

# Bringing a New Car to Market 4

## Engineering and Development

Jim Rauf

# Steps in Bringing a New Car to Market

## Introduction

A little history

Automobile industry

## Product Planning-Market Analysis & Identification of Opportunities

Understand market trends, consumer preferences, emerging technologies and government regulations

Analyze competitors - identify gaps in the market for new car

## Concept and Design

Translate market insights into conceptual ideas for a new car

Collaborate with design teams and engineers to develop innovative and appealing vehicle concepts

## Engineering and Development

Design the vehicle - safety, performance, and efficiency

Extensive testing - prototype testing, crash testing, emissions testing and performance testing

Address any design or engineering challenges that arise during the development phase

## Regulatory Compliance

Demonstrate safety, emissions, mileage compliance

Certify models' configurations

BEV mandates

## Manufacturing Planning:

Manufacturing plan - consider production volume, assembly processes, and quality control

Identify component suppliers establish partnerships

Set up manufacturing facilities and production lines

## Production and Quality Control:

Begin production - ensure adherence to quality standards and specifications

Implement quality control measures - identify and address manufacturing defects

Conduct pre-launch inspections and testing - guarantee the reliability and safety of the vehicles

## Launch and Distribution

Marketing campaigns to generate excitement and drive sale

Coordinate with dealerships and distributors to ensure a smooth rollout

Monitor customer feedback - address post-launch issues

# Cars are Complicated



## Bringing a New Car to Market

## Engineering

## Vehicle Design/Styling

The **design/styling phase** is the starting point of automotive **engineering**, where the overall look and functionality of a vehicle are determined

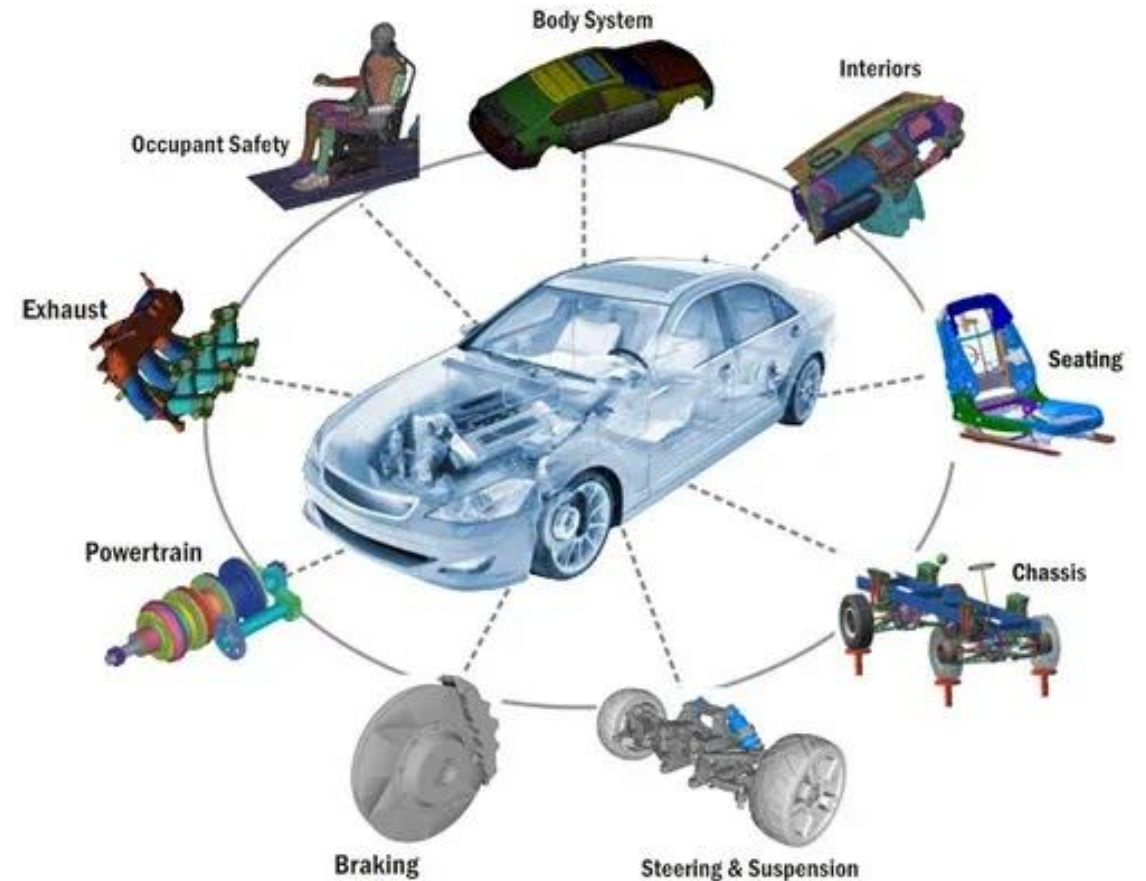
The focus is on creating vehicles that are **aesthetically pleasing**, aerodynamically efficient, safe, and functional

Factors such as **ergonomics**, **interior comfort**, and **exterior aesthetics** are all considered

**Styling** and **functionality** are often not compatible

**Engineers** and **stylists** have to discuss every inch of the vehicle to bring vision and reality together

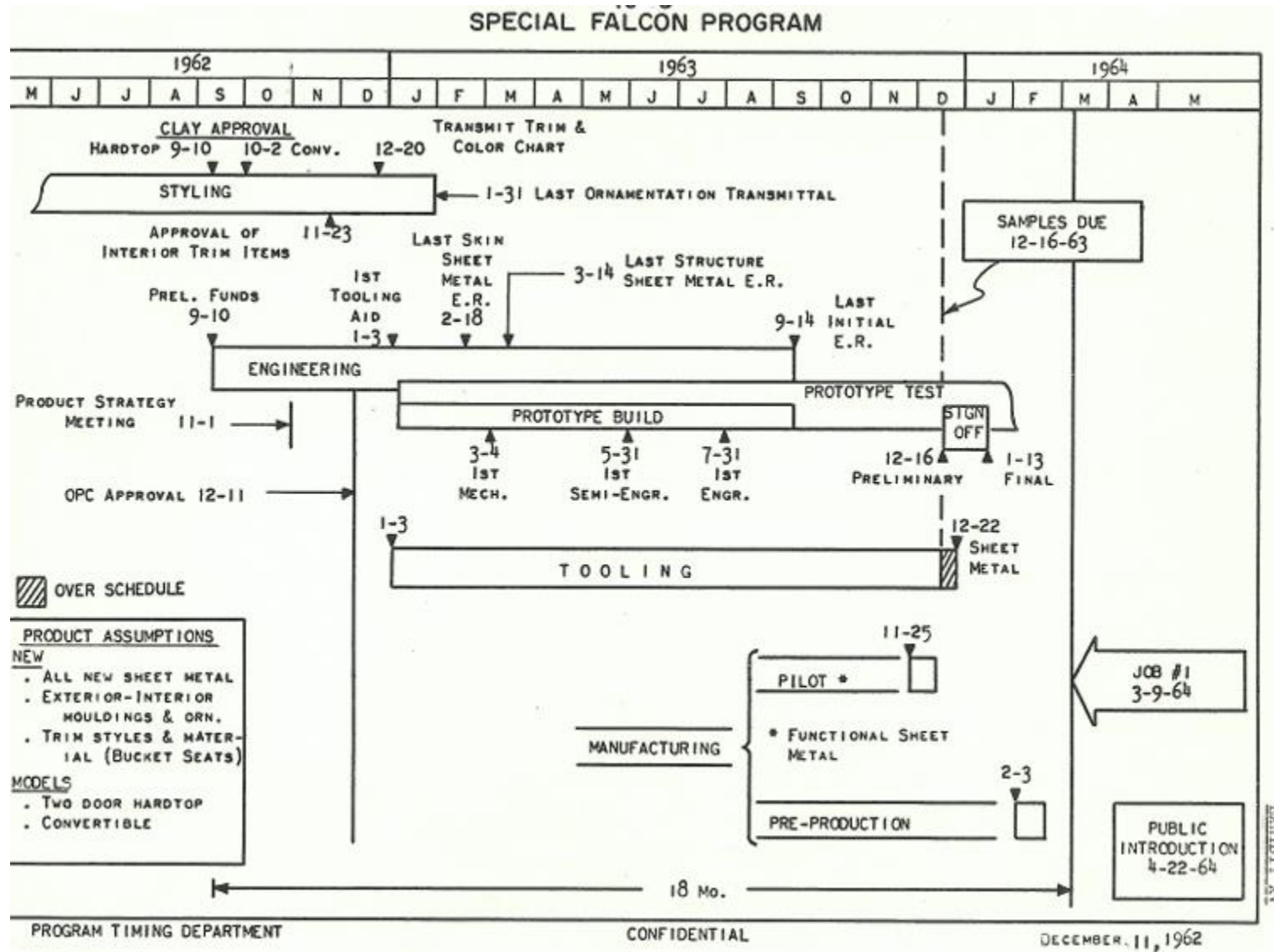
**Manufacturing engineers** assure that styling features can be translated into metal in production



# Bringing a New Car to Market

# Engineering

# Vehicle Design/Styling





## Bringing a New Car to Market

- Engineers work closely with designers to ensure that the aesthetic vision is feasible within the constraints of engineering principles
- They consider factors such as **aerodynamics, structural integrity, safety regulations, and manufacturing processes**
  - Engineers might influence the shape of the vehicle to improve airflow, reduce drag, or enhance crashworthiness
- Engineers help **choose materials** that meet both performance and styling requirements
- They evaluate factors like **strength, weight, cost, and manufacturability**
  - Engineers might suggest using lightweight materials like carbon fiber or aluminum to achieve certain styling goals without compromising performance

## Engineering Vehicle Design/Styling

- Engineers work with designers to integrate **electronic technology** such as **sensors, cameras, and displays** into the vehicle's design
  - They ensure that these elements not only function properly but do not disrupt the overall aesthetics of the vehicle
- Engineers optimize various components such as headlights, grilles, wheels, and body panels to achieve the desired styling effects while meeting functional requirements
- Engineers work to ensure that the design can be **manufactured efficiently and cost-effectively**
  - They work with designers to simplify complex shapes, minimize tooling costs, and optimize assembly processes without compromising the aesthetic appeal of the vehicle

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2.10.2 Solid Polymer Fuel Cell (SPFC)

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## Bringing a New Car to Market

- **ICE** powertrain is the **engine, transmission,** and **drivetrain** components - drive shafts , joints, differential ,etc
- Engineers work to develop **powertrains** that balance performance, fuel efficiency, and emissions
- **BEV** powertrain is **electric motor(s), transmission,** and drivetrain components –drive shafts , joints, differential, etc

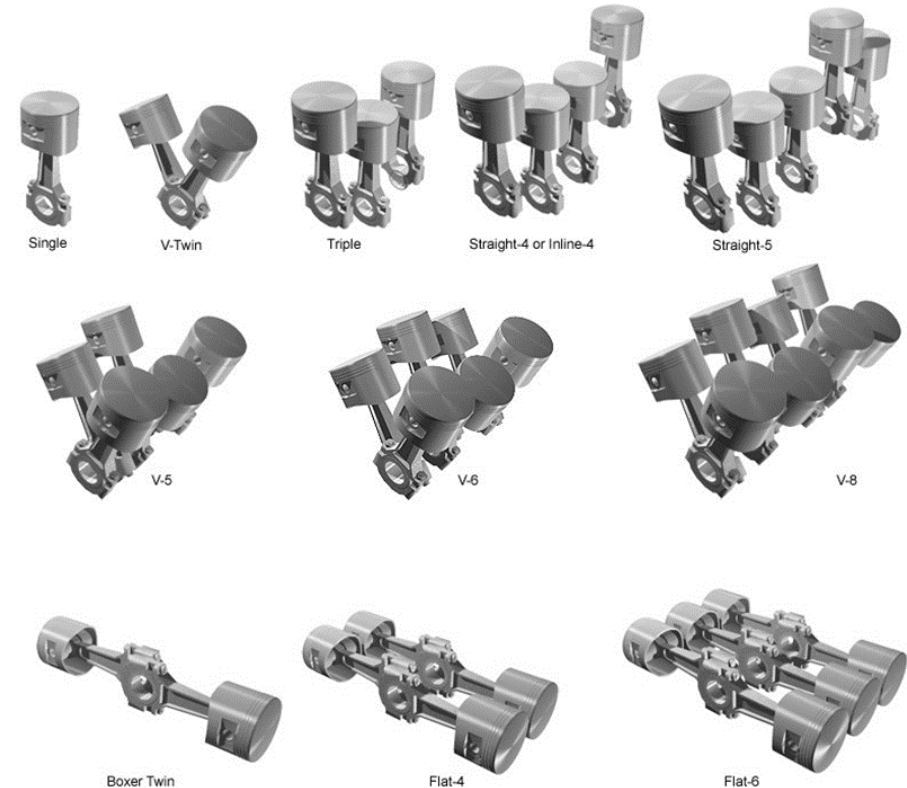
## Engineering Powertrains

- Engineers assess the desired **performance characteristics** of the vehicle , including **power output, torque, and acceleration**
- Goal is to **balance performance** with **fuel efficiency** to meet regulatory standards and customer expectations
- Engineers evaluate the overall cost-effectiveness of the engine, considering factors like manufacturing complexity, materials, and technology required
- The engine must be compatible with the vehicle platform, considering factors like **size, weight, and mounting points**
- The engine choice should **align with the brand image**
- **Consumer preferences** can influence decisions regarding traditional **internal combustion engines, hybrids, electric vehicles, or alternative powertrains**

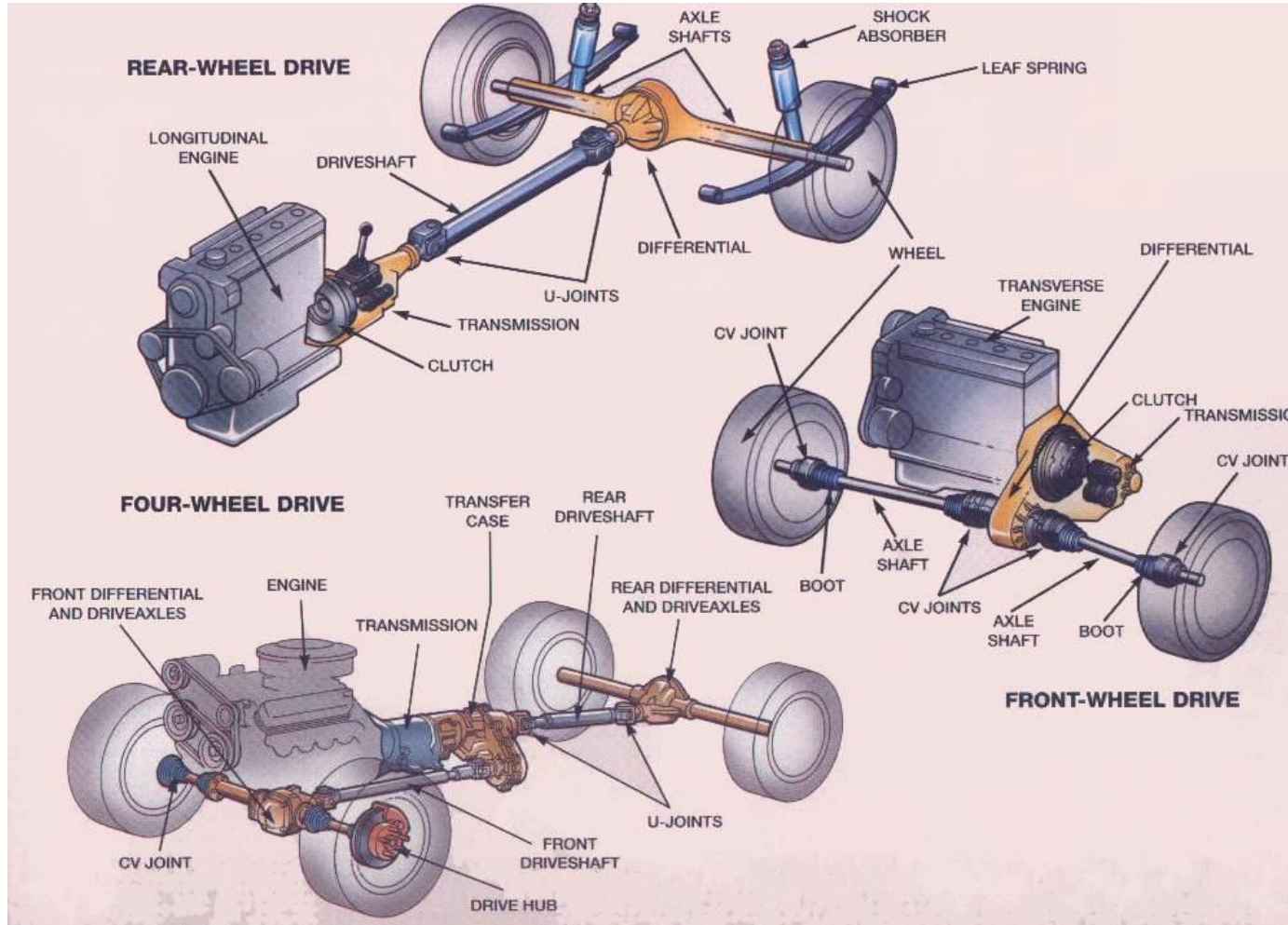
# Bringing a New Car to Market

# Engineering Engines

- **Internal Combustion Engines (ICE)**
    - **Spark ignition –Gasoline fuel**
      - Otto cycle-4 stroke
      - Atkinson/Miller cycle – 4 stroke
    - **Compression ignition – Diesel fuel**
      - Diesel cycle
  - **Hybrid**
    - ICE and electric
  - **Plug in hybrid**
    - ICE and battery
    - Charging capable
  - **Battery electric (BEV)**
    - No ICE
    - Fully electric
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    - 4 cylinders I-3 I-4
    - 5 cylinders I-5
    - 6 cylinders I-6 V-6 H-6
    - 8 cylinders V-8
    - 10 cylinders V-10
    - 12 cylinders V-12 W-12
  - **Induction system**
    - Normally aspirated
    - Super charged
    - Turbo charged

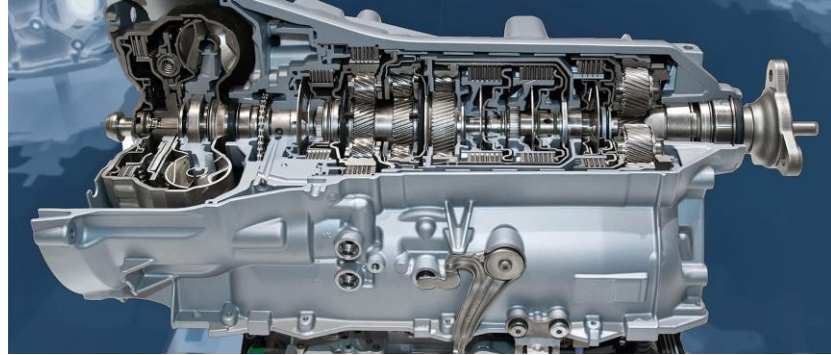




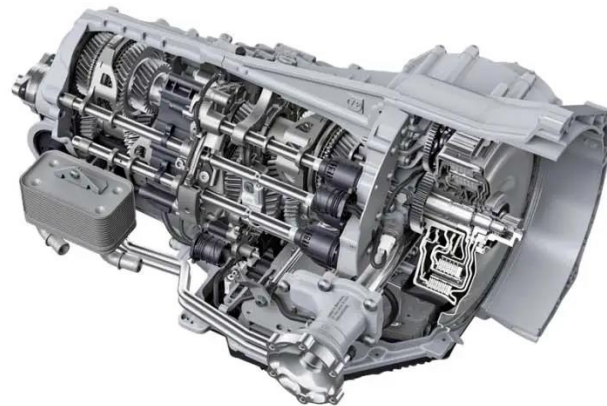
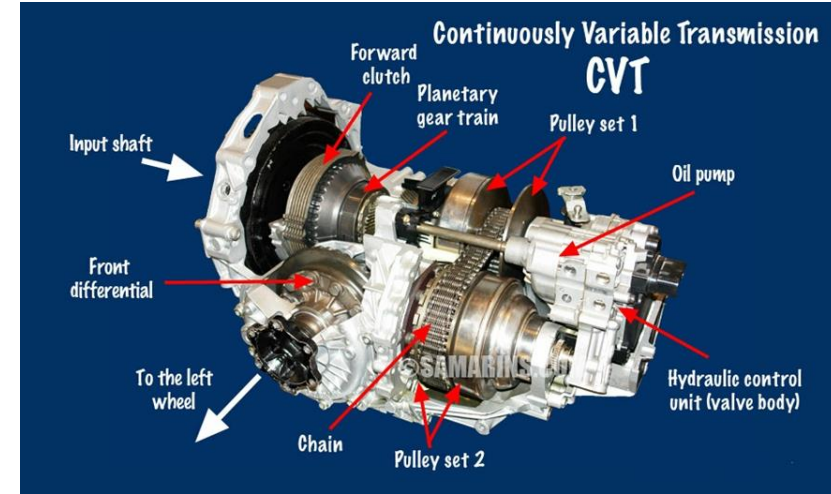


# Bringing a New Car to Market

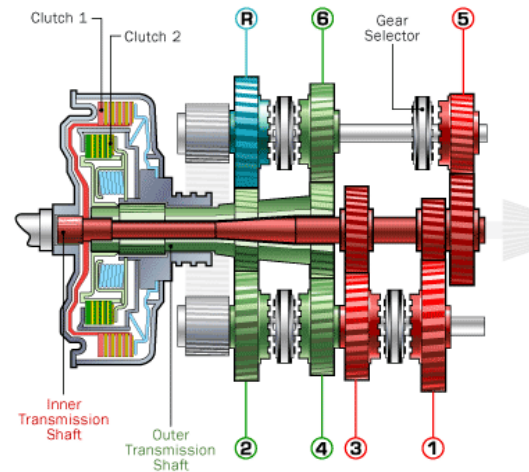
# Engineering Transmissions



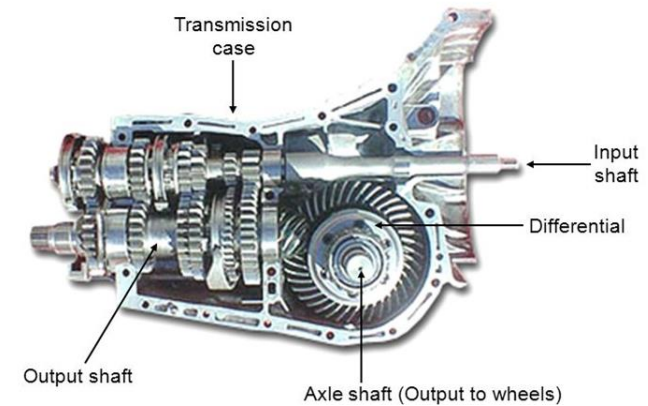
Automatic Transmission



Dual Clutch Automatic Transmission



Manual Transmission Layout



## Bringing a New Car to Market

## Engineering    Suspension- Steering- Brakes

- **Vehicle Dynamics and Handling:**
- Optimal vehicle dynamics and handling characteristics are crucial for safety and driving pleasure
- Engineers select **suspension, steering, and braking systems** consistent with the targeted driving characteristics of the vehicle
- They fine tune these systems to ensure stability, comfort, and control on various road conditions
- **Spring rates** and **damper**(shock absorber) settings are selected based on **brand identity**

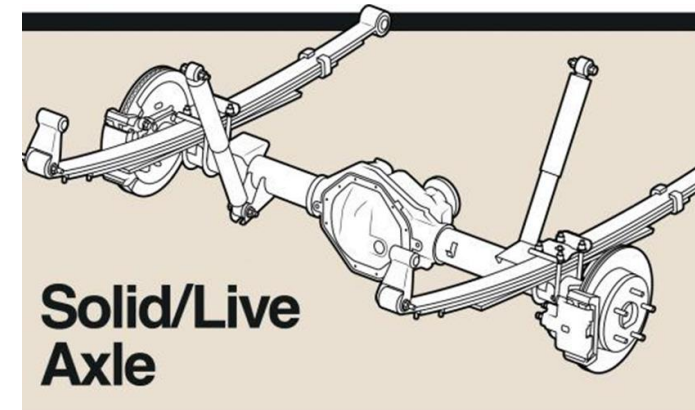
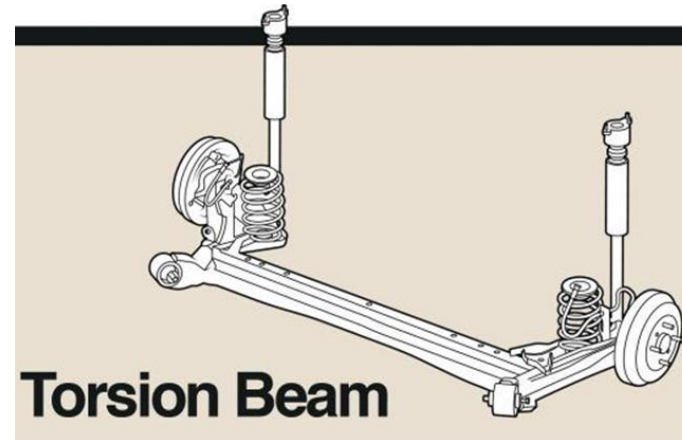
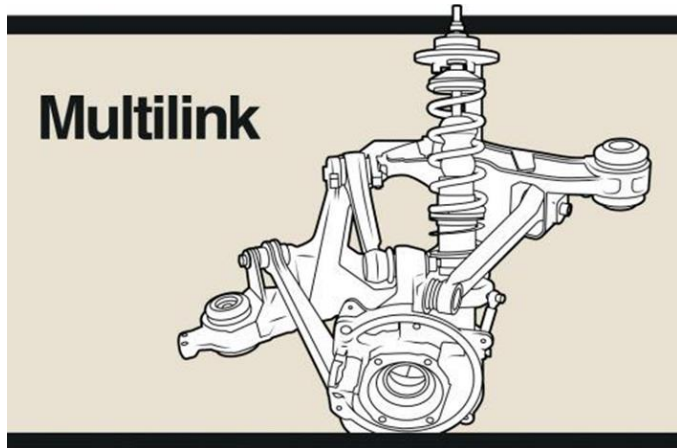
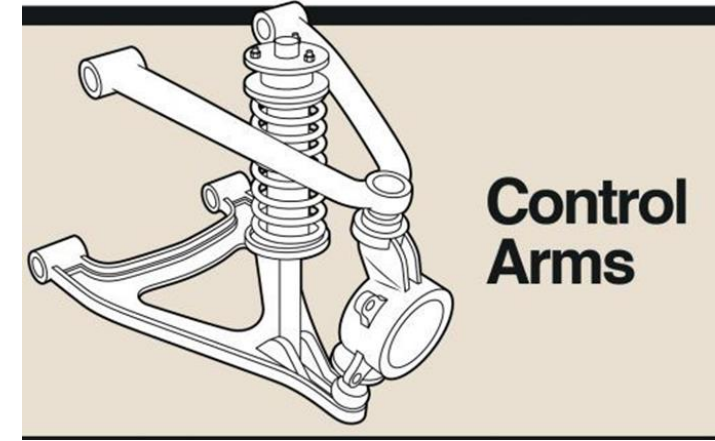
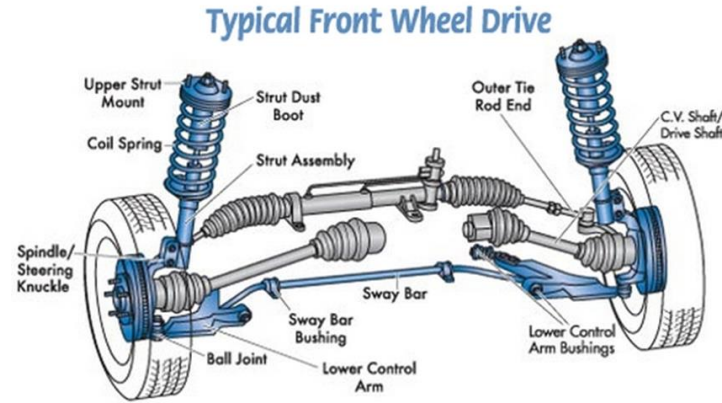
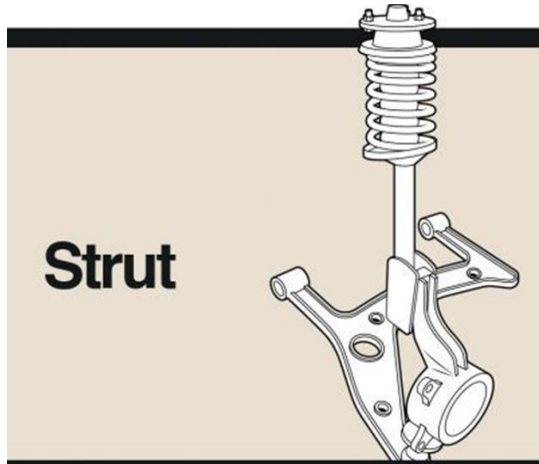




# Bringing a New Car to Market

# Engineering

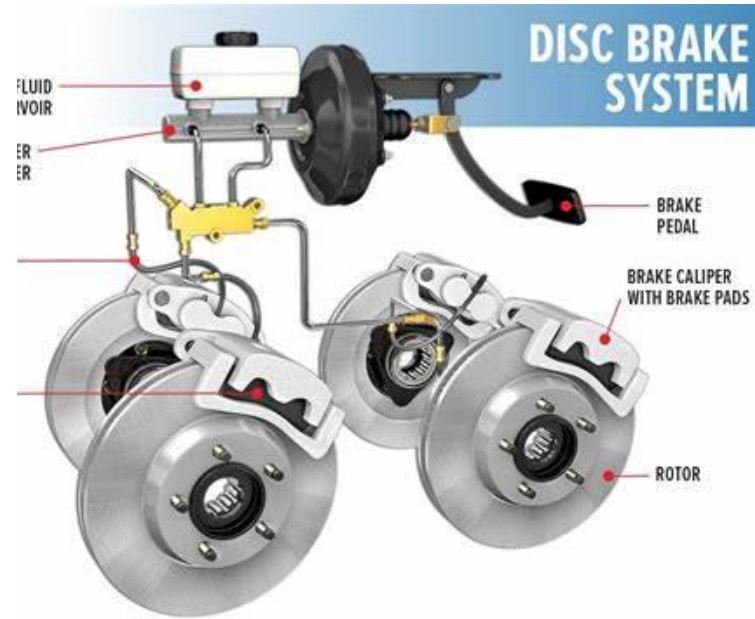
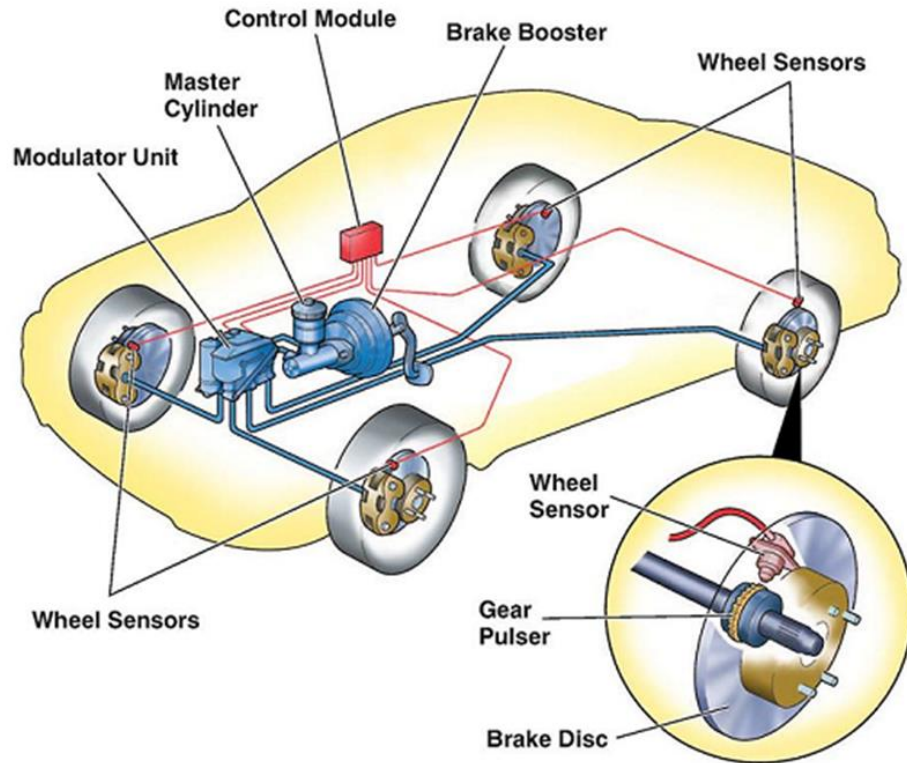
# Suspension- Steering- Brakes





# Bringing a New Car to Market

# Engineering Suspension- Steering- Brakes

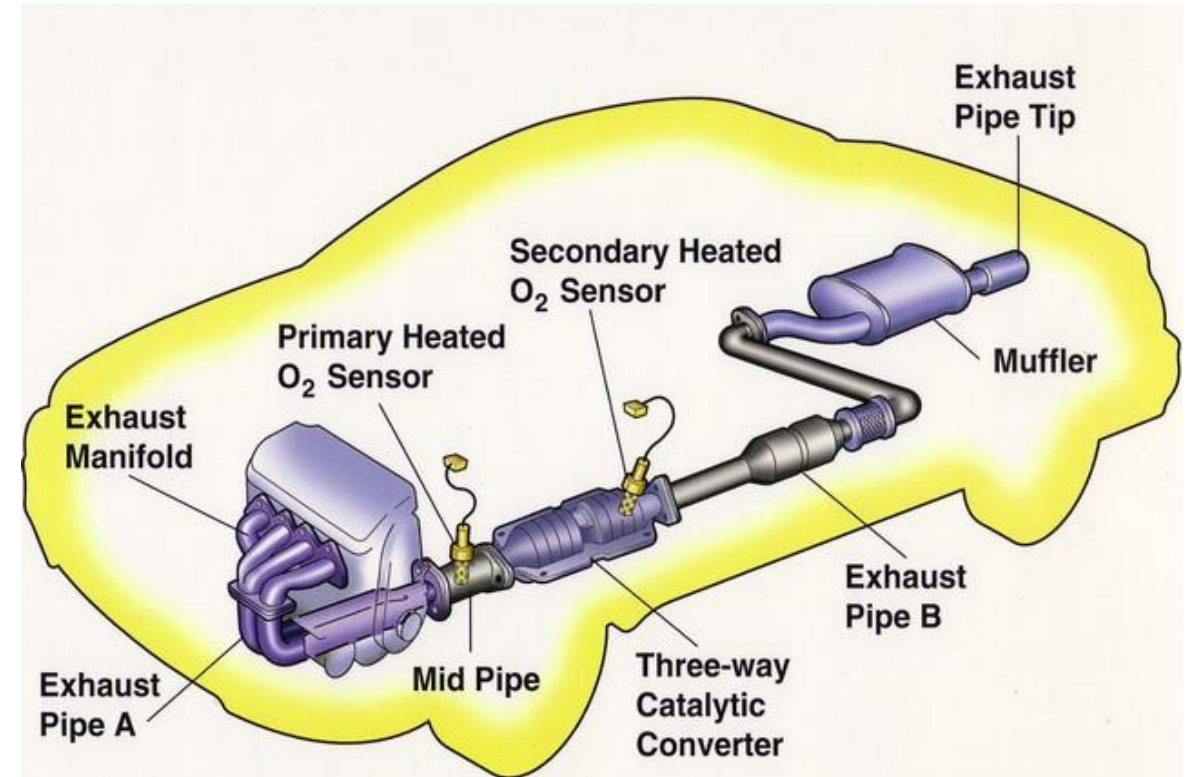


## Bringing a New Car to Market

## Engineering

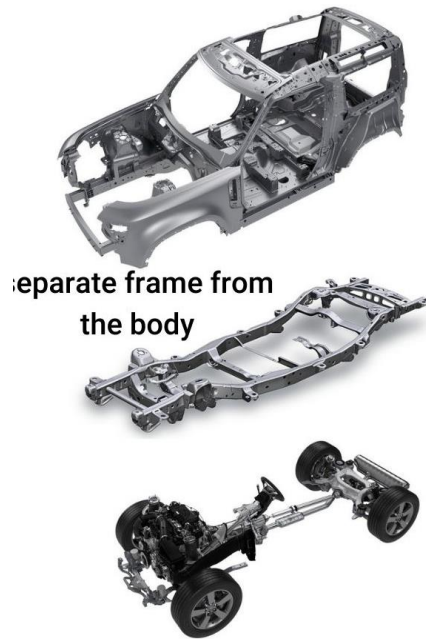
## Exhaust System

- The **exhaust manifold** is the first component of the exhaust system. It contains a stainless steel, cast-iron or aluminum unit that joins with the engine's combustion cylinders
- The **muffler** contains a series of baffles that help in dampening the noise of the engine gases and the engine combustion
- The **catalytic converter** prevents harmful pollutants like nitrogen oxides and carbon monoxide from escaping into the environment
- The piping connecting exhaust system components is a steel or stainless steel pipe
- **Oxygen sensors** in the exhaust system send signals to the **IC engine** control unit to maintain proper fuel flow



# Bringing a New Car to Market

- **Body-on-frame**
- The vehicle body is built on a relatively rigid frame
- The frame supports the drivetrain and the engine
- The Body-on-Frame is easier to design, repair, and is less likely to suffer damage from rust
- This design is heavier and has higher center of gravity



# Engineering Structure

- **Unibody Frame**
- In this frame, both functions are met in the same assembly
- Its success among the others, is due to its lightness
- Even popular midsize SUV's, have acquired the unibody frame construction
- The monocoque or unibody construction has reached the state of art in the automobile manufacturing
- Is so sophisticated that the **windshield** often makes a significant contribution to the vehicle's structural strength

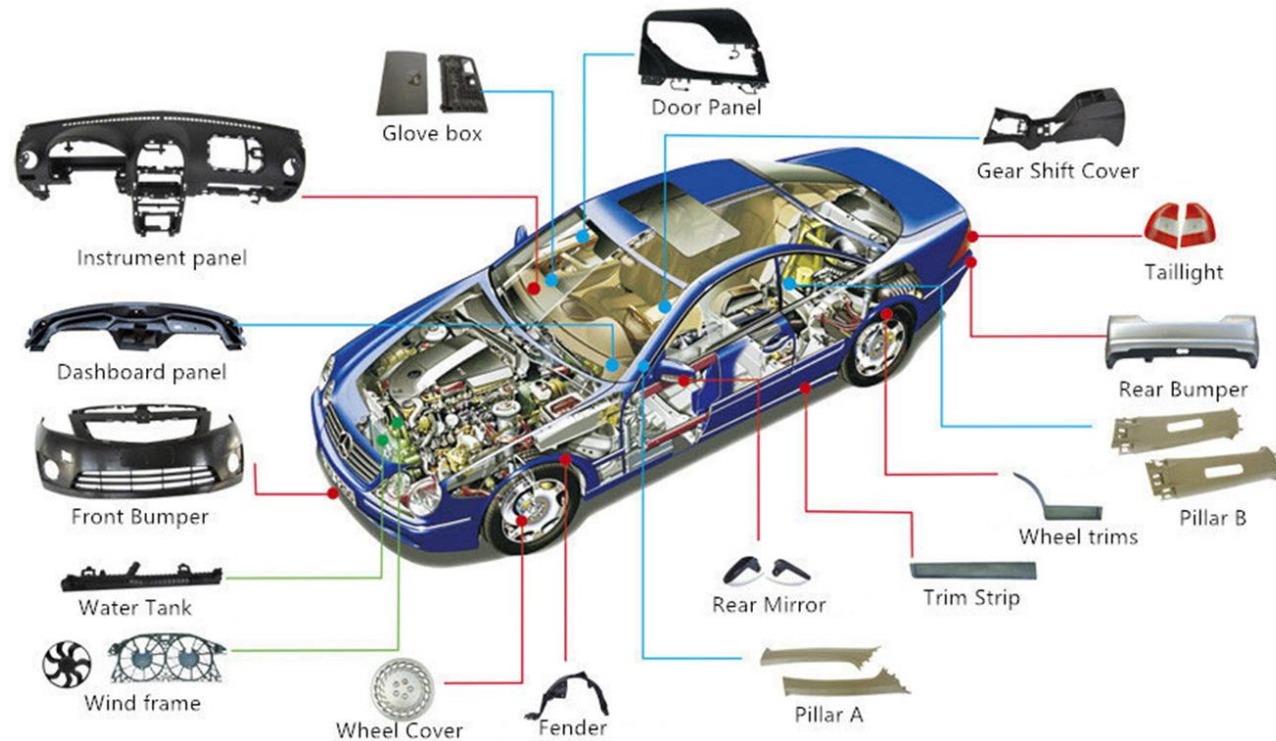




## Bringing a New Car to Market

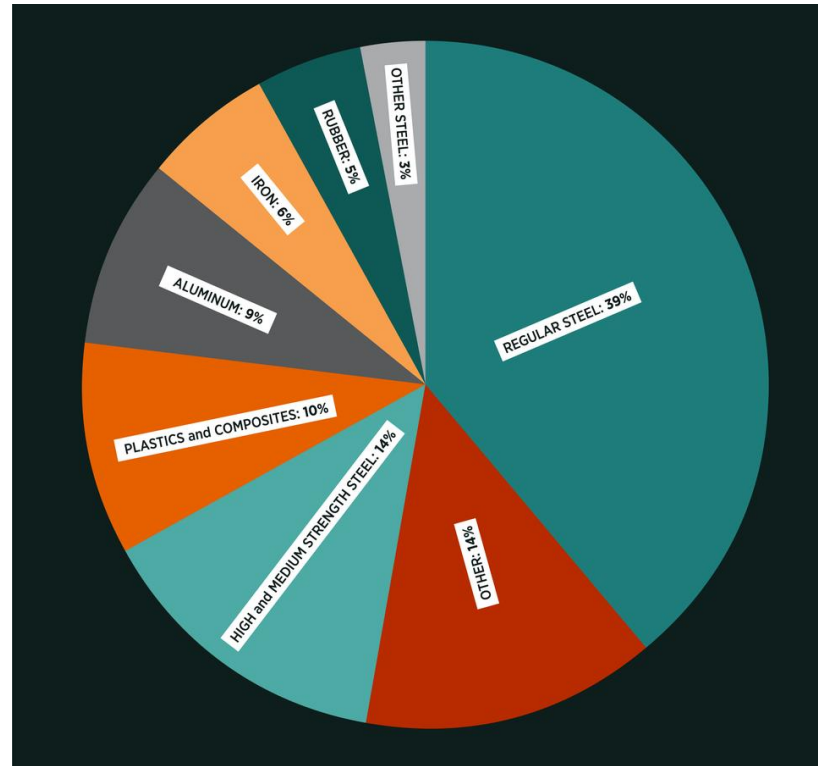
- Selecting the right **materials** and **manufacturing processes** is essential to building reliable and cost-effective vehicles
- Cars use a wide range of materials, from lightweight alloys to advanced composites, to optimize strength, durability, and weight
- A variety of materials is used in different parts of a vehicle to achieve desired strengths, weight and costs

## Engineering    Materials and Manufacturing





# Bringing a New Car to Market



# Engineering Structure Materials

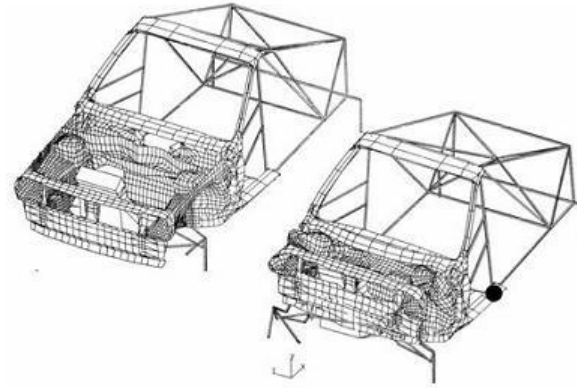
- Ultra High Strength Steel
- Extra High Strength Steel
- Very High Strength Steel
- High Strength Steel
- Mild Steel / Forming Grades
- Aluminium
- Magnesium



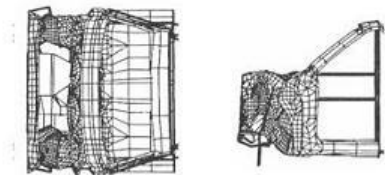
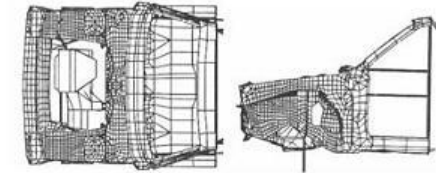
# Bringing a New Car to Market

- Engineers employ crash-test **computer simulations** and **advanced materials** to design vehicles that protect occupants in the event of a collision
- Features like **airbags**, **crumple zones**, and **advanced driver-assistance systems (ADAS)** contribute to vehicle safety
- Safety features must satisfy regulatory requirements and be demonstrated by actual **vehicle testing**

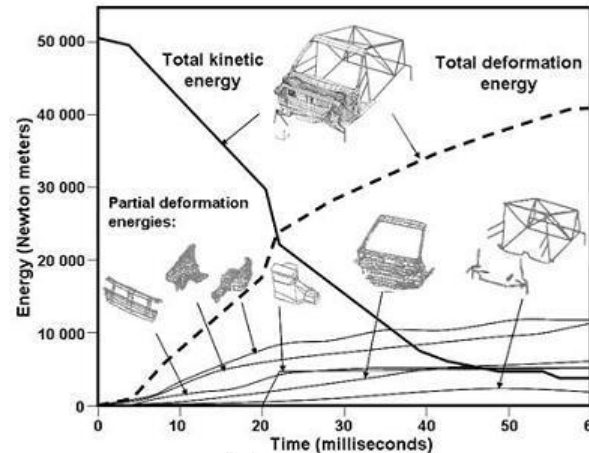
# Engineering Crashworthiness



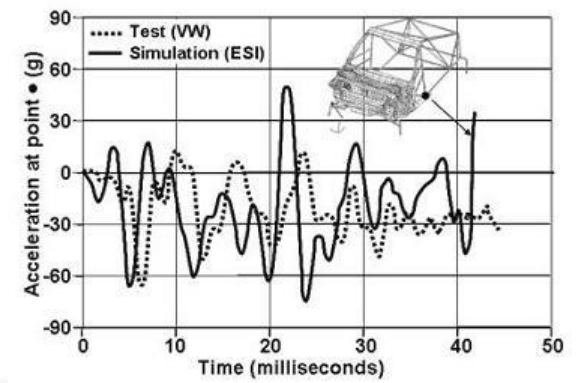
(a) crash simulation



(b) top and side views of simulation



(c) energy balance



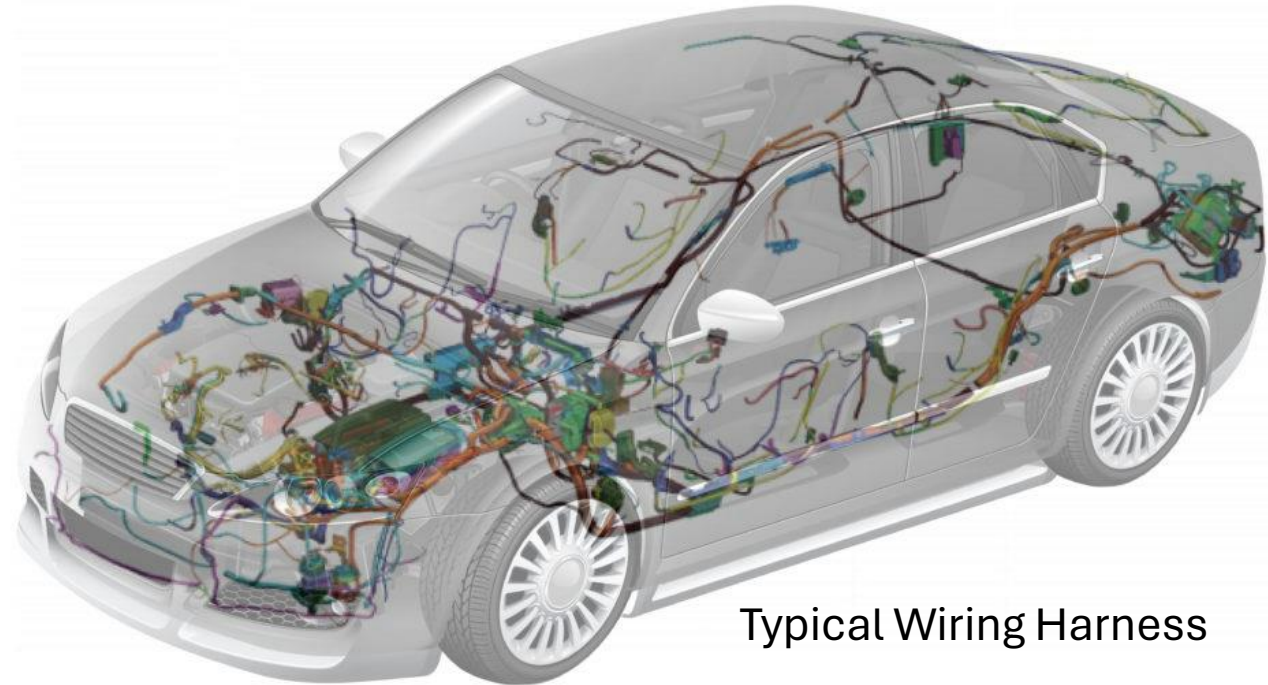
(d) acceleration at point in cabin

## Bringing a New Car to Market

- Engineers develop a number of **vehicle electronic systems**
- **Engine , transmission and suspension system** controls
- **Infotainment systems** to enhance the driving experience
- Systems to **improve fuel efficiency**
- **Driver alert** safety systems
- Systems provide **connectivity options**
- Many of these electronic systems must be integrated into the vehicle structure

## Engineering

## Electrical , Electronic Systems

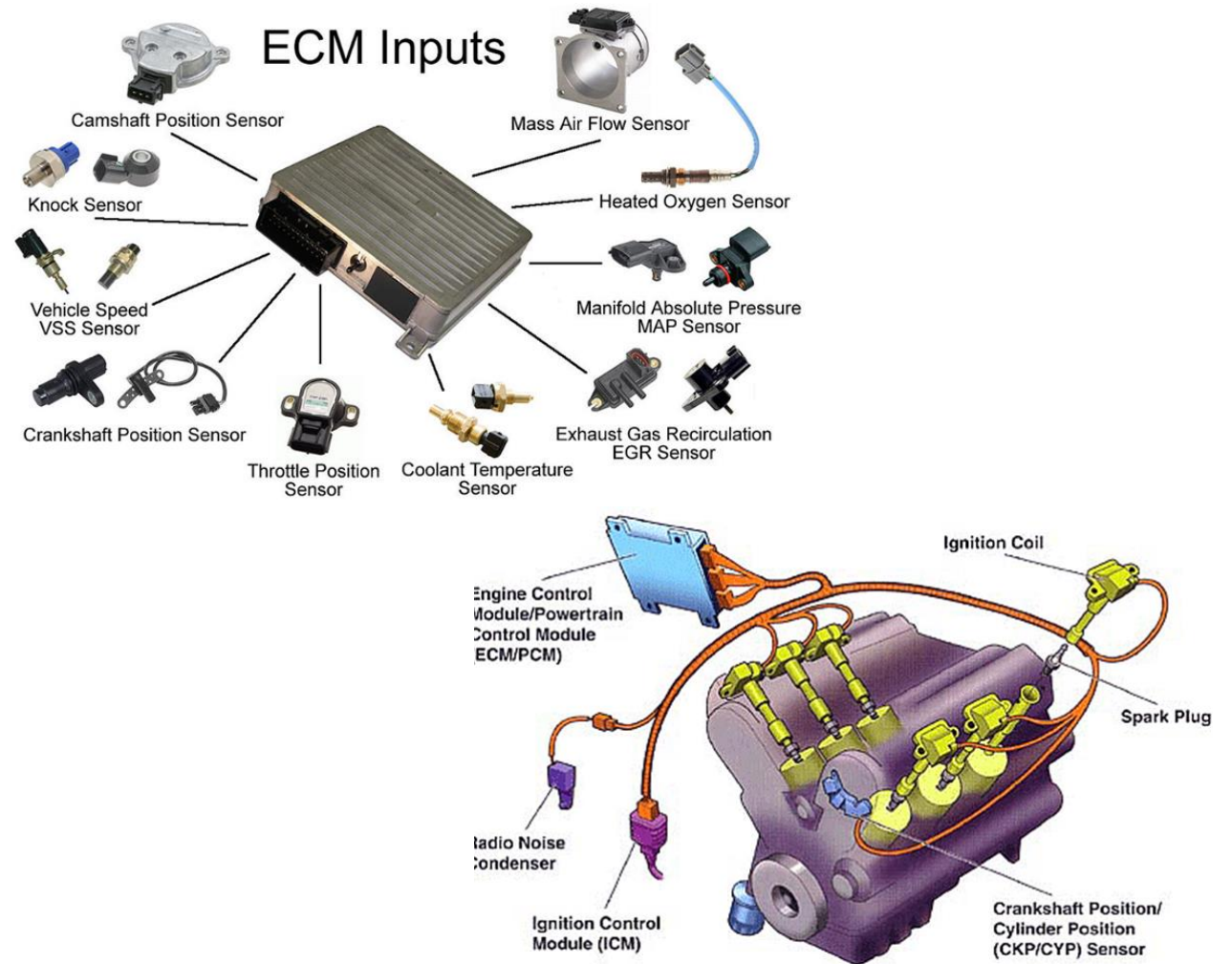


Typical Wiring Harness

## Bringing a New Car to Market

- The **ignition system** is used to create and deliver a spark discharge to the spark plugs of an ICE
- The **engine starting system** creates a certain rotational speed of the crankshaft.
- The **lighting and signaling system** operates the front and rear lights, turn signals, fog lights, and marker lights, instrument and interior lights
- **Electronic control units (ECU)**- a computer that controls multiple systems in the vehicle:
  - Engine , suspension, braking systems

## Engineering Electrical , Electronic Systems





## Bringing a New Car to Market

- **Manufacturing engineering** deals with functions required to build, assemble, test and ship new cars
- Process and assembly development
- Logistics and materials planning
- Tooling design
- Test design and development
- Robotics
- Manufacturing Systems
- Production/Final assembly test
- “Fixing’ problems during production

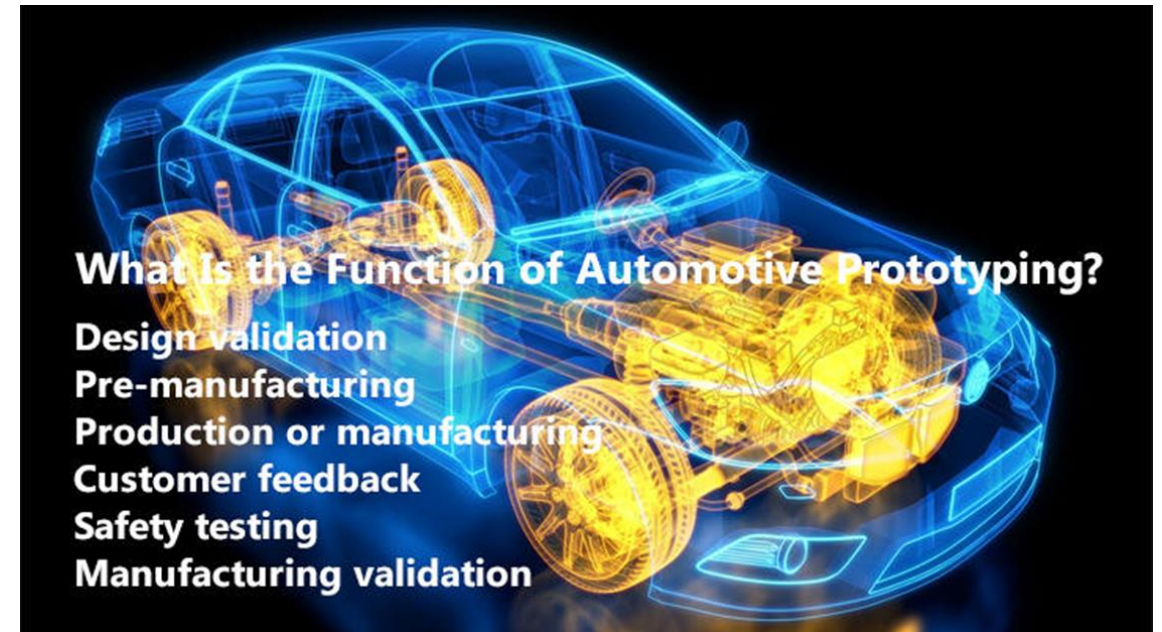
## Manufacturing Engineering



## Bringing a New Car to Market

## Engineering Testing

- Thorough testing and validation are essential to ensure a vehicle meets safety (crash tests) and general performance standards
- Engineers conduct extensive testing, both in laboratories and real-world scenarios, to identify and rectify issues
- They test components and prototype vehicles
- In addition to crash testing, automakers target numerous other quality measurements





# Bringing a New Car to Market

# Engineering Testing



## Bringing a New Car to Market

- How noisy is it inside the cabin?
- How much noise comes from the engine?
- What is causing squeaks and rattles?
- How much noise is created by tires contacting the pavement?
- How much vibration is there at different speeds?
- How fast does the air conditioning system or heater kick in?
- Does the quality and luxury match other products in this brand?
- Does it equal or exceed competitive offerings?
- Are we meeting our own standards for brand expectations for the car are?

## Engineering Testing

- What drivetrain combination will give us optimal fuel efficiency while satisfying emissions requirements?
- How do we reduce weight and waste without compromising safety or comfort or quality?
- How does the car perform in extreme conditions?
- Depending on what's being tested, engineers can make changes immediately to designs but in other cases, test findings may require an extensive rethinking of how a part or set of parts functions in order to develop the most appropriate solution to address the discovered issues
- To make sure the entire testing process stays reasonably on schedule, manufacturers make multiple “test mules,” or pre-production cars, for testing

# Steps in Bringing a New Car to Market

## Introduction

A little history

Automobile industry

## Product Planning-Market Analysis & Identification of Opportunities

Understand market trends, consumer preferences, emerging technologies and government regulations

Analyze competitors - identify gaps in the market for new car

## Concept and Design

Translate market insights into conceptual ideas for a new car

Collaborate with design teams and engineers to develop innovative and appealing vehicle concepts

## Engineering and Development

Design the vehicle - safety, performance, and efficiency

Extensive testing - prototype testing, crash testing, emissions testing and performance testing

Address any design or engineering challenges that arise during the development phase

## Regulatory Compliance

Demonstrate safety , emissions, mileage compliance

Certify models' configurations

BEV mandates

## Manufacturing Planning:

Manufacturing plan - consider production volume, assembly processes, and quality control

Identify component suppliers establish partnerships

Set up manufacturing facilities and production lines

## Production and Quality Control:

Begin production - ensure adherence to quality standards and specifications

Implement quality control measures - identify and address manufacturing defects

Conduct pre-launch inspections and testing - guarantee the reliability and safety of the vehicles

## Launch and Distribution

Marketing campaigns to generate excitement and drive sale

Coordinate with dealerships and distributors to ensure a smooth rollout

Monitor customer feedback - address post-launch issues