Driving the Dream

The History and Motivations Behind 60 Years of Automated Highway Systems in America

Jameson M. Wetmore
Consortium for Science, Policy & Outcomes
Arizona State University

Automotive History Review, Summer 2003, pp. 4-19

Figure 1 – Photo taken from the backseat of a California PATH designed automated vehicle while taking part in a platooning exercise at Demo ’97 in San Diego.

Pick up any automobile enthusiast magazine today and there will inevitably be an article about the newest convertible or sports coupe that describes the thrill and pleasure of driving. The authors in publications such as *Car and Driver* and *Motor Trend* scorn the very idea that the car might simply be a mechanism to get from here to there. And while they occasionally appreciate driving aids such as traction control, they often decry vehicles available only with an

"automatic" transmission. They much prefer the control and connection to the car that a manual transmission and clutch provides. They preach to their millions of readers that happiness is driving a car along windy mountain roads with the wind blowing through your hair as you shift at the right times, brake at the right times, and hit each apex with precision.

But this love of driving is not the only form of automobile enthusiasm. While there are few magazines or fan clubs dedicated to the subject, there have been a group of enthusiasts who have argued that the best automobile is one that would require no driver whatsoever. These enthusiasts advocate the implementation of what is today known as an "automated highway system" or AHS.[1] Although it has been given generic names like "automatic control highways" and brand names like "autoglide," the basic goal has been the same—create a technology that links highways and vehicles to allow for hands-off, feet-off "driving." Since as early as the 1930s, thousands of automobile engineers, vehicle component manufacturers, government officials, individual inventors, and even the readers of popular technology magazines have envisioned the creation of an automated highway system. To achieve this goal, they have planned, designed, researched, developed, funded, and dreamed about the idea of automobiles that drive themselves.

This article is an attempt to better understand the enthusiasm for automated highways. It is somewhat different from a traditional automotive history in that it does not chronicle the success of an automobile, significant individual, or company, and illustrate how they contributed to the joy of driving. Rather, it will examine the continued failure of an idea that would eliminate drivers altogether. But just as automobile success stories have been fueled by dedicated individuals, the idea of automated highway systems has been kept alive by a handful of engineers, civil servants, and others who have pursued their vision for over 60 years. I argue that

although automated highways have not yet been built for public travel, the continued enthusiasm for them is worthy of historical exploration and explanation.

If one took at face value the predictions made by automobile companies, the government, and individual engineers and inventors over the years, one would be led to question why we do not yet have a working AHS. An examination of the difficulties encountered by these groups in the development of automated highways, however, would cause one to ask a very different question: Why has enthusiasm for AHS been so prevalent?

I will address these questions in three separate parts. First, I will sketch some of the historical highlights of automated highways to show how the technology has evolved over the past 60 years. Second, to better understand why the American public does not drive automated vehicles today, I will examine the long list of difficulties that those espousing the technology have encountered. Finally, I will contrast these "failures" with the various reasons why the idea of automated vehicles has had such a powerful effect on people for so many years. Simply put, this essay will attempt to explain the drive behind the dream.[2]

AHS: A 60-Year History

Americans were first formally introduced to the idea of automated highways right off of "Horse and Buggy Lane" at General Motors' Futurama exhibit at the 1939 New York World's Fair. The Futurama was designed to be "a thought provoking exhibit of the developments ahead of us… to help us get a glimpse into the future of this unfinished world of ours."[3] In the exhibit, visitors were carried in three-seat cars around dioramas of what the world was supposed to look like in 1960. The ride took people past an amusement park; multi-modal transportation centers that bring together automobiles, trains, and airplanes; multiple lane super-highways; and a

"modern farm [where] hours of work have been shortened, with almost universal electrification of rural areas."[4] In this future world where technology had solved most of the world's problems and helped to ensure "abundant sunshine, fresh air, fine green parkways—all the result of thoughtful planning and design," automobiles were designed to steer and propel themselves, leaving the public free to enjoy a fast and relaxing ride.[5]

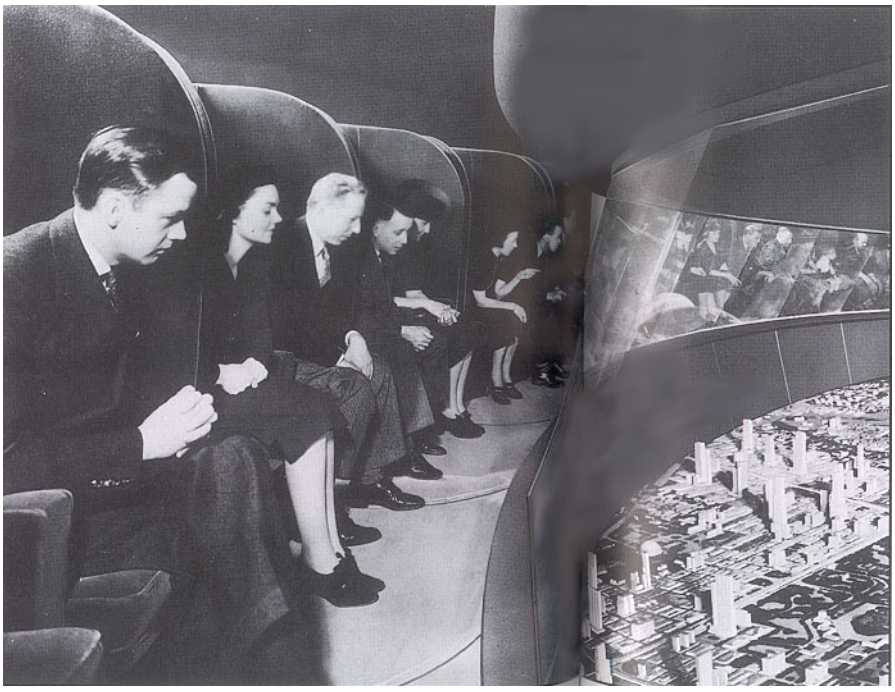

Figure 2 – Visitors in moving seats look down on GM's vision of the future in its Futurama display.

Although computer chips and even transistors were years away at the time, the vision presented at the '39 World's Fair was detailed enough to address the type of technologies that could be used. Every automated highway system must control the vehicle in at least two distinct ways. It must monitor and adjust its lateral movement to keep the car in its lane, and it must maintain a proper headway so that the car does not crash into the vehicle in front of it. GM's '39 exhibit explained that a safety distance between cars would be maintained through a

sophisticated system of radio control (presumably using vacuum tubes). The car's lateral position was stabilized through a little less sophisticated mechanism. Barriers were built between the lanes of the road that curved upward steeply to the height of about three or four feet in much the same manner as a modern day skateboarding "half pipe." If the car began to veer out of the center of the lane, its wheels would begin to climb this barrier. The hope was that the car's inclination to climb the wall would be countered by gravity, and the vehicle would gently "fall" back into the center of the lane.

Little evidence exists that this particular approach was ever developed beyond the simulated model stage. But it does demonstrate that the basic idea of an automated highway was being discussed and was even being sold to the public as early as the late 1930s. Over time, the technologies that have been built into the dreams of automated highway systems have changed, but the ultimate goal has remained the same.

Figure 3 – Two children and a rabbit celebrate an Easter holiday amid the vast limited-access

highways and high-speed on- and off-ramps presented in the 1939 Futurama.

Automated Vehicles in the 1950s and 1960s

Although the 1939 Futurama predicted a working system by 1960, General Motors engineers did not put serious research into an automated highway project until the mid-1950s. If they had originally planned to look further into the idea, such efforts were interrupted by World War II, which was escalating even before the Futurama exhibit had been dismantled. During the 1940s, the major automobile manufacturers turned to producing a variety of equipment for military use rather than develop new civilian technologies.

But even though the idea was put on the back burner for a decade or so, advances made during the war and soon after, like radar and new electronic technologies, would help give automated highway programs a new life. These new technologies were first applied to automated vehicle control in the early 1950s, when General Motors teamed up with the Radio Corporation of America (RCA). By 1953, GM and RCA had developed a scale model automated highway system, which allowed them to begin experimenting with how electronics could be used to steer and maintain proper following distance.[6]

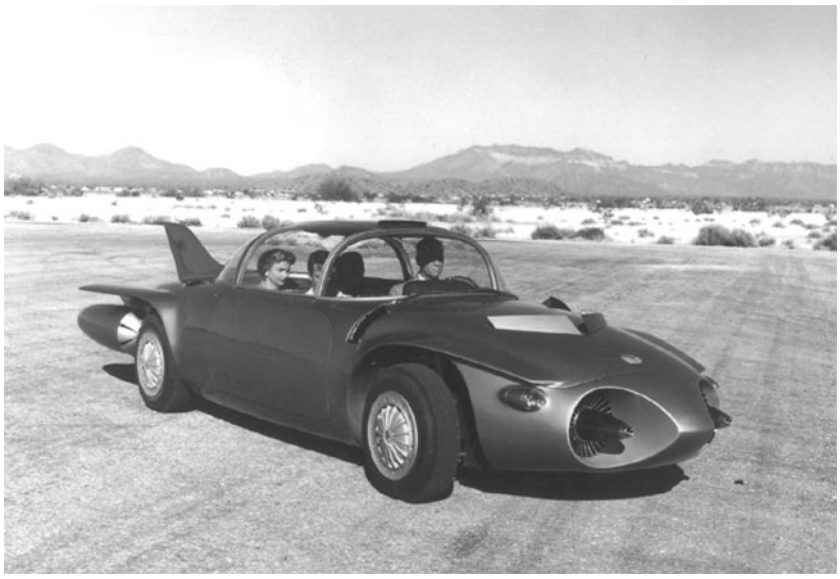

Figure 4 – The Firebird II was promoted as a vehicle that would communicate with control towers to receive traffic and safety information.

Soon after, GM developed a series of concept cars known as the Firebirds. These dramatically styled vehicles served as both running test-beds and promotional vehicles for the idea of automated driving. In 1956, General Motors demonstrated the Firebird II at its Motorama, a traveling show created to introduce the public to GM products and ideas. In actuality, the Firebird II had no automated capabilities whatsoever. Its highlight was the gas-turbine engine that powered it. But in films shown at the Motorama, it was supposedly "under the direction of an 'electronic brain' on a dream highway of the future."[7] The concept was that Firebird II would be electronically controlled by traffic control towers placed at various spots along major highways.

Within two years, General Motors had moved from mockups to full-scale technologies that could spark the interest of the public not only through conceptual ideas, but also demonstrations. A group of engineers led by Joseph Bidwell, head of the GM Research Engineering Mechanics Department, and overseen by Lawrence Hafstad, Vice President in charge of GM Research installed a pair of "pick-up coils" on the front of a 1958 Chevrolet. These coils could sense the alternating current of a wire embedded in the road and would adjust the steering wheel accordingly. On Friday, February 14, 1958, a GM press release proudly announced:

> An automatically guided automobile cruised along a one-mile check road at General Motors Technical Center today, steered by an electric cable beneath the concrete surface. It was the first demonstration of its kind with a full-size passenger car, indicating the possibility of a built-in guidance system for tomorrow's highways…. The car rolled along the two-lane check road and negotiated the banked turn-around loops at either end without the driver's hands on the steering wheel.[8]

To emphasize the fact that no driver was required, one of these vehicles was even built without a steering wheel.

Figure 5 – GM/RCA demonstration of a convertible Chevrolet Impala navigating a road course without driver or steering wheel.

Although this demonstration was considered a successful technical test, GM executives wanted to present this new technology to the public in something a little less mundane than a ’58 Chevy, so it created the third car in the Firebird series. Firebird III had a gas-turbine engine like the previous model, but it also sported a new electronic control system called “unicontrol.” Instead of using several input technologies to pilot the vehicle, like the steering wheel and brake and accelerator pedals, unicontrol united all of these input systems into a single joystick. A driver could simply wrap his or her hand around it and, “Move it forward to accelerate, back to brake, right or left to steer, twist it back up to park.”[9] According to the engineers involved, it was this development of centralized control through hydraulic and servomechanisms that made possible the “Autoguide” automated driving system they were developing.[10] By placing all directional instructions into a single instrument, GM engineers could progress beyond “steering only” systems.

Figure 6 – The 1958 Chevrolet Impala with "Unicontrol."

While General Motors was developing new vehicle systems, others were developing road and centralized control systems. Most notable was television pioneer Dr. Vladimir Zworykin from RCA who had been working on a road system for several years.[11] Zworykin had devised a system based on railroad block signals that used circuits buried in the road to magnetically sense a vehicle's speed and location. Based on this information, a central "computer" could send back instructions to the vehicle to ensure safe passage and avoidance of accidents. In 1960 such a system was demonstrated in 1/40th model form at the Highway Research Board's (now the Transportation Research Board) Annual Meeting in Washington D.C.[12] The model was able to detect if a car or object was blocking a lane and automatically stopped the cars short of the obstacle to avoid an accident.[13]

Throughout the late 1950s and early 1960s, General Motors focused on presenting concept vehicles to the public, until 1964 when a *new* New York World's Fair was held. GM took this second Fair as an opportunity not to just display cars, but also to present an updated vision of the future in Futurama II. Created with the same goals in mind as the first, the second Futurama gave a peek into the future at the height of the excitement over nuclear power. In its dioramas, everything from a five-story tall road-building vehicle that cuts through the "green hell" of the South American rainforests to Antarctic submarine trains ran on nuclear power.[14] There were no nuclear powered automobiles, but General Motors did present an automated highway concept. A magazine article from the period described the display as quite similar to the AHS envisioned by Zworykin: "A revolutionary 'Autoline' expands the capacity of a three-lane expressway: Electronically, a control-tower operator steers, brakes and sets the speed of each car in an automatic lane; groups of cars move at equal intervals as a group."[15]

Figure 7 – A presentation of Firebirds I, II, and III shown at a demonstration area in the Arizona desert.

This presentation sparked public interest for a few years, but with the passing of the '64 World's Fair, AHS research and development sagged. According to one engineer involved, "there was sort of a hiatus as we came to limitations in terms of the technology that was available when measured against the economic feasibility."[16] Although technological progress (or lack thereof) may have been a part of the lack of enthusiasm, the industry was also being distracted by several new concerns. Beginning in the late 1960s, the federal government began passing a series of safety standards, and by the early 1970s, it was also putting in place new fuel consumption and emissions standards. These new mandates led to rising costs and there was impetus to focus much of the research and development efforts on near-term solutions to meet these new demands. Automated highways were again put on the backburner for about a decade.

Recent Developments

In the early 1980s, a handful of General Motors engineers revisited automated highway systems. This time, however, there was little fanfare and the public was not presented with a futuristically styled vehicle. They simply produced a paper report for the Federal Highway Administration

that explored the possibilities, challenges, ramifications, and potential benefits of an AHS system.

Although it was not coupled to a radically styled show car, this 1981 report did not disappear silently. The GM report and reports like it provided inspiration to a group of public and private transportation engineers who were under more and more pressure to fix the problems of the nation's highways. Although they did not foresee a completely automated system in the near future, this disparate group envisaged applying new advances in technologies—such as computers, radar, and telecommunications—to automobiles and highway infrastructures to alleviate congestion and potential dangers. In 1986 they formed an initiative known as "Mobility 2000." After lobbying and obtaining the U.S. Department of Transportation's backing, these transportation officials and engineers convinced Congress to insert a special section in the 1991 Intermodal Surface Transportation Efficiency Act (ISTEA). The section called on the Secretary of Transportation to "develop, submit to Congress, and commence implementation of a plan for the intelligent vehicle-highway systems program" (or IVHS).[17]

In response to this order, the U.S. Department of Transportation (DOT) helped form IVHS America, an organization that changed its name a few years later to ITS America because the label "Intelligent Transportation Systems" was more inclusive than "Intelligent Vehicle-Highway Systems." Since the early 1990s, this organization's mission has been to "foster public/private partnerships that will increase the safety and efficiency of surface transportation through the accelerated development and deployment of advanced transportation systems."[18] Using conferences, committees, publications, and a web site, ITS America has promoted a number of technologies that link highways with electronics and communications technologies.

Although ITS America occasionally mentions automated highway systems in its literature

and broad predictions for the future, much of its efforts have focused on “nearer term” technologies. Rather than attempt to overhaul the entire system of automobiles and highways, ITS America promotes technologies such as electronic toll collectors, driver information systems, and traffic management systems. But the establishment of this organization did not completely satisfy the Congressional directive given to DOT. There was also a small section of ISTEA that had large implications for automated highway system research. In 1991, Congress also called upon the Secretary of Transportation to:

> Develop an automated highway and vehicle prototype from which future fully automated intelligent vehicle-highway systems can be developed. Such development shall include research in human factors to ensure the success of the man-machine relationship. The goal of this program is to have the first fully automated roadway or an automated test track in operation by 1997.[19]

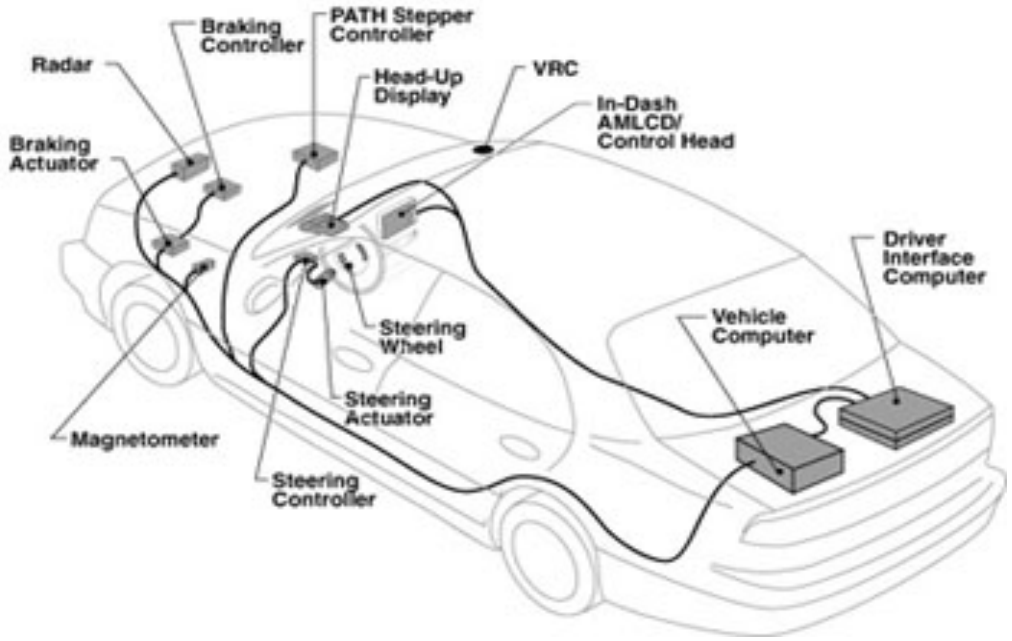

Figure 6 –A generic AHS vehicle architecture presented as a schematic drawing by the NAHSC in 1997.

DOT cautiously responded to this directive in 1993 by granting a contract to Honeywell Aerospace to study the one question given specific emphasis in the legislation, human factors. Later that year, DOT began a series of 15 “Precursor Systems Analyses” to determine the

feasibility of the automated highway system idea. But DOT still had to deal with the call for a "fully automated roadway… or test track" by 1997. Therefore, before it had even seen the results of a single precursor study, DOT issued a request for applications for a consortium to research AHS and perform a demonstration by 1997. Ford Motor Company applied, but a group of nine companies led by General Motors won the contract and the National Automated Highway System Consortium (NAHSC, or Consortium) was formed.

By 1997, the Consortium had gathered over 120 associate participants, reviewed various AHS concepts, and put together a demonstration to show the world what could be done with automated highway systems. "Demo '97," as it was called, brought together motor vehicle companies and universities from across the world to showcase cars that could relieve the driver of most or all tasks. The demonstration was focused on a seven-mile stretch of Interstate-15, just north of San Diego. Magnets buried in the road, magnetic tape on the surface of the road, and all sorts of optical recognition systems and radar devices, guided a fleet of over twenty different vehicles in an effort to show the progress made on applying AHS ideas to interstate highway travel. Companies like Delco Electronics argued that they had finally created "an integrated vehicle control system that is helping move automated highways from science fiction to reality."[20]

The Difficulties of Implementation

For the last 60 years, Americans have been told that AHS was right around the corner. Before people even had a chance to be skeptical in the 1939 Futurama, the voice guiding them through the future argued, "Does it seem strange? Unbelievable? Remember, this is the world of 1960."[21] In 1958, *Business Week* magazine noted that, "Some knowledgeable auto men

predict we'll have… complete electronic control 15 or 20 years from now."[22] Although the NAHSC was hesitant to publish official figures, many of those involved in the program in 1997 estimated it would be 20 to 30 years until there is a substantial automated highway network. Automated highways have been "only 20 years away" for over 60 years.

The primary reason for this delay is that regardless of the fanfare surrounding displays like Demo '97 and GM's Futuramas, AHS has never been as simple to implement as various press releases and government officials have made it seem. Every AHS development project has encountered more than a handful of difficulties. And despite the fact that the technology of 2001 is significantly different from what automotive engineers had to work with in 1939, the difficulties of implementation have remained remarkably similar. A brief explanation of some of these recurring problems will help to show why automated highway systems are so difficult to construct.[23]

The Traditional Concern of Cost Effectiveness

As with many new technologies, one of the concerns about implementing AHS has been the cost involved. For the most part, the cost of changing the roadway has not been seen as a problem. For instance, in 1960 RCA argued that installing the necessary equipment would run about $100,000 per mile, or about 10 percent the total cost of building the road itself. Current estimates sit at the low price of $10,000, largely because the recent plans call for most of the sophisticated technology to be installed in the vehicles. The extra money AHS would add to the price of a car, however, has usually been seen as more significant. 1960 RCA estimates ranged from $100 to $1,000. Current estimates hover between $1,000 and $2,000.[24] Such costs are significant in terms of the total price of a new car and could make it difficult to sell the technology to the public. [25]

But in actuality, the cost problem is rather insignificant. There are examples throughout the history of technology where expanding markets and new production processes have solved the problem of cost. What are more important for the future of AHS are the problems that are specific to AHS technology.

Computer Concerns

Computing systems have been a central part of AHS plans since at least the 1950s and as such, much work has gone into making them as fool-proof as possible. But, even though the development of new computing systems have alleviated some problems, additional problems have developed. In fact, new understandings of computers have uncovered many difficulties never before conceived.

During the early development of automated highways, it was felt that a major difficulty of implementation would be the reliability of the computing hardware. Especially in the 1950s and ‘60s when automated cars were controlled by stacks of vacuum tubes and fragile transistors, simply keeping the components in one piece was a key concern. A bad bump could jar a vacuum tube and shatter its glass bulb. A small mistake like that at 60 miles-per-hour could be deadly.

Most of the basic hardware reliability problems have been alleviated with the evolution of the silicon chip, but new computer concerns have taken their place. A question that has been increasingly asked is whether or not a computer can be programmed to handle every situation a vehicle might encounter. For vehicles with optical recognition systems, this has been seen as especially difficult. Passing through the shadows cast by overpasses can confuse the computer and result in the car veering off the road.[26]

Cars that bypass this difficulty by getting their lateral guidance data directly from systems embedded in the roads run into other problems. Implementing this set-up often requires

that computers in the car communicate with computers in other cars and/or the road. The stumbling block here lies in the fact that computers do not always "speak the same language." Should one small bit of information be misread, the results could be deadly. When computers are produced by different people at different times and with different programs, it is difficult to say how well an AHS system would be able to integrate everything without problems. Many of those involved are concerned about whether computer systems can be designed to safely deal with an uncertain environment made up of both foreign scenarios and computers.

Dealing with a Reckless Public

Another important cause for concern has been problems in the area of "human factors." In fact, the ISTEA legislation singled it out as being perhaps the biggest hurdle to clear. The anxiety arises from questions about how people will interact with automated vehicles, especially considering that how people interact with normal motor vehicles is not very well understood. Because engineers cannot directly design the driver, unknown and perhaps dangerous variables can be introduced into the driving environment. Efforts have been made to solve this problem. For instance, the federal government has funded the creation of enormous simulators to try and determine what exactly goes on in the driver's seat.[27] But many questions still remain.

With automated highways, many of the problems resulting from human factors are multiplied because it is difficult to strike a balance between computer and human control. There are many reasons why human drivers should be given some control of automated vehicles. For instance, a human driver would be useful as a backup in case of computer failure; to navigate rural areas or local roads that cannot cost-effectively be equipped with automatic controls; and even just to park in one's own driveway. Situations like these give rise to many questions. If non-automated vehicles are allowed to drive alongside automated vehicles, how can reckless

drivers be mitigated? If automated interstates are the first form of AHS built, and vehicles must transition from automatic to "manual" lanes, how exactly will a person handle the shift from relaxing or sleeping to being in control of a 3,000 pound automobile traveling 60 miles per hour? If an override button exists, what happens if an impatient driver grabs the controls and slams on the accelerator? Again, the concern about human factors is not new. A 1958 article on the Firebird III noted that one "factor that will retard the total victory of electronics is the familiar, 'nut that holds the wheel.'"[28]

Institutional Conservatism

One problem that has surprisingly received a lot of attention is the difficulty of changing large American institutions. The engineers and officials that oversee the U.S. transportation system were trained in a specific way of thinking and it is difficult to adjust their viewpoint. Building, running, and maintaining a nationwide AHS would require an enormous number of people who understand the complexities of electronics, computers, and vehicle/road interfaces. Most of the current government highway engineers come from a strict civil engineering background and are not terribly excited about introducing new technologies they do not understand.

These problems were recognized at least as early as 40 years ago. A magazine article from 1958 noted that when General Motors proposed its "Autoguide" external control system, "Highway officials screamed at the idea that their new superhighways might be torn up for such cables."[29] The fact that every state, every county, and every city has its own set of engineers and administrators does not make the job any easier. In addition to the need for highway engineers to understand electronics and vehicle dynamics, the producers of the vehicles themselves have to understand the basics of civil engineering and road management in order to design the vehicles

properly. Major organizational change like these come slowly and only when absolutely necessary.

Discouraging Examples

Despite all of these technical and institutional reasons for why it is difficult to build automated highway systems, a few isolated systems have been built. But although engineers have succeeded in developing and assembling these localized systems, the experiences tend to make one less optimistic about public systems rather than more.

Demo ’97 in San Diego, for instance, showed that automated highways could be made to work in very controlled circumstances. But, each demonstration was composed of carefully built vehicles that were specifically prepared for a single seven-mile stretch of road that was carefully inspected between every run. The amount of controls that were established was staggering. Most drivers were specially trained test drivers from the U.S. Army, each driver had a button physically attached to his or her hand to deactivate the system should anything go wrong, and all operations were halted if there was inclement weather. Despite all of this, there were still occasional failures. More than once the “disengage” buttons were used. After the demonstration was over, many transportation experts were curious as to what had actually been proven about the feasibility of a public system.[30]

Those involved in the one automated highway system that is up and running and used almost daily paint an even bleaker picture. Chrysler Motors has developed an Automated Durability Road at its Chelsea, Michigan, Proving Grounds. Engineers at this proving ground use this automated vehicle-highway system in order to test the suspension and durability of new suspensions over bumpy roads without sending drivers to daily chiropractic visits. Chrysler installs coils on the front end and robotic control systems inside test vehicles. These vehicles are

then controlled from a central tower around a road embedded with a wire in a system fairly similar to the GM proposals of the early 1960s.

Despite triple redundancy to shut down the system if there is a problem, they have had several "run-offs." One vehicle went over a berm and into the parking lot, crashing into several trucks. The company is still not completely sure why.[31] The automated testing road is still used because the cost of a few trucks is cheaper than the cost of broken backs. It does not, however, make those involved optimistic about the future of automated highway systems. Even this strictly controlled system that has been used for several years on a regular basis has not been made completely foolproof.

The Environment

Should all of these socio-technological difficulties are eventually solved, however, some still argue that AHS would remain bogged down with problems because of the negative consequences it would have. A large part of this criticism has been directed at the potential environmental effects of AHS, which is somewhat ironic because for many years, automated highways were hailed as a solution to several environmental problems. It had been argued that if automated vehicles increased the efficiency of a given set of highway lanes, it could reduce the amount of land changed into highways each year and "the natural" environment could be preserved. In addition, smoothly flowing traffic would save fuel and reduce emissions thanks to the elimination of traffic jams. Recently however, many have argued that the likelihood of such promises coming true is rather suspect.

Hank Dittmar, Director of DOT's Surface Transportation Policy Project, argued in 1997 that:

> recent models indicate that traffic flow improvements [which could be made possible by AHS] actually worsen emissions of another pollutant, NOX. In

> addition research indicates that most of the traffic flow improvements from added capacity are short term, as added capacity is soon filled by induced travel as motorists change routes, alter timing of their trips and make new trips.[32]

Should automated highway systems actually be built, they could very likely result in a large increase in both the vehicle miles traveled and the accompanying fuel consumption and emissions. This is a scenario that many environmentalists dread, and it is a possibility they are working against.

There are also critics who claim that automated highways would not create the free-flowing highways that have been promised. It is commonly argued that an automated highway can carry two to three times the current capacity of a given stretch of highway. But if automated highways feed into smaller manual lanes, backups are likely to occur. For instance, if an AHS is built into a busy downtown area, and many previously hesitant drivers take advantage of the new form of transportation, where will all of these cars go? Parking lots in most cities are already full to capacity. Adjoining roads are crowded as well. If an AHS must depend on existing manual roads, exits, and parking lots, many of its benefits are lost.

Many AHS critics argue that in order to evaluate the benefits of an automated highway system, one must look at the big picture. One must understand not only the individual technological components, but also the organizational difficulties, the interaction of complex systems, and the human sphere in which these technological artifacts would need to perform. In the end, they argue that the problem does not lie in any single technology that can be the focus of extensive engineering efforts. Even though GM built a car that could follow a wire in 1958, integrating everything into an enormous workable system is a systems problem that is rather baffling.

After examining all of these difficulties—the seemingly insurmountable technical

problems, new environmental concerns, and the complexity of establishing large systems—the fact that we do not yet have automated highways does not seem so puzzling. Instead, the fact that begs for an explanation is why the idea of automated highways has been so powerful for so long.

What Drives the Dream?

The answer to the question of why the dream of automated highway systems has been so persistent over the last sixty years is difficult to pin down. There are likely as many reasons as there have been engineers, politicians, government officials, and industry advocates involved. But while it may be impossible to cover all of them, there are a handful of factors that stand out as especially important in the history of AHS. Like the difficulties encountered by AHS promoters, the roots of the enthusiasm for automated highways have been surprisingly similar throughout its 60-year history.

A New Type of Personal Mobility

Perhaps the most basic of all, and the one to which most people can relate, starts with America's fascination with the automobile. Personal mobility, and all of the things that are wrapped up in it, has had an enormous impact on the culture of this country. People demand to go where they want, when they want. While schedules regulate buses and trains, the automobile gives people the freedom they have come to expect.

But the automobile in its present form has some drawbacks. Certainly driving can be quite enjoyable at times. The fascination with the Sunday drive has a history as long as the automobile. But at other times, the fact that the driver must stay in control of the car at all times can make life difficult. Some may argue that there is nothing better than a summer drive in a

convertible, but more than a few believe the daily commute to be one of the worst parts of their day. Others enjoy taking their cars on vacation so that they have easy mobility once they get to their destination, but dread the multiple hour trips it takes to get there.

Automated highways could potentially solve these nagging problems. Tired of twenty-hour drives to Florida that take two days? Set your course for an automated highway and read stories to your kids while you enjoy the scenery. Frustrated with the morning commute? Pull onto an automated highway and spend your extra time getting another 30 minutes of sleep or enjoying a more leisurely breakfast. A souvenir pamphlet from the 1964 Futurama described this motivation well as it took visitors past a diorama of an automated highway:

> We move smoothly beside the highway, which is acquiring new lanes and picking up considerably more traffic as we approach the City. But despite the traffic volume, there doesn't appear to be any confusion or delays. There's a good reason for this free flow; it's the automatic highway that man is using here. How smoothly and effortlessly cars move on and off this road of tomorrow. We envy the drivers in the automatic lanes as we watch them relax and read, or talk with passengers, while their cars move along swiftly, safely and surely.[33]

Figure 9 – A recent depiction of what traveling in an automated vehicle might be like.

Automated highway systems would combine the best of both worlds: personal mobility and the ability to relax. This has perhaps been the major driving force behind automated highway systems since the beginning. What the driver/passenger should do with this free time is about the only thing that evolves. In a GM film from the early 1960s called *Easy Street*, a male driver leans back and lights a cigarette.[34] In some of today's promotional material, a woman turns to the passenger's seat where she has a laptop computer and phone to conduct business.[35] Regardless of what one does with their extra time, many believe that the added comforts and conveniences that could come with automated highway systems would be the ultimate realization of the automobile.

Creating Visions of the Future

In many ways, automobile companies like General Motors were quick to pick up on the advantages and disadvantages of the automobile and in the early part of this century. At the time, they were not certain that the automobile would remain a dominant form of transportation forever. Playing up the AHS idea gave themselves, and the general public, the hope that the automobile would continually progress and become an ever better way to travel. In justifying the work on Firebird III, for instance, Dr. Hafstad argued, "If others are not to wrest away Detroit's primacy in providing personal transportation, the auto industry must get down to basic research."[36] Automobile manufacturers promoted the AHS idea to get people excited about both the future of automobile travel.

To share/promote its idea of the future, General Motors hired Norman Bel Geddes, an industrial designer as the primary contractor for its 1939 Futurama. Bel Geddes argued that: "One of the best ways to make a solution understandable to everybody is to make it visual, to

dramatize it…. [U]ntil mass opinion is crystallized, brought into focus, and made articulate, it amounts to nothing but vague grumbling."[37] In constructing the two Futuramas and countless other displays, GM shared its vision of the future in moving, three-dimensional forms and went a long way in crystallizing positive public opinion for the automobile and its future.

Such an approach was not uncommon. The Futuramas are some of the best known examples, but throughout the century and a half history of world's fairs, companies and even countries have used the idea of the future to both construct the present and shape the future. Mitchell Wolfson, Jr., a world's fair scholar, describes the process in the following way:

> World's fairs are the very soul of propaganda in its most constructive form. Their persuasiveness is evident in their lasting effects upon history and our daily lives. All the elements of human activity are incorporated in a fair's structuring, organization and presentation. By coordinating these elements of human endeavor, man is able to review his immediate past, reflect on what is being summed up, and move forward into new areas, secure in knowing that the past has been absorbed…. And though world's fairs are generalizations, they serve mankind as monumental beacons, showering light not only for protection but for *guidance*.[38]

The Futuramas were immensely successful in achieving this very status. The interstate highways and cloverleaf interchanges that connected them in the 1939 dioramas inspired an entire generation of civil engineers. Over the next several decades these engineers worked to make such a system of highways a reality. In a similar way, the vision of AHS exhibited by GM at world's fairs was contagious and was caught not only by the public, but by automotive engineers as well.

Marketing and Showmanship

But, as Wolfson alludes to, by selling the future GM was also selling the present. Through these presentations of future automated highway systems, GM was making the automobiles of the day more appealing. At the 1964 World's Fair, William L. Mitchell, GM

styling vice-president argued that the presentations were not predictions, but rather illuminations of the possibilities of the present: "We are not saying all these things will be done, but we *are* saying current technology shows they can be done."[39] The hope was that the future would captivate people and cause them to believe in the present.

In many ways, the presentations of AHS in the Futuramas were a rather complex marketing plan. In fact, automated highway systems have been wrapped up in the ideas of marketing and advertisements from the very beginning. Even the display of AHS in Demo '97, which was constantly referred to as a "Congressionally mandated demonstration of feasibility," was criticized by many as simply being a marketing ploy. Over the years, nearly every automated highway system project was affiliated with a large demonstration or exposition that linked it closely with current models for sale.

It was probably General Motors that advanced the idea of marketing a vision of the future into an art form. GM participated in nearly every world's fair held in the 20th century. When there was not a world's fair available, its corporate planners created their own in the form of public presentations in traveling "Motoramas." Each of these expositions gave GM a chance to introduce its newest model year with flare. As potential buyers were shown advanced vehicles like the Firebird III and a corresponding vision of the future, they were reminded that this same car company was producing products that could be purchased today. To buy a car from GM was to participate in the future. This type of advertising has continued to the present day. A Buick press release issued during the summer of 1997 argued that the LeSabre is the perfect car for an automatic highway system. Buick had donated eight LeSabres to the University of California PATH program to be used in an automated platooning demonstration at Demo '97, and was hoping to sell a few more of them by linking the product with AHS, the vision of the future.[40]

Publicity through Entertainment

While presentations of AHS were meant to inspire visions of the future, they also had the simple objective of entertaining the public. This can be seen in General Motors' decision to hire the industrial designer Norman Bel Geddes to work with its own designers in building its 1939 World's Fair exhibit. Bel Geddes had a certain flair for causing excitement. This was evident not only in the Futurama he helped to design, but also in the other major projects at the Fair that he spearheaded, including a concession called the "Crystal Lassies" or "A Peep Show of Tomorrow."[41]

Crystal Lassies was a peep show "of the future" because while there was only a single "dancer," she was surrounded by hundreds of mirrors, providing views from many angles and giving the illusion of dozens of women, all moving in perfect harmony. The connection between the Futurama and this peep show did not go unnoticed by the people of the day either. The *Brooklyn Eagle* argued that "the same showmanship which has made General Motors' Futurama the most popular exhibit at the Fair is responsible for the Crystal Lassies."[42] As a result, the "Peep Show of Tomorrow" was often simply referred to as the "Sexorama." GM's choice of Bel Geddes was an effort to made sure that the display and visceral experiences a person had sparked a lot of interest, and possibly some desire.

Bel Geddes-type showmanship was employed at the Motoramas as well. An article in *Harper's Magazine* describes the opulence of the 1958 New York Motorama held at the Waldorf-Astoria:

> Five long, cream colored cars—Chevrolet, Pontiac Oldsmobile, Buick, and Cadillac—were suspended high in the air…. The performers [who were for the most part scantily clad women] hailed each car with song and dance. In a final rite, the dancers genuflected to the new Cadillac, a magnificent Golden Calf made of plastic and steel.[43]

The AHS-equipped Firebird III presented at this Motorama may have lured some of the public to come in, but GM executives were hoping they would leave with more than a vision of the future. Visions of the future were meant to entertain as well as instruct and shape expectations. Presenting AHS was just one of many techniques that GM and others used in an effort to get the public to "Come for the show, leave with a car."

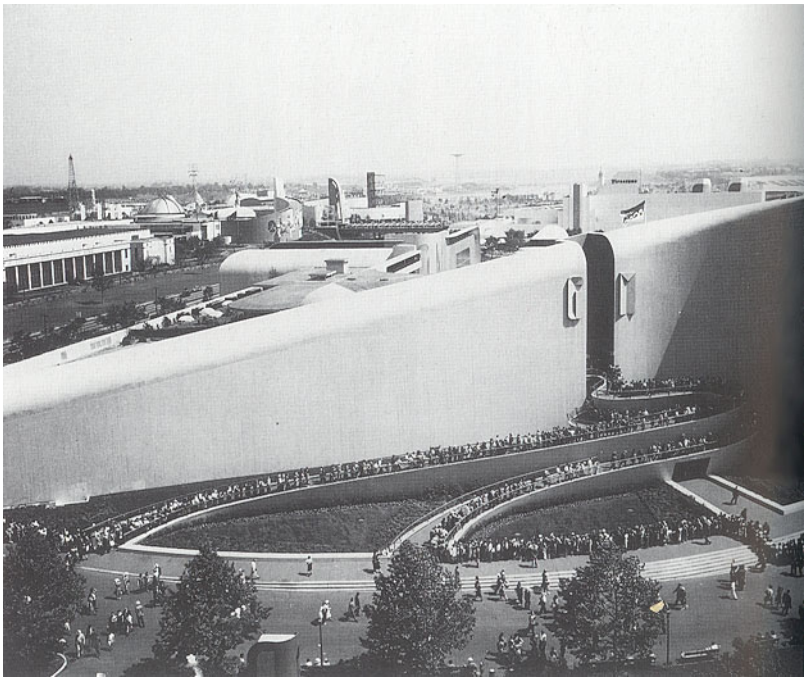

Figure 10 – The line to GM's Futurama exhibit at the 1939 New York World's Fair often stretched to over two miles in length.

In the end, General Motors did get a great deal of publicity out of its exhibitions. The line to the 1939 Futurama was often two miles long and it is still known to this day as the great success of the Fair. 28,000 people a day fought to get inside.[44] GM certainly used this captive audience for its benefit. It was not uncommon for the dazzling displays to have a lasting influence on the overall opinions of GM. One young man at a Motorama remarked: "They'll

take Ford apart; they've got eye-appeal."[45]

Transportation Problems

As was mentioned in the brief history of AHS above, some of the primary motivating factors behind the recent increase in AHS interest are a bit more practical than public showmanship and the desire to sell cars. Of particular concern are the ever-increasing problems this country is having with its transportation system. In 1995, 42,000 people were killed on American roadways.[46] In the same year, DOT estimated that motor vehicle travel would grow 35 to 50 percent over the subsequent two decades.[47] With the problems of cost, traffic fatalities, ever-increasing traffic jams, and a desire not to allocate more land to roads, many people believe the future of America's highway system looks bleak. AHS is seen by some as a silver bullet that will alleviate, if not eliminate, all of these problems.

Many argue that putting vehicle control in the hands of computers would eliminate the number one source of automobile collisions today—human drivers—thereby making the roads significantly safer. Traffic jams would be eradicated because these computers could allow vehicles to follow very closely to each other at high speeds, thereby allowing many more vehicles to drive on a given stretch of highway. And the increased efficiency that would result would reduce not only the amount of fuel required for traveling, but also the emissions produced and the future land required for roadways and shoulders.

The view of AHS as an automotive panacea is not simply a recent phenomenon either. Nearly every time the idea of automated highway systems has surfaced throughout the years, these basic transportation problems are mentioned as justification for developing an AHS. In 1960, GM argued that developing and building an automated highway was worthwhile because it would create: "Increased highway capacity through controlled spacing of vehicles… [and]

potential safety improvements through elimination of driver error."[48] That same year, Dr. James Hillier, Vice-President of RCA Laboratories, argued that: "This pioneering approach uses advanced concepts of both electronics and automotive engineering to achieve a practical system that can vastly increase convenience and safety in driving, and multiply the traffic handling of our highways."[49] Automated highways have a history of being justified by and seen as a potential solution for the ground transportation problems of this country. AHS continues to capture the imagination of engineers and the public because it appears to be a technique that would eliminate many of the problems that plague current automobile travel as well as prevent many of the negative visions of the future from being realized.

Government Funding and Support

Often these visions of turning crowded highways into Elysian Fields have been presented in popular science and technology magazines and are dreamed up or at least embellished by writers. But such presentations would have little effect and would likely dry up quickly if they were not backed up by concerted technological research. To keep the idea of AHS vigorous and full of life, money is needed to turn ideas into hardware. Much of this funding has come from the institution that gets most excited about the arguments for solving national transportation problems with AHS—the federal government.

The U.S. Department of Transportation and its officials take it as their responsibility to ensure that the transportation systems of this country run smoothly and fulfill the needs of American citizens. With the promises AHS has made over the years, it is little wonder that the government has responded favorably to movements like Mobility 2000. In return, the public and many engineers have been given new reasons for enthusiasm. When Congress passed ISTEA in 1991, a new generation of automated highway engineers was born and the hopes of many federal

officials ran high.

In October 1993, the Administrator of the Federal Highway Administration (FHWA), Rodney Slater, made a public announcement of the DOT's desire to begin an automated highway system project. His speech gives the reasons why the USDOT was pursuing AHS so "vigorously":

> Our current highway transportation system, as effective and as elegant as it is, is at a critical crossroads in its evolution and has started to plateau in its ability to provide significant new operating performance in its present form. The deployment of IVHS technologies will offer substantial performance improvements in this and in coming decades. However, the benefits to be derived from a mature IVHS system will be limited by the abilities of the person in the driver's seat. This, combined by increasing traffic demand and our nation's desire for greater safety on the roads and lessened environmental impact, compels us—yes, it challenges us—to consider this next major leap: full automation of the driving function.[50]

Along with this inspirational speech, the FHWA promised over 20 million dollars a year for seven years to a consortium of companies that would eventually be the NAHSC.[51] Hundreds of people were organized, and many ambitious AHS programs were begun. A large part of the transportation industry had become engaged in the idea. As can be seen by the results of government "intervention" in space travel, computing systems, and airplane design, nothing gives a technology a boost like government attention *and* funding.

Technological Enthusiasts

Although I have described the justification and motivations for AHS largely in terms of corporations and the government, at the root of all of this has been the desire and motivation of individuals. People like Lawrence Hafstad, Charles Kettering, Vladimir Zworykin, and GM's recently retired director of ITS, William Spreitzer, dedicated a fair amount of their lives to automated highway systems and many others continue to push for their ultimate creation. Why do all of these people fight so hard? Partially because they can envision all the benefits of a

working system, but perhaps just as importantly, because they believe that man's ability to create beneficial technology will triumph in the end.

In the last few decades, many Americans have lost their intrinsic enthusiasm for technology because of significant disasters like Three-Mile Island, Bhopal, and Challenger. Others base their pessimism on the sum effects of technology on things like the environment, interpersonal relationships, and democracy. But throughout the 20th century, there were those who focused on the benefits of technology and the possibilities that exist for transforming the world into a better place. The potential negatives that others present to them are downplayed as "ultimately solvable." Harold Skramstad, the president of one of the U.S.'s premier technology museums, the Henry Ford Museum & Greenfield Village, described the history of these types of enthusiasts when he argued: "Their attitude scarcely differed from that of millions of other Americans, whose enthusiasm for technology was a basic tenet of their faith in democracy. They believed that the right tools and the right system could solve almost any problem."[52]

Figure 11 – To demonstrate their enthusiasm that the vehicles were doing the driving, many "drivers" of AHS vehicles stuck their hands out of the windows at Demo '97.

Much of this enthusiasm originated in dreams of the future, like those that were presented at the Futuramas and at other world's fairs. Some even argue that it is "engineers fleeing boredom [that] are enchanted with the prospects of a whole new family of developments."[53] But most of these enthusiasts retort that their beliefs are more than wistful dreams or diversions. They argue that technologies are more of a positive than a negative and when people still express doubt, they point to the mistakes of the skeptics and the accuracy of the world's fairs of predicting a brighter future that had been created.

For instance, in 1939, Robert Moses, organizer of both the 1939 and the 1964 New York World's Fairs and legendary urban planner, visited the originally Futurama and apparently "brickbatted GM's transcontinental-highway network as 'plain bunk' [while] President Franklin D. Roosevelt, who seldom lined up with the mauling Moses, agreed."[54] History has shown that neither of these esteemed men successfully predicted the future. In addition, General Motors forecasted that 38,000,000 vehicles would be driving American roads by 1960. The figure was actually reached 12 years earlier than that and had more than doubled by 1963.[55] An article from the 1960s noted that the technological enthusiasm of the first New York World's Fair had become reality:

> Ten million Americans took the General Motors Futurama ride during the 1939–40 New York World's Fair. They saw a startlingly accurate preview of what the nation's landscape would look like in 1960. Concrete ribbons laced major cities, tunneled mountains, vaulted streams. Traffic flowed swiftly, unhindered, along expressways and wheeled off via looped ramps at 50 mph. This was a dream. Engineers soon turned it into a reality… It was… a crystal-ball triumph. In fact, it *was* the future.[56]

With all of this success in past predictions, many technological enthusiasts do not shy from arguing about the amazing possibilities in the future. They simply ask the skeptics to step aside while they make the future happen.

In addition, it is important not to forget that to a large extent, the general public is still fairly enthusiastic about technology. An Internet poll was taken in 1997 to determine how interested people were in AHS. 70 percent of respondents rated AHS positively.[57] Of course, the Internet approach was selected because it is an excellent source of "Innovators" and "Early Adopters," but then again these are the same people who shape much of the technologies the general public eventually uses. Technological enthusiasts have a large influence on the evolution of technologies. When people argue that the automated highway system is just too complicated a system and would require too many institutional changes, the average technological enthusiast simply points to the existence of an immensely complex interstate highway system in the United States. It seems that AHS is the only thing from the first Futurama that this country is still waiting for. Technological enthusiasts are working to fulfill its only outstanding promise.

Technological Improvements

Despite the criticisms they have received, the technological enthusiasts have had much to be enthusiastic about. While they may cite the realization of other dreams as justification for their hope, they will argue that the technologies available today make AHS more feasible than ever. The view is that we have certainly made progress because progress is easily seen in the present. After all, improvements in radar, global positioning systems (GPS), and advanced computing systems have made pinpointing the location of objects a much more reliable task. Such technologies make AHS appear a distinct possibility. Looking back at the technologies available in the past, it is difficult to discern how people even thought AHS was possible before recent times.

Again, citing technological improvements as a genuine reason for being enthusiastic about AHS is nearly as old as AHS itself. In the 1950s and 1960s, vacuum tubes and transistors,

technologies that seem mundane today, were sparking great interest in the automobile industry.[58] After all computing systems were getting "amazingly" smaller. Why not put one on a car? Research that was felt to be closely related to automated highways was making great strides as well. The improvement of the unicontrol in the late 1950s made direction controllable from a single stick. With this step forward, it did not seem that automating this stick would be far behind.

While the engineers had an intimate knowledge of research and development going on behind the scenes, the general public was being showered with an array of new electronic components. At the time, each one must have seemed more amazing than the previous and must have made AHS seem inevitable. For instance, in the early 1950s, many new American automobiles were assisting the driver with power steering.[59] In 1958, General Motors introduced cruise control to American motorists. Cruise control was so new that an article published that year on the Firebird III had to describe it in detail, explaining: "a device… by which a predetermined speed is maintained by servomechanism connected with the throttle."[60] The cruise control is now such a widely accepted and used technology that it is considered mundane. But at the time, it must have appeared to be a significant achievement toward the realization of automated highways. With technologies that appeared to be stepping stones to a fully automated highway system being invented, released, and appreciated, AHS must have appeared right around the corner.

Despite the continued failures and setbacks that those who develop automated vehicle technology have encountered, the enthusiasm that they hold is not unfounded. Perhaps part of the spark for developing AHS was started by corporate promoters at public expositions, but such presentations were more than self-serving visions of the future. They inspired a series of

engineers and dreamers to work out the technological difficulties of establishing automated highways. As problems with our existing transportation networks have increased, the push for AHS has also increased. With each advance that is made, those who push for automated highways are further justified that their dream can be made a reality.

The Future of the Dream

But even if the dream is justified, the question remains as to whether the syndrome of AHS being "just 20 years away" is ever going to end. Unfortunately, that is a difficult question to answer. It is nearly impossible to disprove the possibility of a technology. As has been argued, many people have made that mistake in the past. It seems as though the only certain way to resolve the question is to actually build the technology and answer the question in the affirmative. If they are never built, the question always remains. Many things over the years have been built that were thought impossible. As a result, this is no longer the question that many government and transportation officials ask. Rather they are looking into the ramifications of the technology, and demanding to know whether or not it can solve the problems for which they need remedies.

For the near future, however, things do not look promising for AHS. Government interest in AHS reached a peak in the 1991 ISTEA legislation that went out of its way to give support to automated highway systems. It compelled DOT to fund 80 percent of what eventually became the National Automated Highway System Consortium. But when ISTEA expired on October 1, 1997, much of the government funding for, and interest in, AHS ended as well.

There were several debates between Congress and DOT as to what an ISTEA replacement should look like, but AHS did not figure prominently in the discussions. Despite the fact that the Consortium was initially intended to be a program spanning from 1994 to 2002,

the legislation that DOT proposed as an ISTEA replacement went out of its way to discourage government funding of AHS projects. Instead of sponsoring most of the costs of programs like the Consortium, the DOT-proposed National Economic Crossroads Transportation Efficiency Act (NEXTEA) stated: "For long range activities undertaken in partnership with private entities for the [purpose of ITS research and program support activities], the Federal share payable on account of such activities shall not exceed 50 percent the costs thereof."[61]

DOT's support of the NAHSC waned in 1997 as well. During that year, it began to shift its interest to vehicle automation technologies that it believed could be implemented in the short term, like advanced cruise control and blind-spot warning systems. It began organizing an Intelligent Vehicle Initiative (IVI) "to accelerate the development, introduction, and commercialization of driver assistance products to reduce motor vehicle crashes and incidents."[62]

Congress considered several ISTEA replacement proposals. It passed a six-month bill in October of 1997 to continue the salaries of many people whose jobs are funded through ISTEA. All funding to the Consortium, however, was cut and it reduced its expenditures by 70 percent and relied upon money it has saved while it awaited its fate.[63] On June 9, 1998, ISTEA's replacement, The Transportation Equity Act for the 21st Century [TEA-21], was enacted.[64] The legislation made no special mention of fully automated highway systems as ISTEA had. Instead, the priority areas listed under the category of ITS research focused on near-term "IVI-like" technologies like toll collection, traveler information, and crash-avoidance.[65] A mere four months after Demo '97 the NAHSC web page was taken down.[66] The corporations involved in the Consortium shifted their resources to other projects.

Although TEA-21 was a blow to those involved in advancing and promoting automated highway systems, it will not likely spell the end of AHS. ITS America is still going strong and

new developments in vehicle control technologies are being made every year.[67] As understanding of computers, systems, and human-machine interfaces grows, so will the possibilities for AHS. Many of those involved in the NAHSC have found new organizations in which they can channel their enthusiasm for AHS. Since the IVI was proposed, many engineers have tried to show how AHS fits into its framework. They have not given up the fight yet, and there are likely to be many more opportunities in the future.

The dream has lasted this long; it will not die easily. It is too compelling to too many people. If automated highway systems are ever made a reality, they would respond to a promise made a long time ago. The only question that would remain is whether or not automated highway systems fulfill all of their promises.

Illustration Credits

Figure 1: From the collection of the author.

Figure 2: General Motors photo as reprinted in Bletter, et. al, *Remembering the Future: The New York World's Fair from 1939 to 1964* (New York: Rizzoli International Publications, Inc., 1989), p. 114–115.

Figure 3: Frank Cronican, as reprinted in The Queens Museum, *Dawn of a New Day, the New York World's Fair 1939/40* (New York: New York University Press, 1980), p. 101.

Figure 4: Photo courtesy of GM Research and Development Center.

Figure 5: General Motors photo as reprinted in Donovan, *Wheels for a Nation* (New York: Crowell Publishing, 1965), p. 291.

Figure 6: Photo courtesy of GM Research and Development Center.

Figure 7: Photo courtesy of GM Research and Development Center.

Figure 8: From the NAHSC website. Website was still posted as of March 2003 at http://www.monolith-mis.com/ahs/delcoUser.htm.

Figure 9: From the cover of the 1997 NAHSC pamphlet, "…Driving the Future of Transportation."

Figure 10: From the New York Post, as reprinted in Bletter, et. al, *Remembering the Future: The New York World's Fair from 1939 to 1964* (New York: Rizzoli International Publications, Inc., 1989), p. 116.

Figure 11: From the NAHSC website. Still posted as of March 2003 at http://www.monolith-mis.com/ahs/overview.htm

Bibliography

Beard, Anton, ed., "On Camera–Firebird II," *GM Research Staff Lab Notes*, February 1956.

Bletter, Rosemarie Haag, "The 'Laissez-Fair,' Good Taste, and Money Trees: Architecture at the Fair," in Bletter, et. al, *Remembering the Future: The New York World's Fair from 1939 to 1964* (New York: Rizzoli International Publications, Inc., 1989).

Boroff, David, "Mr. Harper's After Hours: Showgirls in Big Biz," *Harper's Magazine*, January 1959, pp. 82–84.

Delphi Automotive Systems, "Delphi Automotive, Delco Electronics Make Crucial Vehicle Systems for Automated Highway Test," Pontiac, Michigan, press release, August 1997.

Dittmar, Hank, Executive Director, Surface Transportation Policy Project, "Why We Need to Get Beyond the Automated Highway System," letter to the National Automated Highway System Assessment Committee, National Academy of Sciences, Washington D.C., October 10, 1997.

Donovan, Frank Robert, *Wheels for a Nation* (New York: Crowell Publishing, 1965).

Federal Highway Administration, *Request for Applications Number DTFH61-94-X-00001 to establish a National Automated Highway System Consortium*, December 15, 1993.

Francis, Devon, "Some Dreams, F.O.B. Detroit," *New York Times Magazine*, October 25, 1959, pp. 14, 80–81.

Gardels, Keith, "Automatic Car Control for Electronic Highways," General Motors Research Laboratories report, June 1960.

General Motors Corporation, *Easy Street*, film, 1961.

General Motors Corporation, *Futurama—New York World's Fair 1964–65*, souvenir booklet, 1964.

General Motors Corporation, *Press Release, Warren, Michigan*, "An automatically guided automobile cruised along a one-mile check road at General Motors Technical Center today…" 10:30 A.M. (EST), Friday, February 14, 1958.

General Motors Corporation, *To New Horizons, the 1939 Futurama*, film, 1978.

"General Motors Corporation Building," *New York World's Fair Information Manual*, February 28, 1939 [informal publication for contractors and other New York Fair organizers printed prior to public opening].

"GM's Electronic-Jet Dream Car," *Business Week*, September 13, 1958, pp. 125–130.

Going to the Fair: A Preview of the New York World's Fair 1939… (New York: The Sun Dial Press, 1939).

Horowitz, Avraham Horowitz, "User Needs for Automated Highway Systems (AHS); Results from an Internet Survey," Motoresearch Incorporated, http://www.carsurvey.com/results/nahscresults.html, downloaded September 25, 1997.

"Intelligent Vehicle-Highway Systems Act of 1991," Part B of the Intermodal Surface Transportation Efficiency Act of 1991, Public Law 102–240–Dec. 18, 1991.

ITS America, *ITS America Access*, http://www.itsa.org/, downloaded December 18, 1997.

Kilbon, Kenyon, "Tomorrow's Thruway," *Electronic Age*, Autumn 1960, pp. 26–29.

Kettering, Charles F., "Future Unlimited: A great inventor tells how he helped put America on wheels and what remains for bright young minds to do," *Saturday Evening Post*, May 17, 1958, pp. 44–45, 126–128, 131.

NAHSC, "…Driving the Future of Transportation," pamphlet, 1997.

NHTSA, *Rural and Urban Crashes: A Comparative Analysis*, Report DOT-HS-808-450, U.S. Department of Transportation, 1996.

The Queens Museum, *Dawn of a New Day, the New York World's Fair 1939/40* (New York: New York University Press, 1980).

Robertson, Bernard, Vice President for Engineering, Chrysler Corporation, presentation at Second

Committee Meeting of the Transportation Research Board Review of the National Automated Highway System Consortium, open session, Washington D.C., October 10, 1997.

Roesch, Roberta Fleming, *World's Fairs: Yesterday, Today, Tomorrow* (New York: The John Day Company, 1962), p. 65.

Rothenberg, Al, "Fair: Builder of Dreams," *Look*, February 11, 1964, pp. 90–91.

Rydell, Robert W., *World of Fairs* (Chicago: The University of Chicago Press, 1993).

Slater, Rodney, Administrator of the Federal Highway Administration, *Speech Inaugurating the NAHSC Program*, October 21, 1993.

Spreitzer, William M., Technical Director of General Motor's ITS Program, interview at General Motors Research and Development Center, Warren Michigan, November 26, 1997.

Transportation Research Board, *Estimating Demand for the National Advanced Driving Simulator* (Washington, D.C.: National Academy Press, 1995).

Transportation Research Board, *National Automated Highway System Research Program—A Review*, Special Report 253 (Washington D.C.: National Academy Press, 1998).

USDOT, *1995 Status of the Nation's Surface Transportation System: Condition and Performance*, Report to Congress, 1995.

USDOT, "Intelligent Transportation Systems Act of 1997," of the *National Economic Crossroads Transportation Efficiency Ac*t, proposed legislation, 1997.

USDOT, *Intelligent Vehicle Initiative (IVI) Draft Business Plan*, October 1997, p. 1.

"Will this be the No.1 show?" *Science Digest*, April 1964, pp. 13–19.

Wolfson, Mitchell, Jr., *The Great World's Fairs and Expositions* (Miami, Florida: Miami-Dade Community College, 1986).

Wright, John L., ed., *Possible Dreams: Enthusiasm for Technology in America* (Dearborn, Michigan: Henry Ford Museum & Greenfield Village, 1992).

ENDNOTES

I would like to thank the many people who offered helpful comments on drafts of this paper including Ron Kline, Tom Menzies, William Spreitzer, and Steve Shladover. I would also like to express my gratitude to all those who put the time and effort into reviewing this article including *Automotive History Review* editor Taylor Vinson, Sinclair Powell, and the rest of the 2001 Society of Automotive Historians Student Paper Prize Review Committee.

[1] As with many technical and governmental endeavors, the rhetoric surrounding automated highways is full of abbreviations.

[2] This essay is exclusively about AHS in America and concentrates on the role of General Motors in these efforts. Engineers in Europe and Japan have also been involved, but as there has been little interaction between the United States and other countries until recently, they will not be addressed in this essay. The essay's GM-centric focus is a result of the fact that General Motors has had a more concerted AHS effort than any other American corporation. In addition, it has been by far the most active in getting the public excited about the prospects of the technology by presenting the idea in a variety of forms.

[3] "General Motors Corporation Building," *New York World's Fair Information Manual*, February 28, 1939; General Motors Corporation, *To New Horizons, the 1939 Futurama*, film, 1978.

[4] Ibid.

[5] From the Futurama's running audio commentary, as quoted in Rosemarie Haag Bletter, "The 'Laissez-Fair,' Good Taste, and Money Trees: Architecture at the Fair," in Bletter, et. al., *Remembering the Future: The New York World's Fair from 1939 to 1964* (New York: Rizzoli International Publications, Inc., 1989), p. 114.

[6] General Motors Corporation, "An automatically guided automobile cruised along a one-mile check road at General Motors Technical Center today…" 10:30 A.M. (EST), Friday, February 14, 1958, Warren, Michigan, press release, p. 1.

[7] Anton Beard, ed., "On Camera–Firebird II," *GM Research Staff Lab Notes*, February 1956, p. 9.

[8] General Motors Corporation, "An automatically guided automobile cruised along a one-mile check road at General Motors Technical Center today…" 10:30 A.M. (EST), Friday, February 14, 1958, Warren, Michigan, press release, p. 1.

[9] "GM's Electronic-Jet Dream Car," *Business Week*, September 13, 1958, p. 126.

[10] William M. Spreitzer, Technical Director of General Motor's ITS Program, interview at General Motors Research and Development Center, Warren Michigan, November 26, 1997.

[11] Devon Francis, "Some Dreams, F.O.B. Detroit," *New York Times Magazine*, October 25, 1959, p. 80.

[12] William M. Spreitzer, interview, November 26, 1997.

[13] Although the videotapes that remain of this model show it working perfectly, a few transportation engineers that were there remember seeing cars pile up on top of each other.

[14] "Will this be the No.1 show?" *Science Digest*, April 1964, pp. 14, 16.

[15] Al Rothenberg, "Fair: Builder of Dreams," *Look*, February 11, 1964, p. 91.

[16] William M. Spreitzer, interview, November 26, 1997.

[17] "Intelligent Vehicle-Highway Systems Act of 1991," Part B, Sec. 6054 (a)(1), of the Intermodal Surface Transportation Efficiency Act of 1991, Public Law 102–240–Dec. 18, 1991.

[18] ITS America, *ITS America Access*, http://www.itsa.org/, downloaded December 18, 1997.

[19] "Intelligent Vehicle-Highway Systems Act of 1991," Part B, Sec. 6054 (b) of the Intermodal Surface Transportation Efficiency Act of 1991, Public Law 102–240–Dec. 18, 1991.

[20] Delphi Automotive Systems, "Delphi Automotive, Delco Electronics Make Crucial Vehicle Systems for Automated Highway Test," Pontiac, Michigan, press release, August 1997.

[21] General Motors Corporation, "To New Horizons, the 1939 Futurama," film, 1978. Seeing these words in print does not do the voice-over justice. The emphasis and determination in the original voice is quite dramatic.

[22] "GM's Electronic-Jet Dream Car," *Business Week*, September 13, 1958, p. 127.

[23] For a more detailed explanation of many of these difficulties see: Transportation Research Board, *National Automated Highway System Research Program—A Review*, Special Report 253 (Washington D.C.: National Academy Press, 1998).

[24] These recent figures are, however, somewhat suspect as they were not justified by economic analyses of the time and materials involved, but rather the price auto-manufacturers believe people would pay for AHS.

[25] The RCA estimates in this paragraph and the previous one are taken from Kenyon Kilbon, "Tomorrow's Thruway," *Electronic Age*, Autumn 1960, p. 29. The current estimates are from talking with various engineers at

Demo ’97.
[26] This was one of the most common failure at Demo ’97 in San Diego.
[27] Transportation Research Board, *Estimating Demand for the National Advanced Driving Simulator* (Washington, D.C.: National Academy Press, 1995).
[28] “GM’s Electronic-Jet Dream Car,” *Business Week*, September 13, 1958, p. 127.
[29] Ibid, p. 126.
[30] The information for the material in this paragraph and most of the other material pertaining to Demo ’97 in San Diego comes from my own personal experience. I rode on two of the scenarios and was an observer of the demonstration from August 6–8, 1997.
[31] Bernard Robertson, Vice President for Engineering, Chrysler Corporation, presentation at Second Committee Meeting of the TRB Review of the NAHSC, open session, Washington D.C., October 10, 1997.
[32] Hank Dittmar, Executive Director, Surface Transportation Policy Project, “Why We Need to Get Beyond the Automated Highway System,” letter to the National Automated Highway System Assessment Committee, National Academy of Sciences, Washington D.C., October 10, 1997.
[33] General Motors Corporation, *Futurama—New York World’s Fair 1964–65*, souvenir booklet, 1964, p. 8.
[34] General Motors Corporation, *Easy Street*, film, 1961.
[35] NAHSC, “…Driving the Future of Transportation,” pamphlet, 1997.
[36] “GM’s Electronic-Jet Dream Car,” *Business Week*, September 13, 1958, p. 125.
[37] Norman Bel Geddes, *Magic Motorways* (New York: Random House, 1940), p. 4, as quoted in The Queens Museum, *Dawn of a New Day, the New York World's Fair 1939/40* (New York: New York University Press, 1980), p. 57.
[38] Mitchell Wolfson, Jr., *The Great World’s Fairs and Expositions* (Miami, Florida: Miami-Dade Community College, 1986), Forward.
[39] Al Rothenberg, “Fair: Builder of Dreams,” *Look*, February 11, 1964, p. 90.
[40] “Platooning” is a popular technique advocated in many automated highway system concepts. In platooning, groups of 3 to 10 vehicles are linked electronically through radar and computer systems. These platoons then act as a unit in negotiating the road and other vehicles. This organization is a more manageable distribution of control than outside control towers because the logistics of controlling a few vehicles traveling close to one another are much simpler than coordinating hundreds or thousands of vehicles spread over a large area.
[41] Robert W. Rydell, *World of Fairs* (Chicago: The University of Chicago Press, 1993), pp. 135–141.
[42] *Brooklyn Eagle*, May 30, 1939, as quoted in Rydell, *World of Fairs*, p. 141.
[43] David Boroff, “Mr. Harper’s After Hours: Showgirls in Big Biz,” *Harper’s Magazine*, January 1959, p. 82.
[44] Roberta Fleming Roesch, *World’s Fairs: Yesterday, Today, Tomorrow* (New York: The John Day Company, 1962), p. 65.
[45] David Boroff, “Mr. Harper’s After Hours: Showgirls in Big Biz,” *Harper’s Magazine*, January 1959, p. 82.
[46] National Highway Traffic Safety Administration (NHTSA), *Rural and Urban Crashes: A Comparative Analysis*, Report DOT-HS-808-450, U.S. Department of Transportation, 1996.
[47] USDOT, *1995 Status of the Nation’s Surface Transportation System: Condition and Performance*, Report to Congress, 1995.
[48] Keith Gardels, “Automatic Car Control for Electronic Highways,” General Motors Research Laboratories report, June 1960, p. 1.
[49] Kenyon Kilbon, “Tomorrow’s Thruway,” *Electronic Age*, Autumn 1960, p. 27.
[50] Rodney Slater, Administrator of the Federal Highway Administration, *Speech Inaugurating the NAHSC Program*, October 21, 1993.
[51] FHWA, Request for Applications Number DTFH61-94-X-00001 to establish a National Automated Highway System Consortium, December 15, 1993, p. 45.
[52] John L. Wright, ed., *Possible Dreams: Enthusiasm for Technology in America* (Dearborn, Michigan: Henry Ford Museum & Greenfield Village, 1992), p.7.
[53] Devon Francis, “Some Dreams, F.O.B. Detroit,” *New York Times Magazine*, October 25, 1959, p. 14.
[54] Al Rothenberg, “Fair: Builder of Dreams,” *Look*, February 11, 1964, p. 90.
[55] Ibid.
[56] Ibid.
[57] Avraham Horowitz, “User Needs for Automated Highway Systems (AHS); Results from an Internet Survey,” Motoresearch Incorporated, http://www.carsurvey.com/results/nahscresults.html, downloaded September 25, 1997.
[58] William M. Spreitzer, interview, November 26, 1997.

[59] In 1954 power steering became standard on all Chevrolet products.
[60] "GM's Electronic-Jet Dream Car," *Business Week*, September 13, 1958, p. 126.
[61] DOT, "Intelligent Transportation Systems Act of 1997," Sec. 6058 {c} (3) of the *National Economic Crossroads Transportation Efficiency Ac*t, proposed legislation, 1997.
[62] DOT, *Intelligent Vehicle Initiative (IVI) Draft Business Plan*, October 1997, p. 1.
[63] William M. Spreitzer, interview, November 26, 1997.
[64] See the DOT website for the full text of "TEA 21" at: http://www.fhwa.dot.gov/TEA21/h2400.htm
[65] Transportation Equity Act for the 21st Century, Sec 5207 (b).
[66] Parts of the NAHSC website have actually been reposted, but only as a way for the web design company that created the page to demonstrate what it can do. See: http://www.monolith-mis.com/ahs/Default2.htm
[67] For recent activities of ITS America, see its website at: http://www.itsa.org/