Propulsion System

- Conventional
  - This is your internal Combustion Engine (Gas and/ or Diesel)
- CNG (Also, Propane, Butane, LNG)
  - Powered by compressed Natural Gas
- Electric
  - Electric battery powered vehicles
- Hybrid
  - Electric low speed and gas high speed

Propulsion System

- Conventional
  - Majority of vehicles on the road
  - Use internal combustion engines
  - Burn gasoline or diesel fuel
- Hazards
  - Fuel leaks
  - Short circuits
  - Battery acid leaks
Propulsion System

- CNG (Also, Propane, Butane, LNG)
  - (CNG) Powered by compressed natural gas
    - Cylinders usually in trunk, but can be in any convenient location
    - City buses and other fleet vehicles
    - Identified by CNG sticker mounted on front and back of vehicle

- CNG
  - After crash, cylinders or fuel lines could be damaged.
    - CNG could escape.
    - Threat of BLEVE

Propulsion System

- Electric
  - On November 14, 1996, General Motors Corporation rolled its’ first all-electric vehicle off the assembly line
  - Named the EV1, this two-passenger coupe is available through its Saturn dealerships in California and Arizona
    - Though Saturn is no long in production these vehicles are and you can still find them on the road.
Propulsion System

- Electric
  - Propelled by electric motor powered by batteries
  - Contains a large number of batteries
- Hazards
  - Large amount of energy stored in batteries
  - Potential electrical shorts
  - Leakage from damaged batteries
  - Voltage higher than 12-volt car battery

Propulsion System

- Electric EV1 is powered by a large bank of 26 12-volt lead-acid batteries

Car can travel a distance of 90 miles before its batteries need recharging

A wall-mounted charger and plug are used to hook into the front of the vehicle for recharging the battery bank
Propulsion System

• Hybrid
  - Use high voltage battery-powered electric motors (144 to 600 volts) and a gasoline-powered engine with a 12 volt electrical system
  - Electric power used at low speed, gas power at high speed
  - When stopped at a traffic light, both sources of power turn off. Sleep mode.
  (WARNING)
    • Car said to be hibernating

Hybrid

• Hazards posed are same as gas and electric-powered vehicles.

Propulsion System

• Hybrid

Others makers:
Chevrolet
GMC
Mercury
Dodge
Porsche
Ford
Lexus
Saturn
Propulsion System

- Hybrid Things to Know:
  - Electrical system wiring is usually bright Orange
  - Chalk Tires until electrical and gas system is disconnected, car in sleep mode!!!
When discussing vehicle anatomy, we will break the car into two basic categories:

- Exterior parts of a car
- Interior parts of a car

**Exterior Parts**

**PILLARS**

- Posts add structural integrity to the vehicle.
- Support the dash assembly (A post/pillar).
- Support seat-belt retractor assemblies.
- Serve as part of a window frame.
- In some cases serve as wiring chase.
- They are primary targets for the rescuer who desires to remove the roof.

**POSTS**

- Post used to be made of rolled sheet metal and were hollow.
- Usually reinforced at each end.
- They were a shingle thickness of metal at the center making the center of the pillar the weakest point.
- Exceptions to this “rule” include the B-pillar that house steel reinforcing plates for seat belts and the rear pillar of most sedans.
When looking at a post, try to imagine that the pillar is a column that extends from the floor level to the roof rail. It is then easier to understand why a car folds around a patient as is does; this columnar concept makes it easier for you to solve the problems of disentanglement.

PILLARS
Exterior Parts

ROOF
Exterior Parts

- The roofs of most cars were framed by hollow, rolled sheet metal of a heavier gauge than the skin of the automobile.

This has changed.

Old School
**Exotic metals**

• B Pillar of a Toyota Camry

**New School**

---

**Steel Strength**

Mild Steel
(56,000 lbs. Max tensile strength)

HSS - High Strength Steel
(50,000 lbs. Minimum tensile strength)

HSLA - High Strength Low Alloy
(87,000 lbs. Minimum tensile strength)

UHSS - Ultra High Strength Steel
(116,000 lbs Minimum tensile strength)

AHSS - Advanced High Strength Steel
(203,000 lbs Minimal tensile strength)

**Hydroforming**

A process in which hydraulic pressure forces water and oil through a steel tube, forming a seamless one piece structure.

---

**Other more exotic metals**

- Iron (Fe)
- Manganese (Mn) - Steel alloy
- Arsenic (As) - Solder
- Boron (B) - Steel
- Nickel (Ni) - High-strength, low-alloy steel
- Silver (Ag) - Electrical contacts
- Magnesium (Mg) - Aluminum alloy
- Lead (Pb) - Battery
- Chromium (Cr) - Plating
- Cadmium (Cd) - Plating
- Nickel (Ni) - Plating, Stainless steel
- Copper (Cu) - Electrical wiring, radiator

* Red Color denotes metals we need to defeat...

- Zinc (Zn) - Anti-corrosion plating
- Vanadium (V) - Steel
- Cobalt (Co) - Steel
- Barium (Ba) - Engine lubricants
- Strontium (Sr) - Steel
- Tungsten (Wo) - Light filaments
- Titanium (Ti) - Steel, paint
- Molybdenum (Mo) - Engine lubricants, steel
- Sodium (Na) - Grease
- Calcium (Ca) - Oils, greases
- Lithium (Li) - Grease in the door locks
- Germanium (Ge) - Diodes
- Gallium (Ga) - Diodes
- Tin (Sn) - Solder
- Antimony (Sb) - Solder

---
Exotic metals

Exotic metals

Thinnest Boron is 1.0mm
Thickest Boron is 1.9mm (75/1000th of an inch)

More exotic metals & foam technology

These metals can be stronger than the best tools produced.

Foam Filled B Pillar

Use Caution!!!

Frame Design

There are three basic trends in the framework of today's automobiles:

• Unit-body
• Full-frame
• Space-frame designs.

Each design has unique qualities, and each type of vehicle should be studied.
**Unit-Body Design**

**Frame design**

- Most prevalent technique used today.
- The design has no frame underneath the body to hold the components together... instead, it uses the floor, posts, doors, and roof to hold the car together.

**Unit-Body Design**

**Frame design**

- Another look...
In 2003, Volvo’s SUV, the XC-90, was an industry first adding a rollover protection system with a BORON steel reinforced roof structure (high strength, low alloy metal).

- Similar to roof truss building construction where construction members are under tension and/or compression, the vehicle is structurally sound.
- Because of the construction, completely stabilize and crib the vehicle prior to taking any actions such as cutting roof posts.
- Why?
• Full-frame type design is found mostly on station wagons and light trucks.
• Full-frame has two steel rails providing the support to which the floor, suspension, drive train, and body are attached.
• While a full frame gives the vehicle good support, it is still essential to stabilize all vehicles properly prior to performing rescue techniques.
**Space Frame design**

**Frame design**

Introduced to the nation in the 1983 Pontiac Fiero.

- This design trend has been well received by the auto industry, and we can expect to see more use of it in the future.
- Space frame resembles a bird cage, the frame is self-supporting, and the body consists of a series of plastic panels attached to a space frame with rivets and screws.

- The body is designed for appearance and to protect the passengers from the elements, not for support of the structure.
- Therefore, it may be necessary for rescuers to remove the body panels in order to get to the metal that is actually entrapping the patient.
- Most older model space-frame materials are steel but all-plastic models have been successfully crash tested.
PLASTICS in Auto's

• In 1986, the United States, for the first time ever, produced more pounds of plastic than steel, largely attributed to the automobile industry.
• Plastics and polymers now replace the heavier steel in many applications. The reason is the all mighty dollar: plastic is cheaper than steel.

Plastics

How does all this affect the rescuer?

• First, plastic burns well, produces harmful and even deadly, gases and heavy black smoke.
• As far as extrication is concerned, plastic panels inside the car can be penetrated by extremities (most often the knees) and trap the patient like a pair of “Chinese handcuffs.”
• This problem presents a challenge to the rescuer, who must cut away the plastic.

ROOF

Exterior Parts

• This frame provides some roll-over protection but is dependent on the strength of the posts.
• Across the opening in the frame you will find pressed sheet metal ribs to furnish rigidity for the sheet metal skin cover.
**ROOF**
Exterior Parts

- Reinforcement plates for the seat belts can be located where the seat belt enters the roof assembly and feeling for the lump around the retractor.

- **Warning:** To avoid damage to the tools you are using to cut the roof and to avoid delays caused by having to cut through the thicker metal of the plate, cut the roof rails.

---

**Doors**
Exterior Parts

- While the doors on a vehicle are designed to allow easy access and egress to the passenger compartment, the doors, when involved in a serious accident, can become the rescuers' biggest headache.

- It is important for the rescuer to consider a door as an assembly with characteristics that can be used in his favor.
• First, inside the door is a side-guard beam that extends from the area around the latch to the front side of the door, somewhere at the pillar.

• The bars are made of heavy-gauge sheet metal, next generation models are made of boron or titanium having a tinsel strength far above many tools ability to cut.

• Note the integrity of the door remains intact.
• Other configurations to consider.
• Note: The door latch is seated into the side guards design.

• Anyway you look at it. They are getting harder to get into.
• This calls for a new technique for rescue, (Window Spread) especially if the side bars have been jammed into the apposing posts due to the impact.

• Traditional door handles operate a long lever mechanism that unlatches the positive latching mechanism of the nader pin.
• This American automobile positive-latching design offers a two-point catch over the nader pin.

• Foreign cars have radically different types of door latches and may pose a more difficult problem for the rescuer.
• Some German-made cars have a receiver that is a solid socket that accepts a latching pin and is solidly secured.
• Asian cars have a latch mechanism that the door surrounds.
• During extrication it is common for the latch to remain intact.
Doors
Exterior Parts Rear Hatch or 5th Door

- Rear deck lid, or hatch on the hatch back or station wagon is usually lifted by means of pneumatic cylinders or torsion bars that are under pressure.
- **DO NOT CUT** such cylinder/bars.
- Use caution when cutting around them because they can literally fly up and out with violence.

---

Doors
Exterior Parts Rear Hatch or 5th Door

The 2003 Honda Element has changed everything...

---

Doors
Exterior Parts Rear Hatch or 5th Door

- 58% vehicle weight supported by front suspension system
- Composite boy panels
- Unit-body construction
- Seatbelt mounted on cargo doors
Doors
Exterior Parts Rear Hatch or 5th Door

- Occupant Position Detection System (OPDS) for front passenger side-impact airbags
- Front seatbelt pretensions
- Clamshell tailgate
- Rear seat stowing and recline features

2007 JATECH Disappearing Door

- In 2007 Jatech LLC a California Corporation introduced the disappearing door.
  - This new design has numerous advantages over conventional door design.

Disappearing Door

- This design works in a tubular type of system and is stronger than conventional design.
- The manufacture has not produced any documentations concerning rescue.
Prototype

- Significant improvement in strength, stiffness and lightness of overall structure.
- Applicable to all traditional and modern construction materials.
- Greater safety in door operation and vehicular crash worthiness.
- Access to occupant and/or their escape greatly enhanced in serious crash situations.
- Convenience of power operation.
- Moving doors will stop and reverse if foreign object detected.
- Vehicle floor and belly pan form a box-like structure which greatly enhances body stiffness and strength.
- New geometry of inner and outer sills also contributes to overall structure efficiency and weight savings.
- Passenger doors can be opened and closed safely from driver’s seat via window lift type activation.
- Side mirrors remain in place when door is opened enabling continued observation of traffic from behind.
- Drop door does not swing out endangering other road users or pedestrians. No door ‘dings’.
- Compact outer sill reduces ‘step over’ during entry and egress.
- It may be constructed as a modular component with the door frame designed to reintegrate structurally with the main vehicle body.

Take 5

- In 1973, it became law that the front bumpers on light vehicles were to be able to withstand a 5 mph impact.
- A year later, the rear bumpers were also included under this law.
- In order to comply, various methods of construction were employed to mount the bumpers in a way that would allow them to absorb shock and spring back into position.

Bumpers

Exterior Parts

- In 1973, it became law that the front bumpers on light vehicles were to be able to withstand a 5 mph impact.
- A year later, the rear bumpers were also included under this law.
- In order to comply, various methods of construction were employed to mount the bumpers in a way that would allow them to absorb shock and spring back into position.
• Warning: When exposed to heat from fire, drive shaft bumpers and gas filled struts can explode in a violent way.

• The problem with shock-absorbing bumpers lie in their ability to store potential energy during a crash, when the bumper is compressed and becomes tangled in metal, remaining compressed afterward.

• Such unexpected releases can cause great injury to anyone in the path of the traveling bumper.
Bumpers and Struts
Exterior Parts

• The safest approach to use when you encounter a loaded bumper or strut is to avoid it. Therefore, it is essential to avoid approaching a vehicle directly from the front or rear during a fire or extrications.

• Approach at a 45 degree angle.

Vehicle Fires

• Any motor vehicle with open flame visible upon your arrival is already a “Total Loss”

Don't hurt yourself!

Video
Holmatro 6
Vehicle Fires

- Common in most communities
- Important to wear SCBA
- Use 1 1/2" or 1 3/4" hose line
- Vehicles have shock absorbers, bumpers, and trunk/hatchback components that are gas-filled and may burst.
- Consider other hazards.

Fires under the Hood

- Approach from uphill and upwind at a 45° angle.
- Direct water into wheel wells and through the front grill.
- Wheels should be chocked.

Fires under the Hood

- Pull hood release latch.
  - If successful trip secondary latch
  - If not, use a Halligan to pry up a corner on the hood
  - Or, break the grill, cut the release cable and pull with pliers
  - Or, use a rotary saw to cut the latch from the hood
- Open the hood and extinguish fire.
- Care should be used to prevent splashing battery acid.
Fires under the Hood
- Consider leaking fluids that may be flammable.
- Overhaul same as a structure fire
- Use water liberally if significant damage has already occurred.

Fires in the Passenger Area
- Approach from upwind at 90° angle.
- Use straight stream from 50' and approach with slow, sweeping motion.
- Change to a fog when closer
- Foam can be used for any burning flammable liquids.
- Begin overhaul after steam clears.
- Do not place yourself in path of airbags.

Fire in the Trunk
- Use a Halligan tool to force the lock for entry.
- Charged line must be ready.
- Approach with caution; may have a variety of hazards inside.
Alternative Fuel Vehicles

- Be alert for these vehicles.
- Use unmanned master streams.
- Compressed Natural Gas (CNG).
  - Cylinders similar to SCBA cylinders
  - Usually in the trunk
  - Nontoxic & lighter than-air

Alternative Fuel Vehicles

- Liquefied Propane Gas (LPG)
  - Cylinders similar to those in heating/cooking
  - Heavier than air, vapors will pool or collect in low areas.

Tank blown approximately 95' from the vehicle

Alternative Fuel Vehicles

- Hybrid vehicles
  - Small gasoline motors and large battery banks
  - Batteries are very hazardous and may explode when burning.
  - Runoff is hazardous
  - High voltage lines can cause serious injury or death if cut.
LPG Car Fire

Fire & Compressed Gas Cylinders
Exterior Parts

Second strut bounced off building and landed in parking lot
Enough Said…

Get the point?

Fire & Compressed Gas Cylinders (Struts)
The largest strut in any vehicle is the drive shaft. If the drive shaft fails it is catastrophic. They have been shown to fly over 1000 feet and impale themselves in cinder block walls.

Automobile wheels have changed little since World War II. The car can rock from side to side on its tires during rescue if the automobile has not been properly stabilized prior to extrication.
This motion can also displace conventional cribbing if the tires are not deflated during the stabilization process.

Note: Discussing tires and wheels, one has to mention the topic of split rims.

Split rims, or two-piece rims, present serious hazards to rescuers and to anyone else who encounter them.

Step cribbing is essential to control movement.
The trunk of the automobile can house the fuel tank, batteries, hazardous cargos, or even people, in extreme cases.