
The Car	(1977)	R.: Elliot Silverstein
Ein Käfer auf Extratour	(1973)	R.: Rudolf Zehetgruber
Duell	(1971)	R.: Steven Spielberg
Knight Rider	(1982–1986)	Prod.: Glen A. Larson
Christine	(1983)	R.: John Carpenter
Batman	(1989)	R.: Tim Burton
Total Recall	(1990)	R.: Paul Verhoeven
Demolition Man	(1993)	R.: Marco Brambilla
Tomorrow never dies	(1997)	R.: Roger Spottiswoode
Das fünfte Element	(1997)	R.: Luc Besson
The 6th Day	(2000)	R.: Roger Spottiswoode
Minority Report	(2002)	R.: Steven Spielberg
I, Robot	(2004)	R.: Alex Proyas

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