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SECTION 2

PART 1

THE UNITED STATES TECHNICAL PRESENTATION ON ESV DEVELOPMENT

FAIRCHILD INDUSTRIES

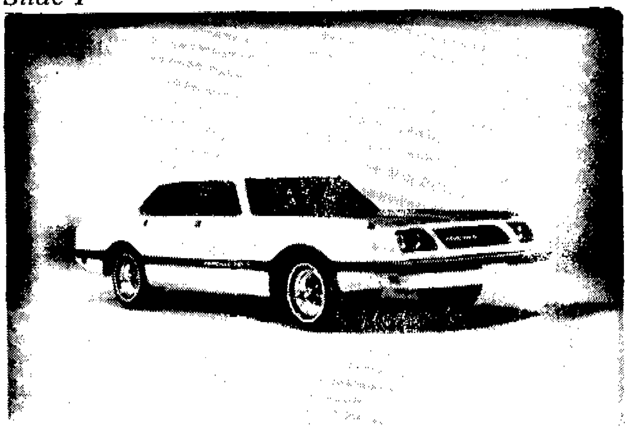
Dr. N. Grossman
Vice President

Good afternoon ladies and gentlemen. The presentation which you will be given is basically in two parts. We will have Mr. Sol Davis, who is our Chief of Systems Engineering, discuss the progress we've made to date on Crash Injury Reduction. He will be followed by Mr. William Wait, who is Chief of Systems Test, on Accident Avoidance. The material was all developed since the summer of 1970 when this contract was awarded to us. Now our primary area of competence is in the field of the design, development, test and production of military aircraft. We used much of the technology from that field in the design concepts introduced into the safety vehicle. However we were very fortunate in having the technical assistance and support of two of our subcontractors in areas where we lacked this competence. And so I would like to take this occasion to acknowledge with thanks the support of the Chrysler Corporation who were technical consultants to us and provided some of the hardware, and to the Digitek Corporation of Los Angeles, Calif. who provided the test facilities. So without further delay I would like to introduce the first speaker, Mr. Sol Davis.

Mr. S. Davis

Thank you Dr. Grossman, good afternoon ladies and gentlemen. It is my pleasure to present the Fairchild Experimental Safety Vehicle.

Slide 1



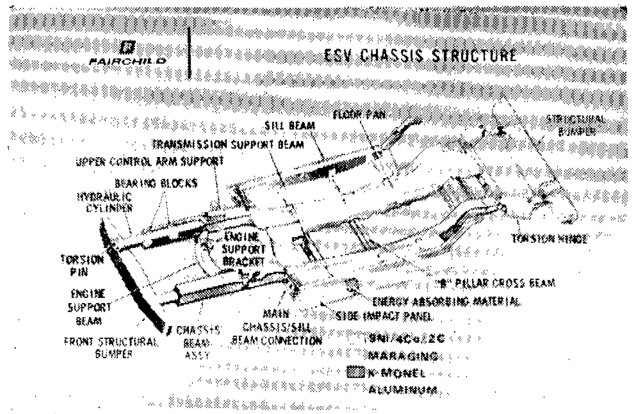
This three quarter view illustrates the program management decision that this Family Sedan should have the appearance and design of a real world automobile. The vehicle has a curb length of 220", it has a width of 80", and a height of 58" excluding the periscope. The chassis is mounted on a 121" wheelbase. The size of the car was dictated by the need to accommodate five 95th percentile occupants, and the padding required by the passive occupant restraint systems.

For the structural design approach we had several options based on our aerospace technology experience. We could have proceeded with a steel tubular truss structure covered with a non-structural material such as fabric – the way simple aircraft was built in the past. This technique would have offered a design easy to analyze and test, and cheap to manufacture. On the other extreme, we could have used sophisticated aerospace materials such as beryllium and titanium, which have very attractive strength-to-weight ratios. We chose the middle route: a structural design that would look and smell and feel like a real world car, within the manufacturing restrictions of a prototype vehicle. Our goal has been an integrated system design that would aid in the setting of future automotive safety standards.

I would like to go into the details of the structural configuration and then we will go into some performance characteristics.

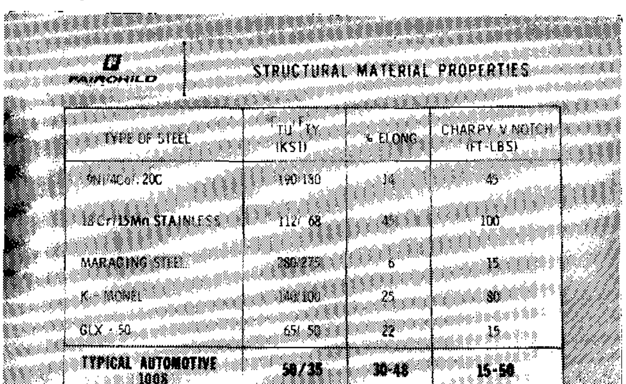
This slide is color-coded to indicate some of the materials that we are using in the chassis structure. The dark blue is a 9-4-20 high strength steel, the yellow is a high strength maraging steel, the small red circles you see are torsion pins made of K-monel metal, and we have used some aluminum as indicated by the light blue.

Slide 2



Starting on the left of the figure we have the front bumper and the hydraulic cylinders. I would point out that the stroke of the hydraulic cylinders is 18" when the bumper is in the retracted position; in the extended position at speeds above 30 miles an hour we have a hydraulic stroke of 30". Continuing toward the right we have the front chassis beam assembly followed by the main chassis beams underneath the passenger compartment; in the rear you see our torsion hinge assembly in yellow. The arms of the torsion hinge assembly are designed not to yield. That is why they are made of the special maraging steel. I would point out that the particular design concept was dictated by the short time schedule of our program. In actual production we feel that an S frame could be designed by a repeated design/test/redesign program to give us the same results. Finally we see the rear bumper.

Slide 3


FAIRCHILD

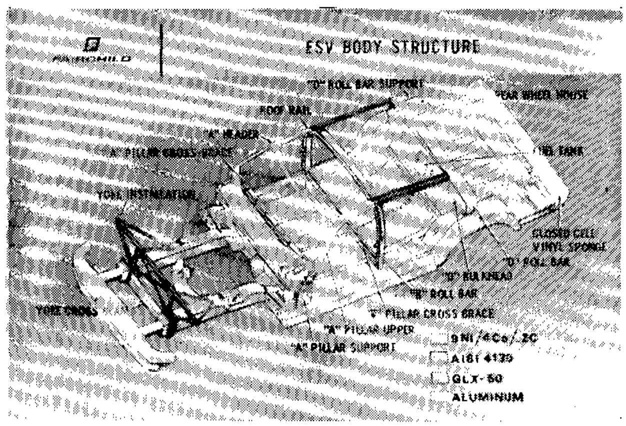
STRUCTURAL MATERIAL PROPERTIES

TYPE OF STEEL	T_U/T_Y (KSI)	% ELONG	CHARPY V NOTCH (FT-LBS)
9NI/4Co/.20C	190/180	14	45
18Cr/15Mn STAINLESS	112/68	45	100
MARAGING STEEL	280/275	6	15
K - MONEL	140/100	25	80
GLX - 50	65/50	22	15
TYPICAL AUTOMOTIVE 1008	**50/35**	**30-48**	**15-50**

In order to understand the choice of materials, we've made up a table showing some of the structural materials and their properties *(Slide 3)*. The first column shows the type of material, for example 9% nickel, 4% cobalt, .20% carbon steel. The next column shows the ultimate strength and the yield strength; for the 9-4-20 steel, it is 190,000 ksi for the ultimate strength and 180,000 ksi for yield. Also important in yielding structures is the percent elongation which is 14% for that particular steel. Also of use in evaluating materials for crashworthiness is the Charpy V notch value in foot-pounds.

We are using some stainless steels where we need very long elongations. As you note stainless steel has a 45% elongation. The maraging steel has an ultimate of 280,000 and a yield of 275,000 pounds per square inch, and the K-monel metal is somewhere between the strength of the stainless steel and the 9-4-20. The GLX-50 is a commercial grade of steel with a somewhat higher yield strength than the typical 1008 automotive steel which has only a 50,000/35,000 ratio of ultimate to yield. In order to get increased strength with minimum weight, our approach has been to go to higher strength steels rather than increase gauges.

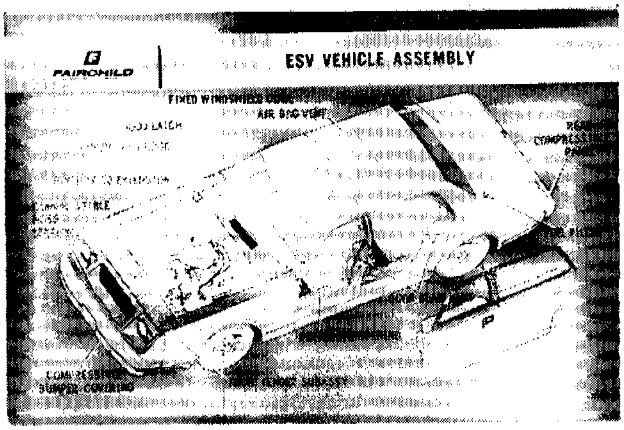
Slide 4



The next slide shows additional elements of the body structure *(Slide 4)*. You'll notice on the left side, in orange, is an AISI 4130 steel we use for our unique radiator bulkhead. This structure serves primarily for rollover protection; if you draw a line between the B pillar and the radiator bulkhead, that line limits the deformation at the A pillar to about 3 inches. We also see more of the 9-4-20 steel being used in the B pillar to improve rollover protection.

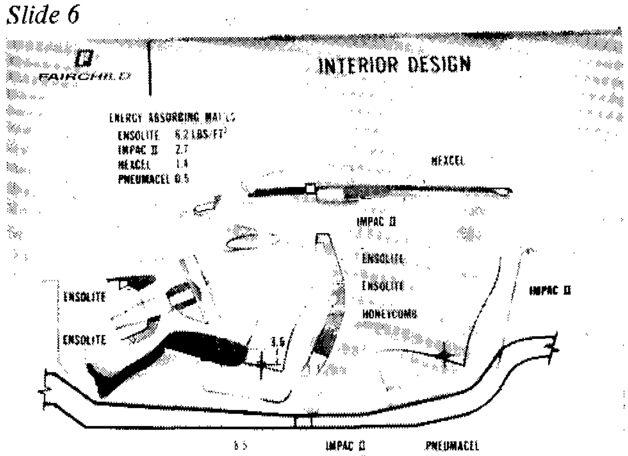
Here is the exterior view of the vehicle assembly which shows that we are primarily using conventional sheet metal on the outside of the car. Inside the doors you will find, not shown here, stainless steel side support beams which will be described later. They are stainless steel because we need very large elongation. This figure also shows the compressible nose section, just in front of the head lights. This will deform during a 10 mph frontal impact, and return elastically to its original position. Also shown in this figure on the roof is the position for

Slide 5



the periscope and for the airbag vent ports which we will discuss a little later.

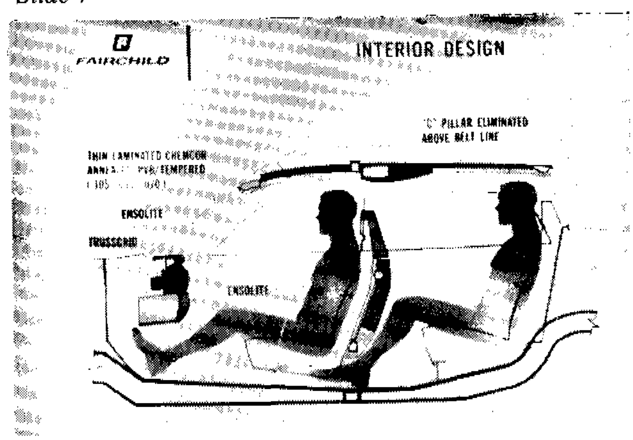
Slide 6



This is an interior view; let us look at the driver position first. The driver's seat range is 8½ inches fore and aft, 3½ inches up and down, in order to accommodate from the 5th percentile female through the 95th percentile male. The steering column is a conventional collapsible column with a forward and aft adjustment of the assembly to accommodate the range of drivers. Also shown in the driver's position is the blue impact area which is Ensolite. Let us look at the table at the top of the chart. This indicates some of the interior padding materials which we are using in our safety sedan. Ensolite, which weighs 6.2 lbs. per cubic foot, is a comparatively heavy material but it has much greater energy absorption per unit volume than any of the others. We are also using Impac II which weighs only 2.7 lbs. per cubic foot in less critical, secondary impact areas. We are using a Hexcel honeycomb which crushes at a prescribed pressure level, and it has a very attractive density of 1.4 lbs. per cubic foot. We are using Pneumacel in the actual seat cushions for comfort, and that has a density of 0.5 lbs. per cubic foot.

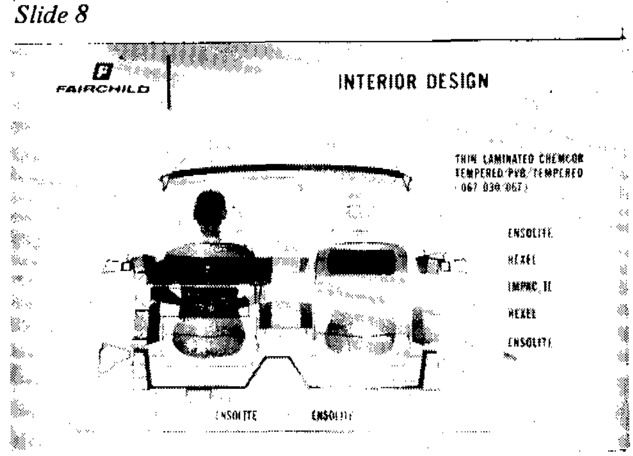
Getting back to the driver, the knee restraint for the driver is a one inch thickness of Ensolite backed up by a crushable panel. There is an airbag inside the deep dish steering wheel, and that bag would be activated at speeds above 15 mph. In this view you can also see the rear passenger. His airbag is mounted in the roof, and his knee restraint is basically Ensolite, backed up by that aluminum honeycomb panel. You can see the Impac II and the Hexcel honeycomb in the roof. It would be desirable to put in Ensolite there, but as it is considered a secondary impact area (it is very difficult to predict what will happen) we have chosen to save some weight there and go to somewhat less efficient Impac II material. Also shown here is the periscope subsystem made by Donnelly Mirrors.

Slide 7



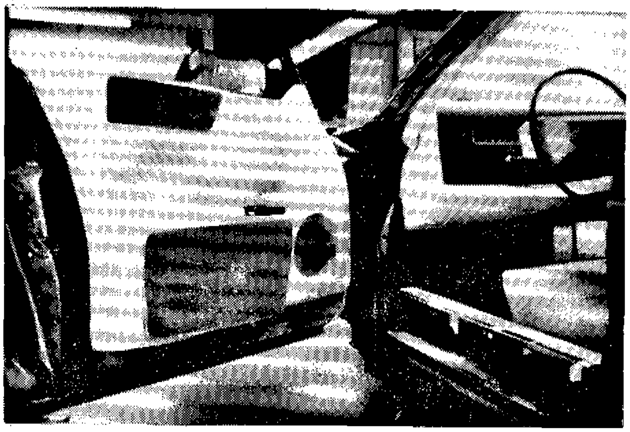
This view shows the front passenger position with the airbag mounted in the dash panel. The knee restraint is made of Ensolite, backed up with Trussgrid, a crushable honeycomb material. The windshield is a thin laminated Chemcor, such as we started to develop on our New York State Safety Car Program.

Slide 8



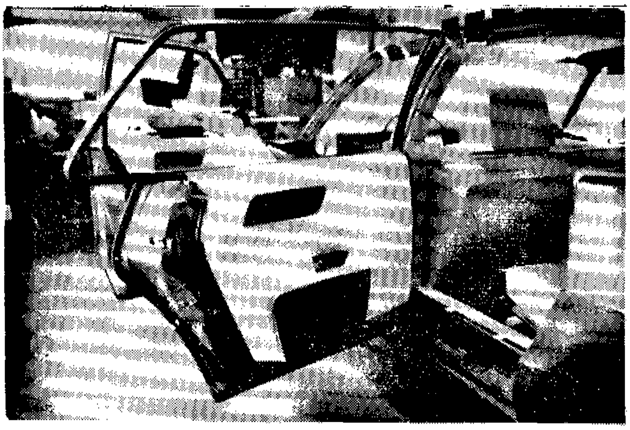
Here is a view that shows some of the side protection safety materials. We have a shoulder restraint. We have a hip restraint. These have been sized to consider the proportion of the weight in the body that has to load up these two areas. We're using a combination of Ensolite and Hexcel honeycomb. The Ensolite has the important characteristic of returnability, so that if you push on it lightly it will return to its original position. In a severe crash the Hexcel, if loaded up to its crushing level, will permanently deform and would have to be replaced. We also have a side support in the center, between the front passenger and the driver, which will serve to restrain them sideways if the crash is on the other side of the car.

Slide 9



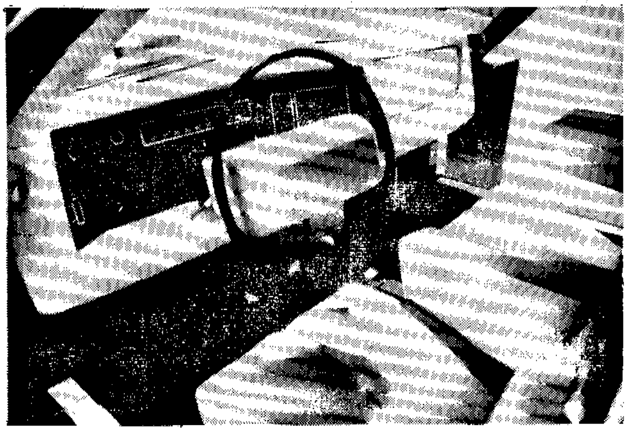
Here is a mockup, made by Loewy/Snaith, showing the front door with the shoulder restraint and the hip restraint and also showing access into the vehicle. We also see the recessed door knob and the window regulator.

Slide 10



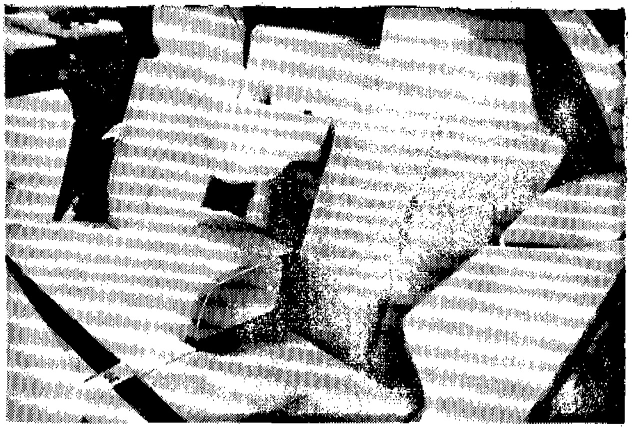
Here is another view, showing the rear door. Notice the cutout on the door, which aids in getting in and out of the car at the rear seat. You'll also notice the very large rear door window that was done for two purposes: one was to increase visibility, and two, to try and get the head side impact area to be glass rather than a steel support post.

Slide 11



This is an interior mockup of the driver's position showing the location of the airbag and a partial view of the instrument panel.

Slide 12

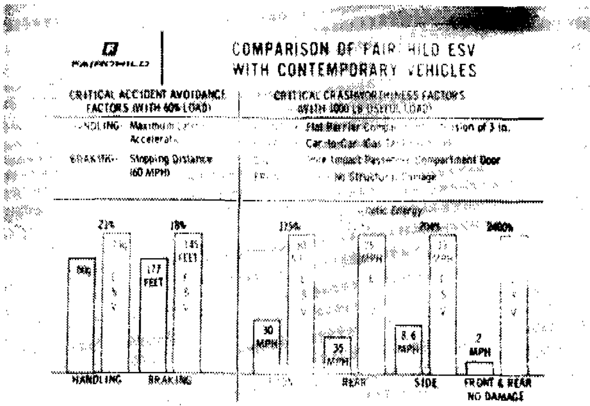


This mockup shows the unique rear system. The rear can accommodate three 95th percentile persons. The hip and arm supports that you see there move up when you want a person to occupy the center seat. It is a passive restraint in that it will normally be in the down position unless you physically push it up.

Now I'd like to discuss some of the performance characteristics and the details of the front impact subsystem which we consider to have the highest priority.

This slide indicates some of the performance that we have in the ESV in comparison to contemporary vehicles. On the left side we have typical accident

Slide 13



avoidance factors, for example, handling. The first two comparisons show that a typical car can sustain about .60 g's as the maximum lateral acceleration, and our ESV can get about .73 g's. Under braking, a typical stopping distance is 177 ft. for contemporary vehicles; our ESV is expected to stop from 60 mph in 145 ft.

But of greatest importance is the crashworthiness area, and we can see from the comparison for front impacts that contemporary vehicles have a capability of 30 mph for no more than 3 inches of intrusion whereby our ESV is expected to have a 50 mph capability. For rear impact, for example, if we use the rupture of the gasoline tank as the criteria, typical current vehicles can sustain about a 35 mph rear impact speed; our ESV should be able to take 75 mph by another ESV without gas tank rupture. For side impact, current vehicles have a capability of about 8.6 mph, our car will have a capability of 15 mph into a rigid pole. But the most dramatic improvement is in the front and rear no damage performance. Current vehicles, and by that I mean at the time the program was started, had a capability of perhaps 2 mph; we are going to have 10 mph front and rear capability with no damage.

We think that this kind of safety improvement is going to be dramatic. However, you don't get anything for nothing, and we just want to point out some of the weight increases we have had to incorporate into the vehicle which we have had very little control over.

For example, in order to accommodate the requirement for passive restraint (and that means the airbags and padding as opposed to a belt system), we have had to put in about 208 lbs. of weight. In order to improve the braking performance, using a Bendix-Chrysler type system there is a weight penalty of 72 lbs. We were forced to go to a periscope because the head restraints for the rear occupants effectively block out the backlight. The Donnelly Mirror Co. periscope system has

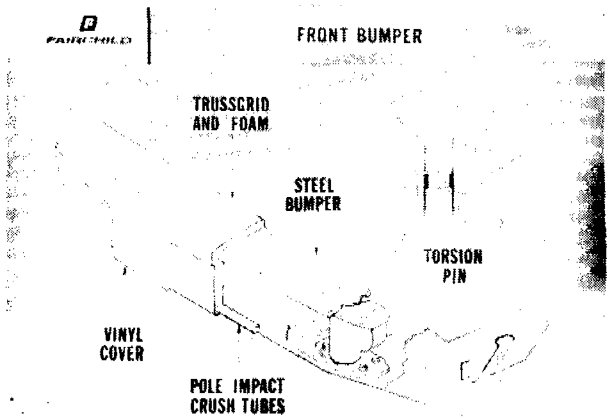
Slide 14

FAIRCHILD | MANDATORY WEIGHT INCREASES

ITEMS	WT-LBS
PASSIVE RESTRAINT	208
ANTI-LOCK BRAKES	72
PERISCOPE	45
SEAT ADJUSTER	19
ANTI POLLUTION (73 vs 71)	25
TOTAL	+369 LBS

added about 45 lbs. Seat adjusters to accommodate the range of the driver and be able to stay in place during the 50 mph crash conditions has added 10 lbs. Anti-pollution requirements to raise the engine capability from the 1971 emission requirements to the 1973 emission requirements have added 25 lbs. A total of 369 lbs. has been added in terms of things we had no control over in order to meet the requirements.

Slide 15



This is a close-up of the front bumper. The bumper itself is made of steel and is covered with Trussgrid and foam, and finally by a vinyl cover. You will see the two pole impact crush tubes which are made of stainless steel; these are there primarily to help absorb the kinetic energy of the bumper itself during a front pole impact at 50 mph. Also shown are the torsion pins that connect the hydraulic cylinders to the front bumper; these aid in getting us better performance in angular impacts which is of course, one of our requirements.

The most severe condition for that front bumper, which I indicated, is pole impact. This shows the