Different Roads

Automobiles for the Next Century

The Museum of Modern Art, New York

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Introduction

When the automobile was first conceived in the late nineteenth century it was imagined as a leisure vehicle for the affluent. Unthinkable to these early inventors would have been the mass proliferation of the automobile and its immense influence on modern society and its economy. The role of the private car began to change in the 1920s with Henry Ford's lucrative concept of the inexpensive auto for the "multitudes," the Model T. Since then, in industrialized nations, the auto has increasingly become a fundamental part of everyday life, a thing more utilitarian and borne out of necessity than for leisure. In recent years the use of the automobile has grown most exponentially in developing nations, where the private car is also quickly becoming a primary form of transportation and an integral aspect of their economies.

Many have predicted that the automobile is ripe for a reinvention and that in the early part of the twenty-first century we will see changes both in the kinds of cars we use and how we use them. Automotive engineer Robert Riley, in his book *Alternative Cars in the 21st Century*, says "The machine itself may need a . . . holistic renewal, a wholesale overhaul in order to remain the central component of our modern society's transportation system." The radical new developments being introduced by many of the major automotive manufacturers support this claim. These innovations are fundamental, from revolutionary types of power plants to new materials, innovative structures, and even new classes of autos. Interestingly, a significant portion of this change is occurring at the entry-level market. The intention of this exhibition is to survey this current generation of automobiles and outline different paths to the future. These are cars intended for the average person and will satisfy the predicted need for simple, affordable transportation in the near future. In short, these automobiles are ultimately more intelligent, efficient, user-friendly, and better suited to the tasks for which they will be most frequently used.

By focusing on the small, efficient, and affordable private car, this exhibition illustrates the scope and direction of the rethinking that is beginning to take place in automotive design. This is not to suggest that these are the only sorts of cars, nor that they are appropriate or everyone or every situation. Instead, these cars represent an important and growing aspect of the market that caters to a consumer who is more attentive to thrift, and thus more attracted to the improved economy of these cars. Unquestionably, many of the innovations first tested in the low-end market will filter up into the production of other sorts of cars, as well as trucks and even public transportation.

The auto industry has been showing fantastical prototypes of futuristic cars since the fifties, but in reality the automobile has actually changed very little since then. Science fiction prepared us for flying-saucerlike cars in the next millennium; however, as we approach the year 2000, these new vehicles are far more sober than we might have expected. The private car of the next century will have to confront real global issues, such as overcrowding, pollution, and finite reserves of fuel with an uneven worldwide distribution, that some believe have already reached a crisis point. Internationally we face a drastic intensification of all of these issues if the proliferation of the auto in developing nations takes place as predicted in the early part of the next century. The most dramatic forecasts suggest that in 2010 India will have thirty-six times more cars then it does now and China may have as many as ninety-one times its present rate. These kinds of increases could wreak havoc on the earth's ecosystem.

Globally, overcrowding already exists in many urban areas—conspicuous in the "go slows" of Lagos, midtown traffic in New York City, or the rush-hour crunch in Los Angeles. Cities like São Paulo, Caracas, and Bogota have already begun to regulate what day of the week a given car can be driven. In some instances the large number of cars literally on the road puts intolerable strain on the infrastructure of urban centers that were planned too long ago to assimilate the growing numbers. A direct consequence of this congestion is, of course, pollution and smog, which have already reached critical points in places like Los Angeles, Hong Kong, and Mexico City. Automotive emissions also significantly contribute to the greenhouse effect that many say is stimulating global warming and will lead to catastrophic environmental circumstances in the next century. Further, we face the fact that the petroleum reserves may at some point dry up. However, because of the basic lack of knowledge about possible reserves and our ability to recover them, this remains a most controversial subject. Despite this debate, the political turmoil and instability created by an uneven distribution of oil reserves recommend that conservation is a worthwhile endeavor.

Conservation and sacrifice, however, don't sell cars on their own. Automobiles that appear hair shirt or underpowered like the previous generation of econoboxes don't inspire the kind of yearnings that prompt consumers to buy, particularly in good economic times. The auto industry has responded—in the U.S., but particularly in Asian and European markets—by manufacturing an entry-level segment of cars that is more appealing, better looking, and safer than in the past. Instead of promoting their economy, the automotive manufacturers have stressed these cars' quality, comfort, and power to meet any highway situation. Manufacturers have also realized that good design doesn't necessarily cost more, and these cars are a testament to this. Frequently these vehicles are marketed to younger consumers who may be naturally more adventuresome and will accept new technologies and types of styling more readily.

Traditionally the small car has never been popular in the United States, with perhaps the short exception of the period soon after the oil embargo of the mid-seventies. This is primarily because gasoline prices have remained extremely low in America, even recently selling for less than the price of bottled water in some areas. Compared with most other industrialized nations, where gasoline sells from $4 to $6 a gallon, there is very little incentive for austerity in the U.S. Not surprisingly, petroleum imports have actually risen to 10 million barrels a day, nearly double the level twenty years ago. At the same time, the average fuel efficiency for all automobiles in the U.S. has also decreased in recent years.

But all this may be about to change, as it runs contradictory to cultural and societal realities that may encourage the use of smaller cars. It is inconceivable that gasoline prices will remain as low as they are forever. Overcrowding in many American cities is a serious problem, and the American family is statistically getting smaller. In the last few decades it has become common for both adult members of the household to work, a fact that has transformed the dynamic of commuting to work and automotive use. Recent statistics show that on average most automobiles worldwide have only a 1.6 to 1.8 average passenger-occupancy rate. And because the distance of that commute is becoming longer, often from one suburb to another, the ordinary car is using more gasoline on a daily basis. These facts suggest that there should be a market in the U.S., as there already is in Europe, for second cars used primarily for travel to and from work (for example, DaimlerChrysler's Smart Car).

New developments in automotive design have also come from outside the ordinary consumer-industry relationship. Governments have begun to encourage better technologies and more efficient cars through legislation. Western European nations and Asian countries have long imposed various types of restrictions that include imposing higher taxes on gasoline than in the United States, charging purchase and income taxes proportional to the size of the automobile, and even requiring proof of a parking space before allowing the purchase of a car, as in Tokyo. Taxes are unanimously unpopular in the U.S., and increased gasoline taxes would generate political turmoil. However, some recent measures have been taken to encourage a broader thinking in America, such as California's Clean Air Act that mandates that manufacturers develop zero- or low-emission vehicles and implements new legislation regarding pickup trucks and SUVs. Other regulatory attempts include the founding of the Partnership for a New Generation of Vehicles (PNGV) in 1993, an automotive think tank supported by the three major American manufacturers: Ford, General Motors, and DaimlerChrysler.

Although governmental legislation has been essential to encouraging research and development, another perhaps more explicit evolution has come from within the automotive industry. The growing globalization of manufacturing has resulted in larger worldwide markets. And with the recent merger frenzy, specialized car markets are declining. Instead, the private car is becoming more universal, and the money savings afforded by the use of shared platforms encourage the manufactures to market the same types of autos internationally. Consumers in Asia and Europe have already embraced smaller, more practical vehicles, which in turn motivates the new, larger motor conglomerates to further develop these car markets elsewhere. Eventually innovations originally pioneered for these smaller, more efficient cars—or even the cars themselves—will appear in the U.S. market. The potential universality of the car market would increase the profit margin for the industry, contradicting the old adage "smaller cars mean smaller profits."

Interior view of the Fiat Multipla

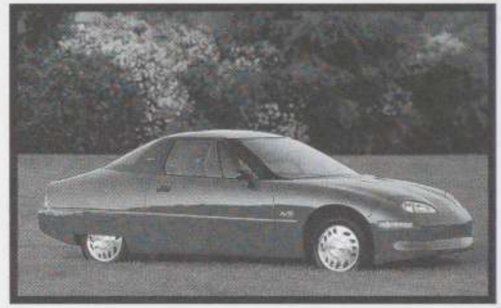
What should be done to ensure that we still have enough petroleum deposits, enough clean air, and enough room to maneuver our cars and prevent global warming in the coming century? One extreme and unfeasible suggestion is that we abolish the private car altogether and find other forms of transportation. However, the most immediate and realistic solution appears to start with a rethinking and redesign of the car itself. Make the private car better; make it a more intelligent and a more efficient machine. Ecologist Amory Lovins refers to this approach as mining the potentially rich "oil fields under Detroit."

The key to making automobiles more gas efficient is to make them lighter and provide them with a less wasteful engine. A large car is not always best suited for its purported function. Somewhere between only two and five percent of the energy used to power a large car is actually employed to move the passengers; the other ninety-five to ninety-eight percent is used to simply move the car itself. This can be remedied without much suffering on the behalf of the consumer.

Consequently, much of the current development focuses on new materials that can replace the steel parts, including strong composite plastics, aluminum, magnesium, ceramics, and even carbon composites. Ironically much of the initial research into use of these substances was pioneered in automotive racing where weight reduction is in direct proportion to higher speeds. These investigations into new materials and structures of course will eventually lead to new kinds of styling and ultimately new aesthetic solutions.

In ordinary cars cutting weight of the vehicle does not always mean cutting size. Many of the cars in this exhibition—the Ford Ka, the Fiat Multipla, the Smart Car, and the Daimler Chrysler CCV—have small exterior dimensions but afford relatively large interior space for passengers. One of the ways this has been achieved is through the development of new skeletal, or space, frames. The space frame is important because it generates greater strength and stability, and also makes these cars safer—an important concern for consumers when purchasing a small car.

Although the laws of physics are undeniable—the larger the car, the more it weighs, the more closely it resembles a military tank, and the safer it will be—because of new developments, these autos are far safer than the compact cars of the past. Several of these cars feature multiple air bags The Multipla and the Smart even have ingenious engine placements that



General Motors EV1


DaimlerChrysler Smart Car

permit the motor and drivetrain, placed underneath the passenger, to absorb much of the impact in a crash. In Europe and Asia, where most vehicles are small, the differential in an accident is less of a problem, and many believe the added agility of a small car reduces the risk of accidents in the first place.

Improvements to the exterior body have also made these cars more efficient. Friction produced by the air passing over the chassis and between the road and the tires can create drag, particularly at high speeds. The General Motors EV1 is surprisingly the most aerodynamically "slippery" auto in production—not, as would be expected, a sleek, expensive sports car. The aerodynamics of this car, however, do not reflect a desire for speed but are necessary because of their limited electric power plant. The Honda VV, the Ka, and the Audi AL2 are also aerodynamic in design, and the Toyota Prius and the EV1 feature thin, low-resistance tires that cut down significantly on the friction created between the road surface and the vehicle.

Although these structural improvements contribute to the overall efficiency, a more radical change is taking place to one of the most fundamental parts of the car—the engine. Experiments with alternative fuels and power plants are transforming the internal combustion engine that has been the automobile's dominant power provider since Daimler Benz's gasoline engines prevailed over early steam engines. Some automotive engineers have equated the significant transformations taking place in this area with the nineteenth-century metamorphosis from horse-drawn carriages to gasoline-powered cars. New investigations are being conducted into the use of alternative fuels like methane, ethanol, and fuel cells. However, the most immediately significant developments may be electric- and hybrid-powered cars.

The electric motor presents some obvious advantages and disadvantages over the conventional combustion engine. Because it doesn't use petroleum to supply power to the engine, it runs clean, without emissions. The electricity can come from many external sources that run on coal, nuclear, or hydroelectric power. Most experts agree that pollution at these plants can be better controlled, and the local smog created by cars would disappear. The use of electricity is particularly appealing to countries like China, which has few natural oil reserves. The electric EV1 can be recharged at stations equipped with a charging device, or even at home. The engine has fewer movable parts and thus needs less service, and it is also far quieter than a conventional engine.

Presently, the major drawbacks of an electric motor stem from the batteries that store the energy. The storage is only sufficient to allow a limited driving range: the EV1 can go approximately fifty to seventy miles per charge, less if the air conditioner is used or in cold climates. This, coupled with the inconvenience caused by the limited availability of charging stations, makes the car inappropriate for long trips. Instead electric autos in the near future seem to be most valuable as commuter cars or in local use, perhaps performing specific tasks as with postal trucks.

For these and many other reasons, the hybrid engine has emerged as the more practical power source of the near future. Hybrid cars combine both an electric motor and an internal combustion gas-driven engine. This combination has the benefit of both types of power plants without the problems of the super clean but limited range electric cars. These cars produce significantly lower emissions and get remarkable gas mileage. The hybrid's batteries don't require recharging because they are continuously recharged by the gasoline engine and through regenerative braking. Sophisticated hybrids like the Honda VV and the Toyota Prius are run by computer that automatically alternates between gas engine and electric motor depending on the driving situation. In a conventional car it is this period from a stop to fifteen miles per hour that produces the most exhaust. The Prius, therefore, employs the electric motor in early acceleration. Faster acceleration may require both engines, and at highway speed the cars most commonly use the gas engine. However, in stop-and-go city traffic, when speed is not a factor, the hybrid cars switch to electric power. Eventually there is little reason why hybrid technology can't be applied to other larger types of vehicles, including public buses, SUVs, sedans, trucks, and vans.

All of these innovations represent an early step in the transformation that the automobile is soon to assume. These automobiles are a preview of the first generation in the reconsideration of the automobile. Some of these cars are in production, some will be soon, and some are prototypes that may never come to the market in their present form. The ideal car of the future is likely to incorporate and synthesize certain elements from each one. We have attempted here to highlight nine differing views in the hopes of provoking thought and debate as to what kind of automobiles we will be and should be driving in the early part of the next millennium.

In regard to the ever-increasing problems that modern automobiles and their users have exacerbated—pollution, overcrowding, and the precariousness of oil reserves—we can be optimistic based on the exceptional technology that will be available shortly. These cars all offer very real solutions. They are produced by major manufacturers and should be available at reasonable prices—a technology that is too expensive for widespread application would be useless. The circumstances are not yet so dire that one cannot be hopeful that human ingenuity will meet the challenges necessary to permit the continued use and proliferation of the private automobile.

Christopher Mount

This exhibition was organized by Christopher Mount, Assistant Curator, Department of Architecture and Design, with Phil Patton, curatorial consultant.

The automobiles in the exhibition have been lent by the manufacturers. Partial funding is provided by The Junior Associates of The Museum of Modern Art.

Public Programs

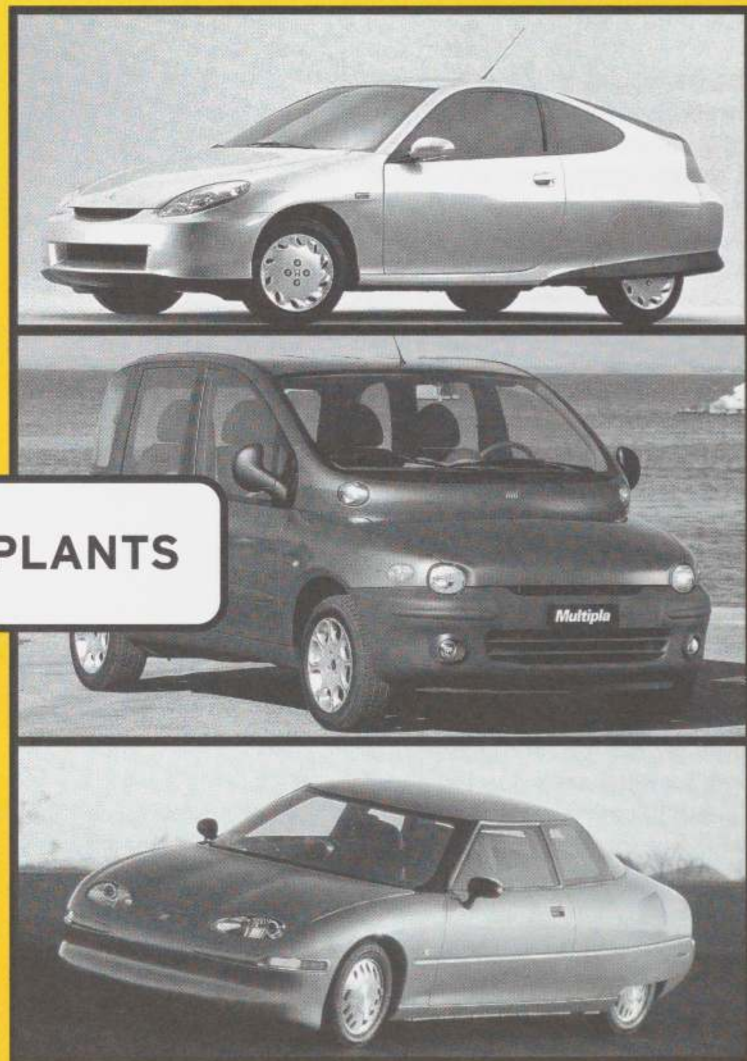
Symposium: What Is the Future of the Automobile?
Tuesday, September 7, 1999

A panel of designers, engineers, and other professionals will discuss automobile design and its implications for the coming century, as well as other issues raised by **Different Roads: Automobiles for the Next Century**.

For further information, please call the Department of Education at 212-708-9781.

More in-depth information related to automotive design, new materials, and fuels is available on MoMA's Web site at www.moma.org.

NEW TYPES OF POWER PLANTS



General Motors EV1

The two-passenger EV1 is the first electric automobile made by a major manufacturer for large-scale distribution and production. Its radical design makes it remarkably efficient in terms of aerodynamics and weight, a fact made more crucial given its electric power plant. The car is the most aerodynamically "slippery" car in production, with rear wheels that are nine inches closer together than the front wheels creating a tear-drop shape, covered rear wheels, and a flat-bottomed undercarriage. Its light weight results from its aluminum skeletal frame, or space frame, paired with composite plastic body panels that are actually, in many areas, glued to the frame. These plastic body panels are extremely sturdy and easily replaceable. The car's overall weight has been even further reduced by such innovations as a magnesium steering wheel.

The aerodynamic qualities and light weight give the car acceleration and a top speed similar to a quality gas-powered car. The 137-horsepower motor can go from 0–60 in nine seconds. The motor never needs a tune-up, and the oil never needs replacing. The batteries, however, have a life expectancy of only 25,000 to 30,000 miles. Refreshingly, no key is necessary to start the car; instead a code is used to open the doors and activate the engine. Regenerative braking converts energy generated by stopping into electricity to assist in recharging the batteries. Otherwise, the EV1 must be recharged at a special charging station or at home with a smaller portable charger. At specially equipped stations, the recharging takes three hours to complete, and at home, the car takes twelve to sixteen hours to recharge fully. Because of its electric motor the car produces zero emission and is extremely quiet—so quiet that a special beeping horn had to be installed to alert pedestrians that the car is coming.

BODY CONSTRUCTION	Aluminum alloy space frame with aluminum and plastic body panels
YEAR AND COUNTRY INTRODUCED	1995
TOP SPEED (MPH)	80 mph
ENGINE	Electric motor
DIMENSIONS (INCHES)	
Length	169 5/8"
Width	69 1/2"
Height	50 1/2"
Wheelbase	98 7/8"
CURB WEIGHT	2,970 lbs.
FUEL ECONOMY (MPG)	N/A
(PREDICTED) PRICE IN $US	Presently for lease only
SECONDS FROM 0-60 MPH	8.5 seconds

ALL SPECIFICATIONS WERE SUPPLIED BY THE MANUFACTURERS.

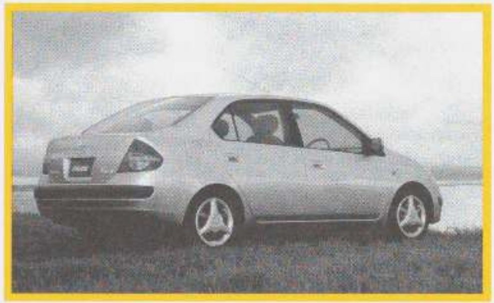
BODY CONSTRUCTION	Aluminum space frame with aluminum and plastic composite body panels
YEAR AND COUNTRY INTRODUCED	1999 in America and Japan; 2000 in Europe
TOP SPEED (MPH)	80 mph
ENGINE	3 cylinder and electric motor
Type	Engine: 1.0 liter. Motor: battery-operated
DIMENSIONS (INCHES)	
Length	155⅛"
Width	68½"
Height	52"
Wheelbase	94½"
CURB WEIGHT	1,750 lbs.
FUEL ECONOMY (MPG)	70 mpg
(PREDICTED) PRICE IN $US	Under $20,000
SECONDS FROM 0-60 MPH	N/A

Honda VV

The Honda VV is scheduled to reach the American market by early winter of 1999. The code-named VV is a two-seat, subcompact automobile. Like the Toyota Prius, the VV is a hybrid-powered car. The principal power comes from a lightweight one-liter, three-cylinder gasoline engine with a five-speed transmission. An electric motor serves as its secondary power source. The activation of one or both of the power drives is determined by an advanced computer system that evaluates their usefulness in any given driving situation. The car's average fuel economy for highway and city is 70 mpg (miles per gallon). Its tremendous fuel economy is a result of its light weight, only 1,760 pounds—800 pounds lighter than the Honda Civic—due to its aluminum space frame and its composite body panels. According to the manufacturer the VV can go 700 miles on one tank of gas, or approximately the distance from New York to Detroit. The car meets California's ultra-low vehicle-emissions standard and, like the Toyota Prius, is expected to sell for under $20,000.

Toyota Prius

Although the Prius looks relatively ordinary from the outside, this belies the sophisticated technology on the inside of the car. The "normal" exterior suggests Toyota's desire to create instant acceptance for the car as a traditional five-seat family vehicle. In Latin the word *prius* means "to go before," and this car is in fact the first hybrid-powered car available for mass distribution and has already begun selling well in Japan. The Prius has significant advances in terms of fuel economy and emission over current gasoline cars. The two power sources include a 58-horsepower, 1.5-liter, four-cylinder engine, and a 40-horsepower electric engine. In congested urban areas the electric motor is the workhorse, and the car uses the gasoline engine when extra power is needed. A computer seamlessly alternates the power sources, only activating the gas engine when necessary. Because idling and low acceleration usually produce the greatest amount of emissions in a gas engine, the Prius employs the electric motor under these driving conditions. In fact, the Prius gets its best gas mileage in the stop-and-go traffic of a city. A unusually long wheelbase enhances handling, and low resistance tires help to produce an estimated gas mileage of 66 mpg.

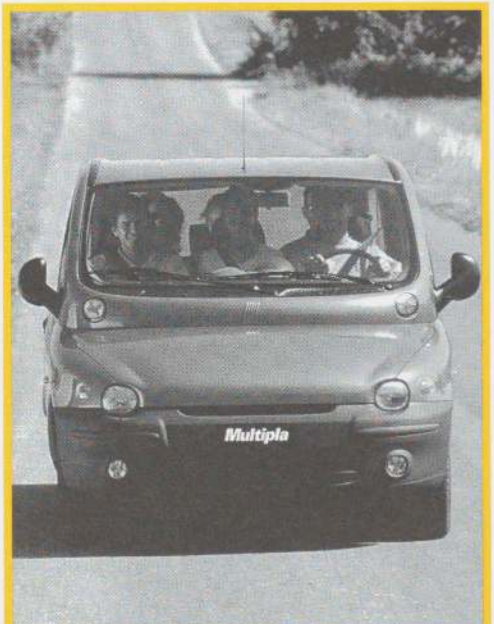


BODY CONSTRUCTION	Space frame and panels made of high tensile steel
YEAR AND COUNTRY INTRODUCED	1997 in Japan
TOP SPEED (MPH)	88 mph (engine alone); 100 mph (engine and electric motor combined)
ENGINE	4 cylinder and electric motor
Type	Engine: water-cooled inline. Motor: battery operated
Displacement	91.3 cubic inches
Power	Engine: 58 hp at 4,000 rpm. Motor: 40 hp at 940-2,000 rpm
Torque	75 ft.lb.
DIMENSIONS (INCHES)	
Length	168 5/16"
Width	66 11/16"
Height	58 11/16"
Wheelbase	100 3/8"
CURB WEIGHT	2,728 lbs.
FUEL ECONOMY (MPG)	66 mpg
(PREDICTED) PRICE IN $US	Under $20,000
SECONDS FROM 0-60 MPH	14 seconds

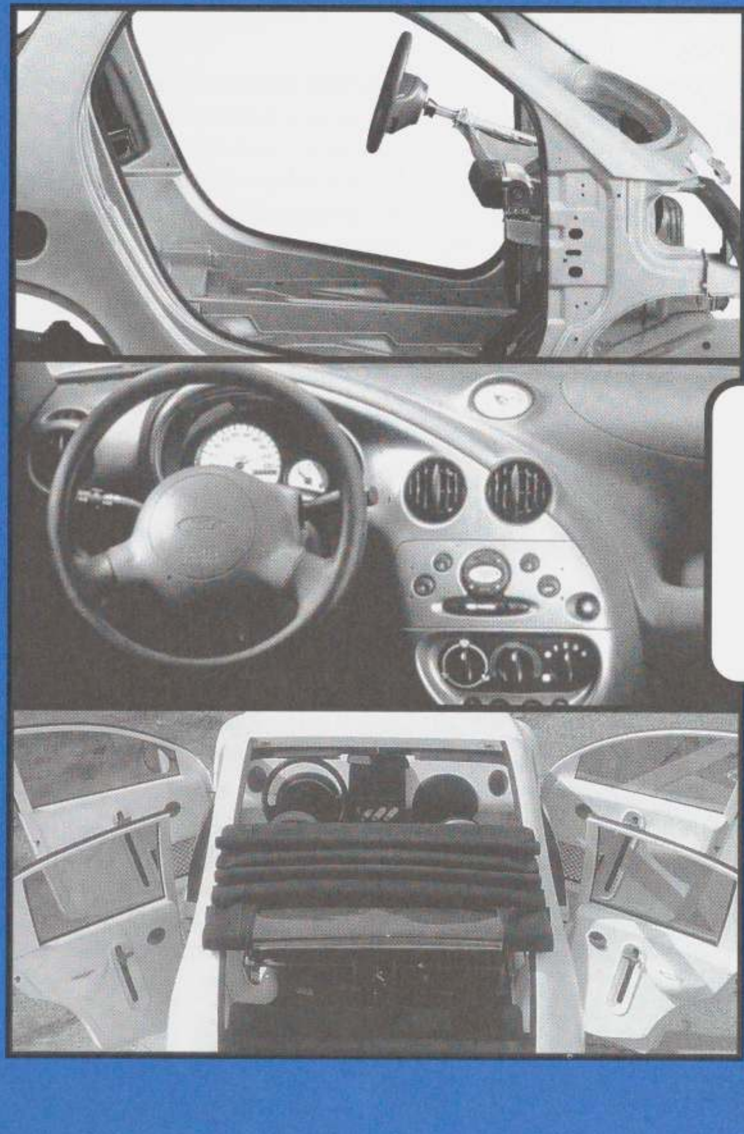
Fiat Multipla Bipower

BODY CONSTRUCTION	Steel space frame with composite body panels
YEAR AND COUNTRY INTRODUCED	1998 in Italy; 1999 in the rest of Europe
TOP SPEED (MPH)	Gasoline: 104 mph; methane: 98 mph
ENGINE	4 cylinder
Type	1.6/16v gasoline or methane
Displacement	96.5 cubic inches
Power	103 bhp (methane 68 bhp) at 5,750 rpm
Torque	106.2 ft.lb. (methane 95.9 ft.lb.)
DIMENSIONS (INCHES)	
Length	157¼"
Width	73⅝"
Height	67"
Wheelbase	105"
CURB WEIGHT	3,241 lbs.
FUEL ECONOMY (MPG) (Combined)	26.4 mpg
(PREDICTED) PRICE IN $US	Under $17,800
SECONDS FROM 0-60 MPH	Gasoline: 13 seconds; methane: 16 seconds

As suggested by its name, the Multipla is an auto that provides for a tremendous flexibility both in terms of choice of power sources and in the configuration of the interior space. Despite its small exterior, the Multipla has the cabin room of a minivan or station wagon and is intended as a family car, large enough for six passengers. It is unusually tall, and the windows have a vertical emphasis that permits a better view as well as an enhanced sense of spaciousness. The night visibility is improved by headlights and taillights that are placed at different heights along the chassis. For safety considerations the auto is engineered in two parts: a lower section containing the engine and drivetrain, and tall upper section for passengers and cargo. In an accident, this lower section of the car bears the brunt of the impact, with the higher riding passengers remaining protected.



The Multipla included in this exhibition is a bipower-engine type that uses regular gasoline or methane or both. The Multipla will soon be available in Europe with a diesel engine, and as a hybrid, with both electric motor and gasoline engine. Methane fuel produces no benzene or particle emissions and reduces carbon dioxide emission by twenty-five percent. The same engine runs on both fuels with two separate tanks and separate routing systems. The driver can switch between methane and gasoline, but the car also does it automatically in cold starts or when the methane has run out.



NEW SOLUTIONS: MATERIALS, STRUCTURES, AND FORMS

BODY CONSTRUCTION	Metal space frame with recyclable composite body panels
YEAR AND COUNTRY INTRODUCED	1997 Concept Vehicle–Frankfurt Auto Show
TOP SPEED (MPH)	70 mph
ENGINE	2 cylinder
Type	800 cc; overhead-valve, air cooled
Displacement	48.8 cubic inches
Power	25 hp at 4,250 rpm
Torque	36 hp at 2,800 rpm
DIMENSIONS (INCHES)	
Length	144"
Width	63"
Height	64½"
Wheelbase	101"
CURB WEIGHT	1,200 lbs.
FUEL ECONOMY (MPG)	50 mpg
(PREDICTED) PRICE IN $US	Low; market dependent
SECONDS FROM 0-60 MPH	25 seconds

DaimlerChrysler Composite Concept Vehicle

The quickly emerging market for personal transportation in developing nations presents many problems for manufacturers. The issues that must be addressed include economy, politics, availability of maintenance and fuel, unusual uses, poor road infrastructure, overcrowding, and the devastating possible repercussions of increased pollution. The DaimlerChrysler CCV, produced as a working prototype in 1997, is an ingenious example of a car designed from scratch for exactly this market; an inexpensive and sturdy car for developing nations. The car's styling and name are reminiscent of the much loved Citroën 2CV, and the designers and engineers of the CCV began the project by rethinking the actual production with an emphasis on keeping costs down. "Our initial direction was to develop a car that was as easy to assemble as a toy," said Chrysler Executive Vice President, François Castaing.

The result of this rethinking is an extremely rational automobile. A process was developed to make injection-molded composite body parts that were three times the size of what was previously possible, and the entire body is joined together using only four bolts and adhesives. The composite body—two halves split front to back—is attached to a steel frame and is molded in color rather than painted, saving costs and production time, as well as reducing emissions at the plant. Because of this new manufacturing process start-up is much faster, the costs are only a quarter of the average costs, a much smaller factory is required, production time is cut to six and a half hours as opposed to twenty for average economy car, and the number of parts is one quarter of the previous amount. The cost of the material polyethene terephthalate (similar to that of plastic soda bottles) is only $1.10 compared to $5-$10 per square foot of material for a normal car and is also one hundred percent recyclable.

Because the car is extremely light, weighing only 1,200 pounds, it can be powered by an extremely small, two-cylinder engine that gets about 50 mpg (miles per gallon) and produces little emission. The sparse interior is easily washable, as is the exterior, and its zip-down hood is desirable in the commonly hot climates of poorer nations. Consideration for the quality of roads is also apparent in the unusually high wheel clearance of eight inches.

DaimlerChrysler Smart Car

"Reduce to the max" has been the marketing line for this city commuter car developed by Swatch watch company and Mercedes Benz. In 1998 Daimler Benz, now DaimlerChrysler, acquired Swatch taking over full control of production of the car. This two-seat, ultra-lightweight, gas-efficient auto represents a rethinking of the private car and the way it is marketed to the public. They are sold across Europe at one-stop "Smart Centers" where one can purchase, lease, rent, finance, and insure a car all under one roof. The auto is intelligently designed for those living in or near crowded urban environments who need a small vehicle to run errands or commute to an office. The car is intended to be affordable, easily customizable, and stylish—bearing a direct connection to the Swatch watch, which revolutionized the marketing and production of watches in the 1980s. The car takes only four and a half hours to produce compared to the approximately twenty hours for most economy cars. The rust- and dent-resistant body panels are available in a variety of colors, and if the owner tires of the color, it can be easily replaced by a technician in two hours for a reasonable fee.

The Smart Car, with its unique multi-colored dashboard and controls, is intended to attract a younger auto buyer or urban sophisticate looking for something unusual. This is further evidenced in features such as front and side airbags and a "softip" gearbox that allows the driver to switch gears manually without the use of a clutch. Passengers actually sit above the mechanical parts and the engine to save space. The Smart is only eight-feet, two-inches long and four-and-a-half-feet tall and wide. Its length is ingeniously only half of the space of a traditional European parking space, potentially creating twice as much parking. It weighs only 1,700 pounds but has a reinforced metal frame visible from the outside that makes the car strong, stable, and relatively safe.

BODY CONSTRUCTION	Steel space frame with plastic composite body panels
YEAR AND COUNTRY INTRODUCED	1998 in Europe
TOP SPEED (MPH)	84 mph
ENGINE	3 cylinder
Type	55 hp
Displacement	36.6 cubic inches
Power	55 hp at 5,250 rpm
Torque	95-119 ft.lb.
DIMENSIONS (INCHES)	
Length	98 7/16"
Width	59 5/8"
Height	60 3/16"
CURB WEIGHT	1,587 lbs.
FUEL ECONOMY (MPG)	49 mpg
(PREDICTED) PRICE IN $US	$9,300-$11,500
SECONDS FROM 0-60 MPH	17.5 seconds

Ford Ka

BODY CONSTRUCTION	Unitary-welded steel body
YEAR AND COUNTRY INTRODUCED	1996 in Europe and Brazil
TOP SPEED (MPH)	96 mph
ENGINE	4 cylinder
Type	1.3i Endura-E 44KW (60 PS) or E 37KW (50 PS)
Displacement	79.3 cubic inches
Power	37KW or 60 PS
Torque	77.4 ft.lb.
DIMENSIONS (INCHES)	
Length	142½"
Width	64³⁄₁₆"
Height	53⅞"
Wheelbase	96⅜"
CURB WEIGHT	1,962 lbs.
FUEL ECONOMY (MPG)	48 mpg
(PREDICTED) PRICE IN $US	$11,200-$14,000
SECONDS FROM 0-60 MPH	15 seconds

The Ford Ka, introduced in Europe and South America in 1996, is an appealing, small, and affordable car that doesn't induce any of the sense of sacrifice that many of the entry-level cars of the past did. The Ka—an Egyptian word for vitality—has an unusual front-to-back bubble shape that offers a sophisticated and likable contour. The car is a mere 1,958 pounds and shorter than even the Ford Fiesta or Escort. Its performance, however, outshines many subcompact cars, even with a fuel rating of 48 mpg (miles per gallon). Its organic shape affords the car a low drag efficiency, and the three-door styling achieves the maximum amount of interior space with the minimal footprint for easier parking and maneuverability. Visibility has also been maximized by including large glass areas. In addition, the interior has been rethought to include a curving wraparound driving console and many small storage units, a feature popular with younger drivers who tend to keep lots of smaller objects in their cars. The production of the car was also streamlined by reducing the number of parts from 3,000 for a Fiesta to only 1,200 for the Ka.

Audi AL2

The AL2, a concept car developed by Audi, addresses many of the issues integral to the car for the next millennium and represents an important departure both in terms of styling and engineering from present automobiles. Scheduled to go into production in the fall of 1999, the AL2 features extensive use of weight-saving aluminum that was pioneered by Audi in the A8 sedan. The overall gas mileage is as much as forty percent better than a conventional car. A sophisticated space-frame structure enhances weight savings, stability, and strength. This automobile weighs approximately 1,700 pounds–575 pounds lighter than the same car with steel parts. The AL2 debuts a three-cylinder, spark-ignition model that produces fifteen to twenty percent better fuel economy than a conventional spark-ignition engine. Like the Multipla and the Smart, the passengers are raised above the power source, creating greater safety and a comfortable amount of room for four occupants.

The rectangular and boxy form of the Audi illustrates a recent trend among some manufacturers away from the sinuously continuous shapes of the past first made popular by the Italian Continental designers of the 1950s and 60s. Like the recent Beetle and the Audi TT, the AL2's styling appears to confirm the manufacture of the automobile as sum of different interconnecting parts. The car's unique transparent roof allows light to stream in through frosted green plastic windows supported by light alloy struts. In an attempt to make the car "family friendly," an advanced electronics package includes a steering wheel-based control system, a navigation system, photo-sensors for parking, emergency call, and an automatic distance control that alerts drivers when they are getting too close to the car ahead. A manual gearbox features an automatic clutch.

BODY CONSTRUCTION	Aluminum space frame with aluminum panels
YEAR AND COUNTRY INTRODUCED	Fall 1999
TOP SPEED (MPH)	106 mph
ENGINE	3 cylinder
Type	Spark-ignition direct injection; aluminum cylinder crankcase
Displacement	73 cubic inches
Power	75 bhp at 5,500 rpm
Torque	115 Nm at 3,000 rpm
DIMENSIONS (INCHES)	
Length	148"
Width	63¾"
Height	60³⁄₁₆"
Wheel Base	94¾"
CURB WEIGHT	1,653 lbs.
FUEL ECONOMY (MPG)	57 mpg
(PREDICTED) PRICE IN $US	N/A
SECONDS FROM 0-60 MPH	less than 12 seconds

BODY CONSTRUCTION	Steel space frame with aluminum panels
YEAR AND COUNTRY INTRODUCED	1997 as concept car only
TOP SPEED (MPH)	130 mph
ENGINE	
Type	Rover K Series
Displacement	109.6 cubic inches
Power	145 PS at 7,000 rpm
Torque	174 Nm at 4,500 rpm
DIMENSIONS (INCHES)	
Length	157½"
Width	67"
Height	55"
Wheelbase	94"
CURB WEIGHT	2,425 lbs.
FUEL ECONOMY (MPG)	36.3 mpg
(PREDICTED) PRICE IN $US	N/A
SECONDS FROM 0-60 MPH	7 seconds

BMW/Rover Group Mini Millennium Concept Car

The Mini, produced originally by BMC (British Motor Corporation) in 1959, is an archetypal example of the small, economical car. Developed to fulfill the growing need for basic affordable transportation in postwar Europe, especially following the 1956 Suez Crisis that necessitated gasoline rationing throughout England, the Mini in one form or another has been in continuous production ever since. Originally designed by Sir Alex Issigonis, who intended it as a sporty and affordable form of transportation for four passengers, the car allows for the greatest interior space with the smallest exterior dimensions. This was achieved by placing the small engine horizontally in the front and providing the car with front-wheel drive. Its popularity is attested to by the fact that over 5 million have been sold internationally.

Built on an existing mechanical platform used for the current MG, the new Mini features a steel frame with lightweight, aluminum body panels. Its shape represents an updating of the traditionally functional and boxy Mini form—more rounded, sportier, and with softer edges than its predecessors—producing a less awkward and more purely functional look than the original. The BMW/Rover Group's new Mini Millennium Concept Car represents a return to a classic people car and confirms the growing need for these kinds of cars in the coming century.

Different Roads

Automobiles for the Next Century