

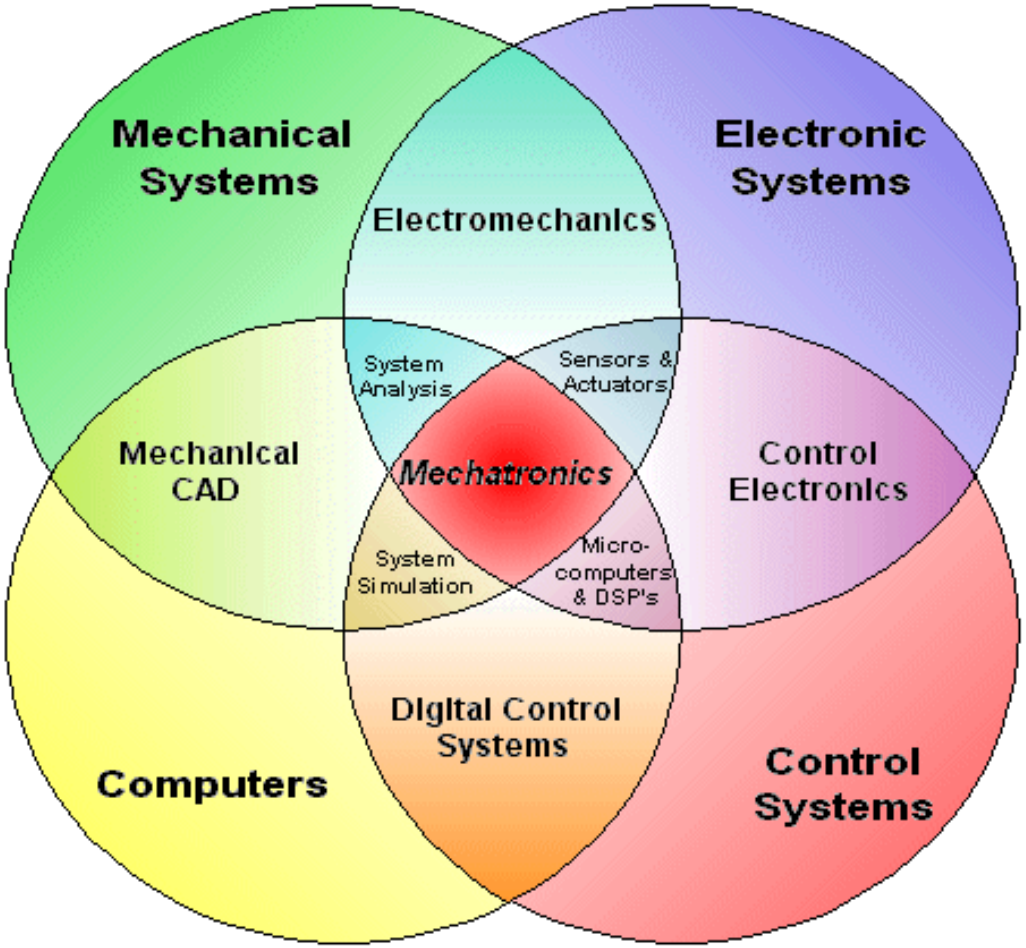
Mechatronics

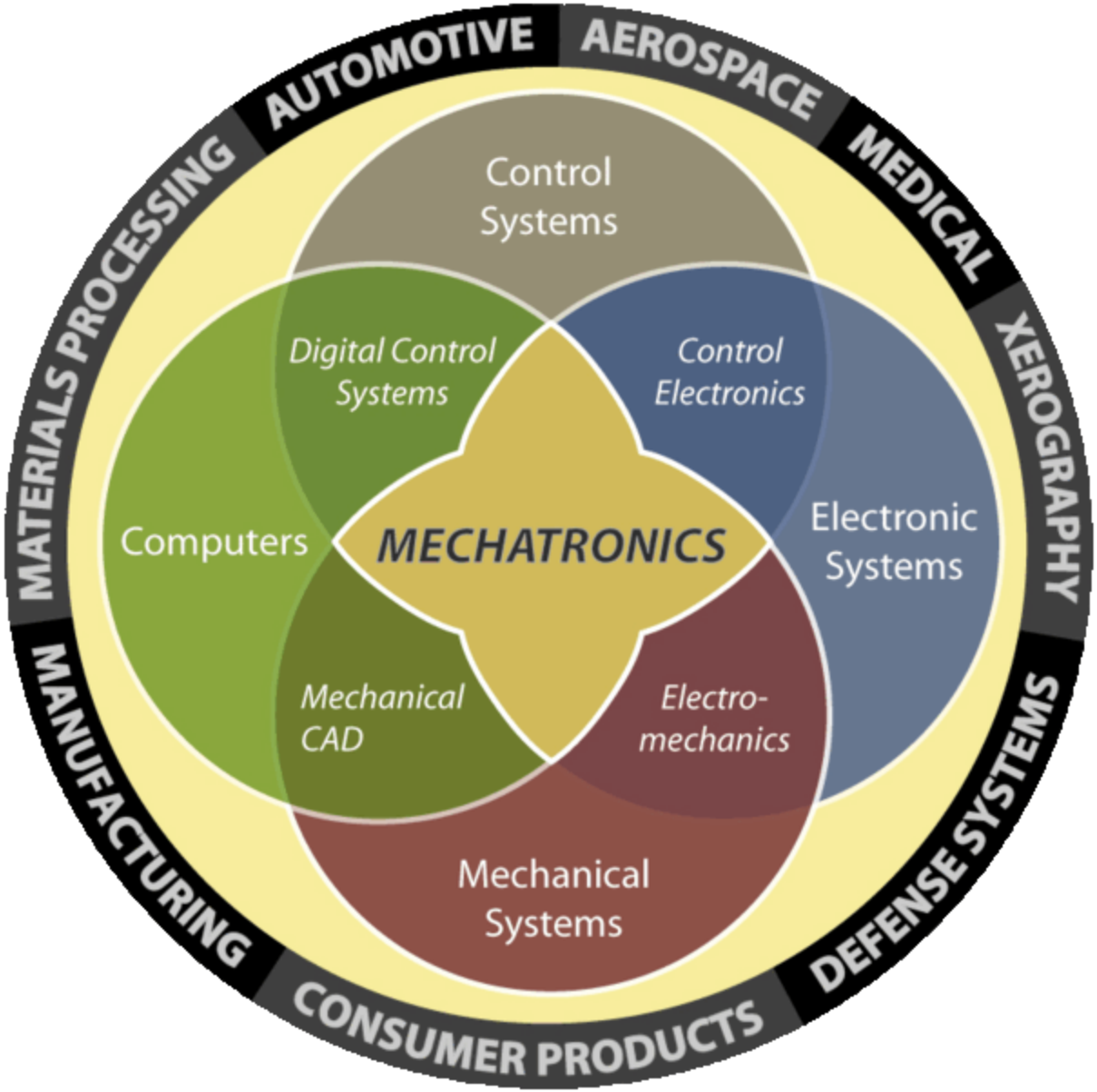
Mechatronics?

Mechatronics refers to **mechanical electrical** systems and is centred on **mechanics, electronics, computing** and **control** which, **combined**, make possible simpler, economical, reliable and versatile systems.

The term "**mechatronics**" was first assigned by Mr. Tetsuro Mori, a senior engineer of the Japanese company Yaskawa, in 1969.

What is Mechatronics?

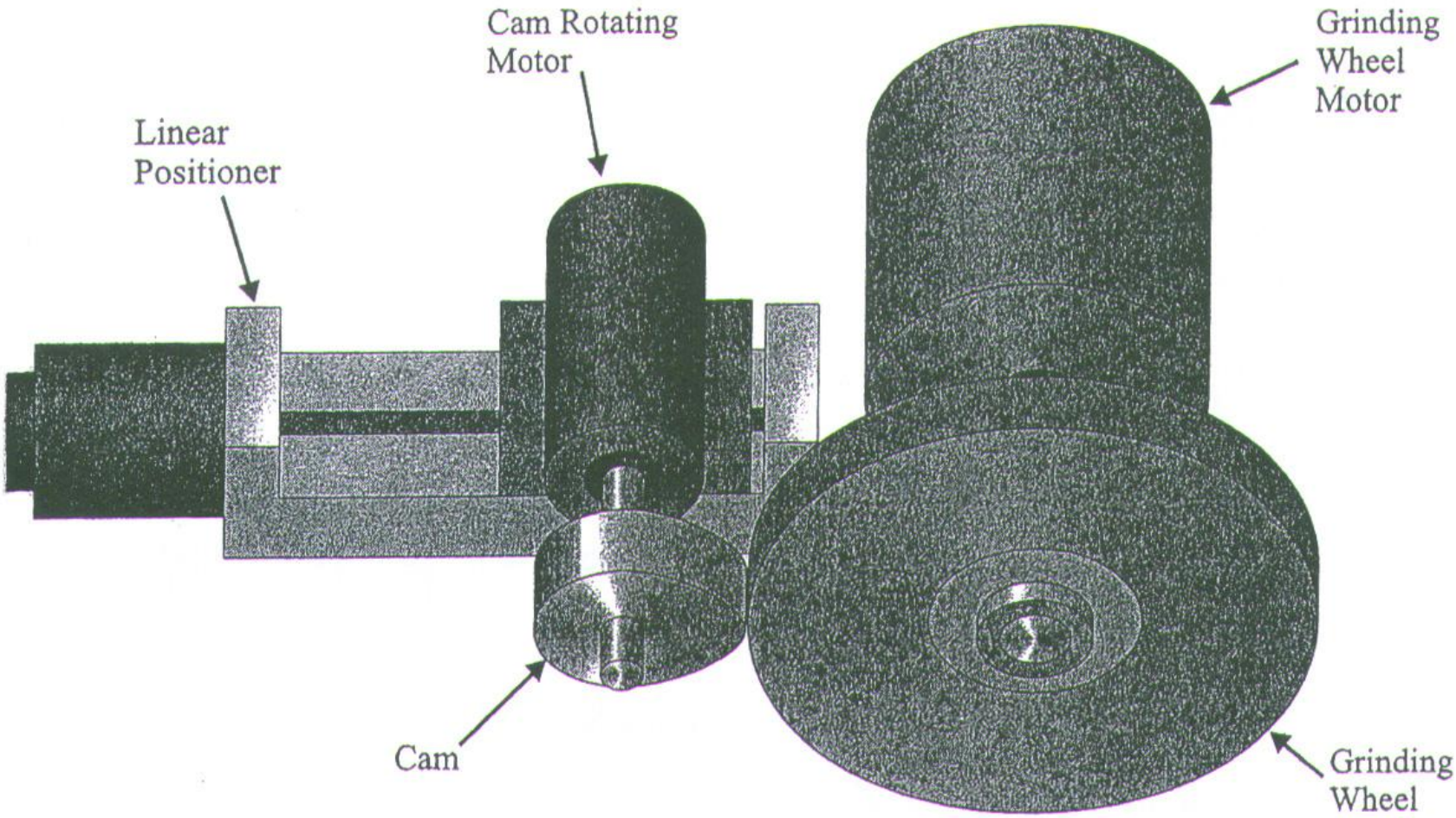



AUTOMOTIVE
AEROSPACE
MEDICAL
XEROGRAPHY
DEFENSE SYSTEMS
CONSUMER PRODUCTS
MANUFACTURING
MATERIALS PROCESSING
Control Systems
Digital Control Systems
Control Electronics
Computers
MECHATRONICS
Electronic Systems
Mechanical CAD
Electro-mechanics
Mechanical Systems

Typical Mechatronics Curricula

- Introduction to engineering
- Engineering software; C, Java, Matlab, Labview, Linux etc.
- Fundamental of mechanical system design and analysis
- Electronic devices, circuits and systems
- Digital systems and computer architecture
- Applied control theory
- Robotics (sensors, actuators, control, vision, AI, etc.)
- Instrumentation and measurements
- Signal & image processing
- CAD/CAM, NC and CNC
- Embedded systems, sensors, actuators and software
- Fine mechanical parts, MEMS and nanotechnology
- Integrated mechanical/electrical systems

Mechatronics Revolution: Example



Masterless Cam Grinder

Mechatronic Systems



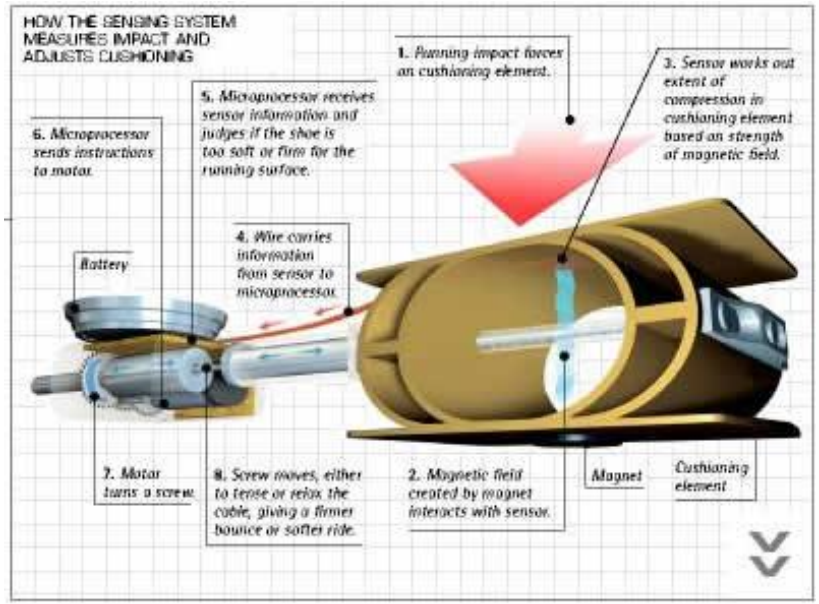
computer disk drive

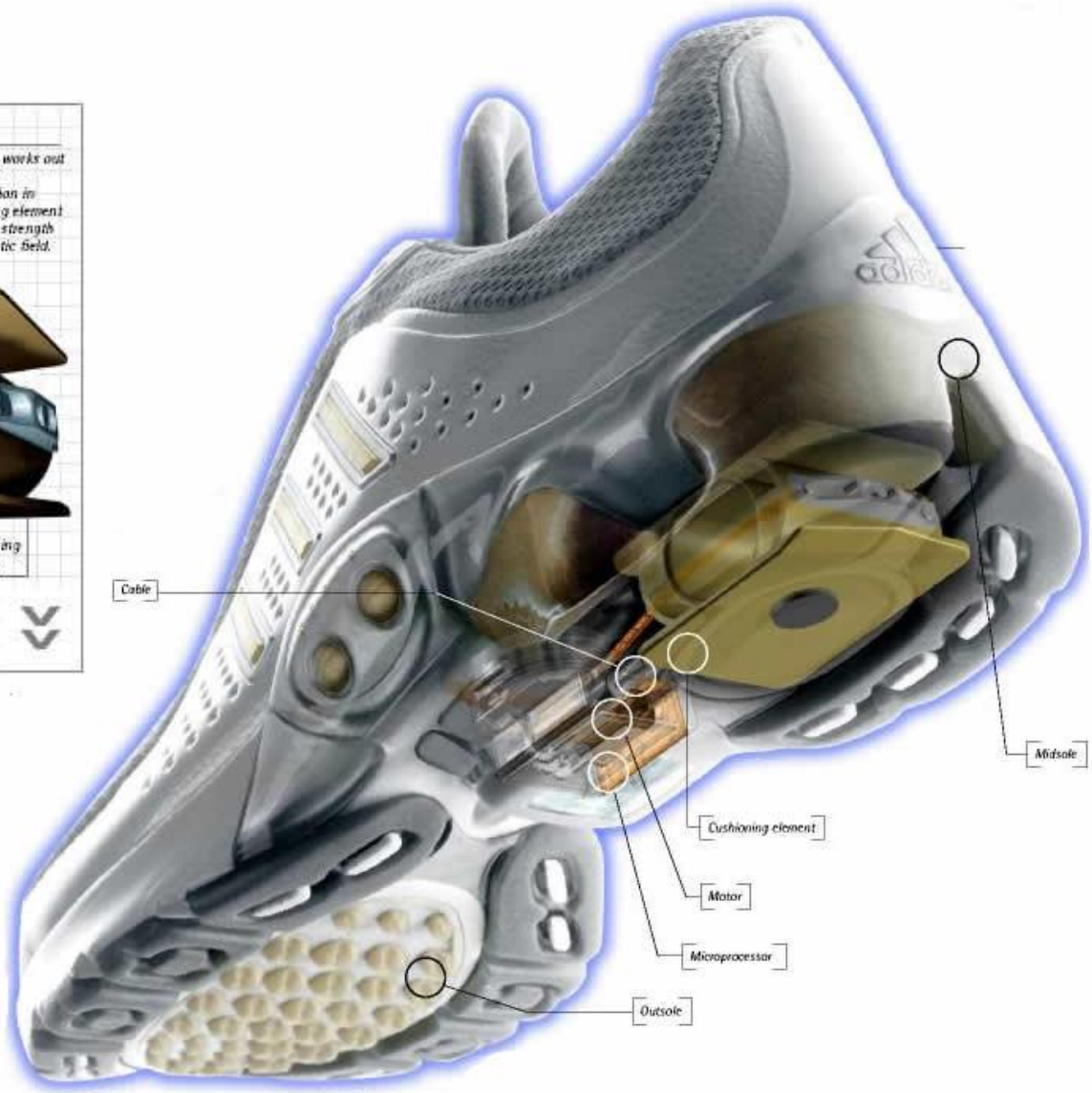


clothes washer

Mechatronics Systems
-Sports Applications-

Running Shoes





Advantages

- **Automatically changes cushioning** in shoe for different running styles and conditions for improved comfort

Mechatronics Systems
-Sanitation Applications-

Systems Uses
- Motion sensors
- Control circuitry
- Electromechanical actuators
- Independent power source

Soap Dispenser



Paper Towel Dispenser

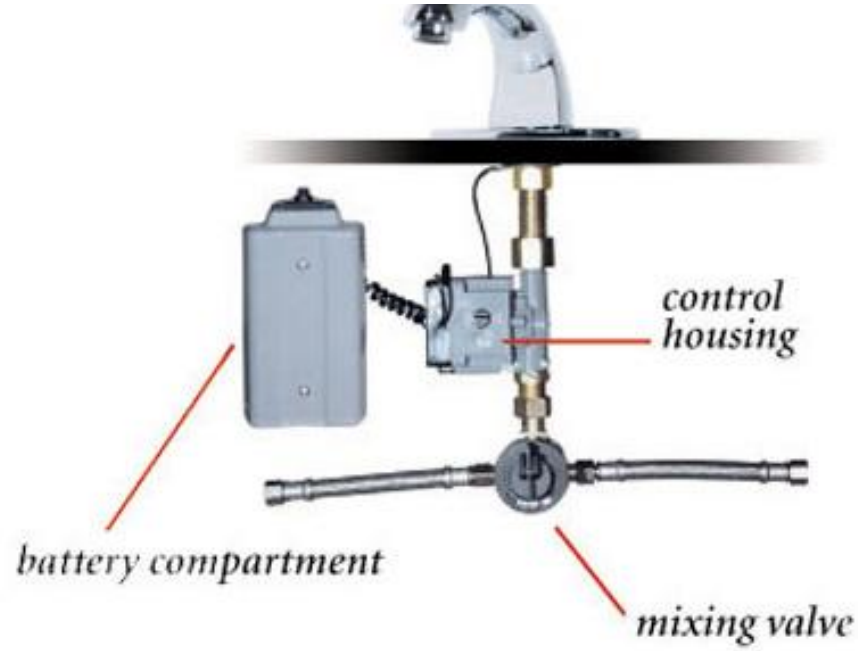


Advantages
- **Reduces spread of germs** by making device hands free
- **Reduces wasted materials** by controlling how much is dispensed

Mechatronics Systems
-Sanitation Applications-

System Uses
- Proximity sensors
- Control circuitry
- Electromechanical valves
- Independent power source





Advantages
- **Reduces spread of germs** by making device hands free
- **Reduces wasted water** by automatically turning off when not in use

Mechatronics Systems
-Defense Applications-

- Advanced technology is making our soldiers safer.
- Some planes can now be flown remotely.

Stealth Bomber



Unmanned Aerial Vehicle



Mechatronics Systems
-Smart Robotics Aplications-

- Robots can vacuum floors and clean gutters **so you don't have to.**

Cleans Gutter

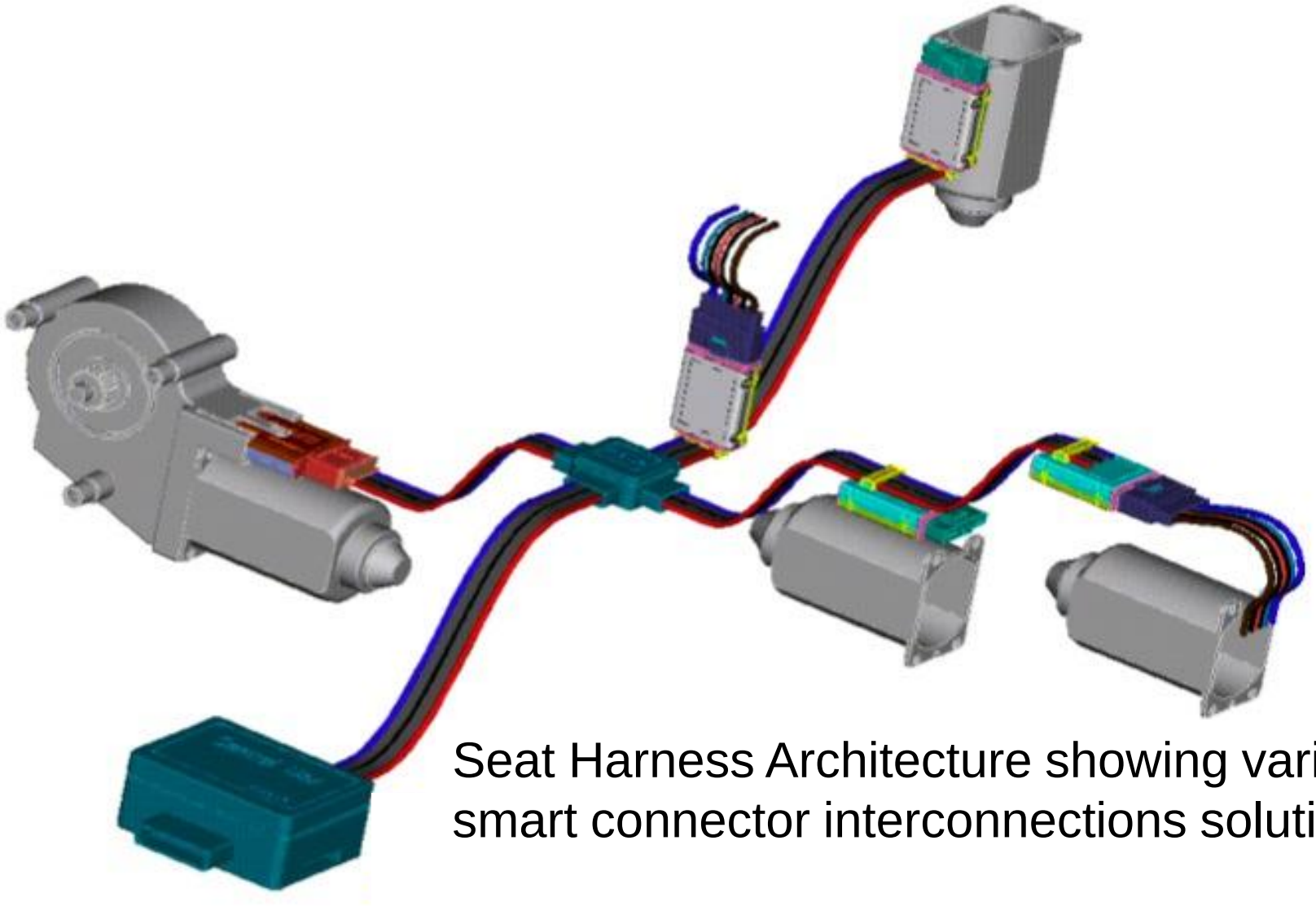


Vacuum Floors



Mechatronics Systems

-Seat System/Module-



Seat Harness Architecture showing various smart connector interconnections solutions

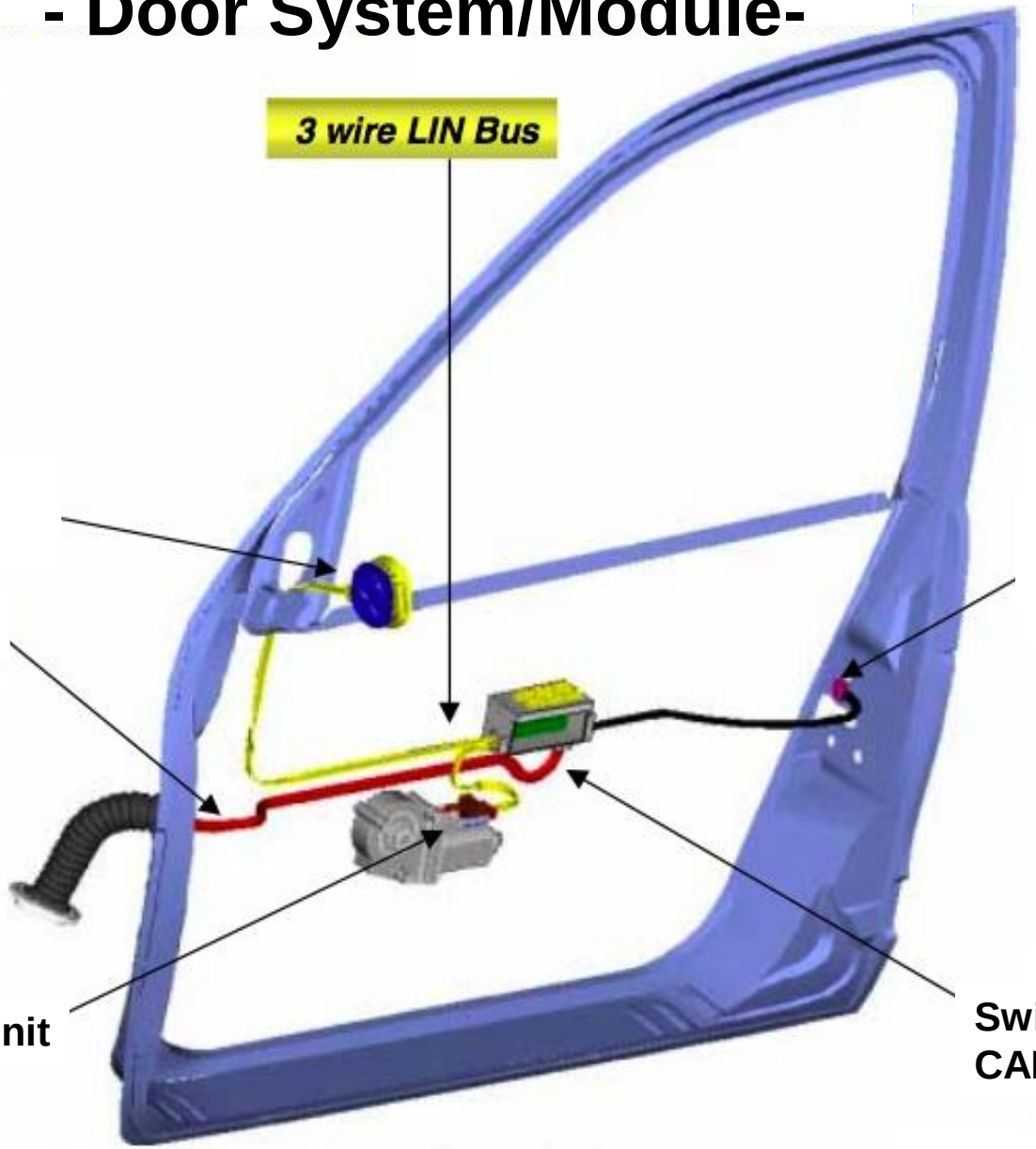
Mechatronics Systems

- Door System/Module-



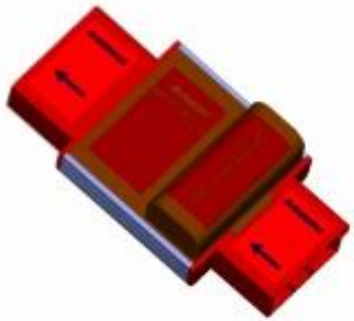
“Smart” Mirror motor-unit pin-header





CAM Bus

“Smart” Doorlock



“Smart” Window Lift-unit



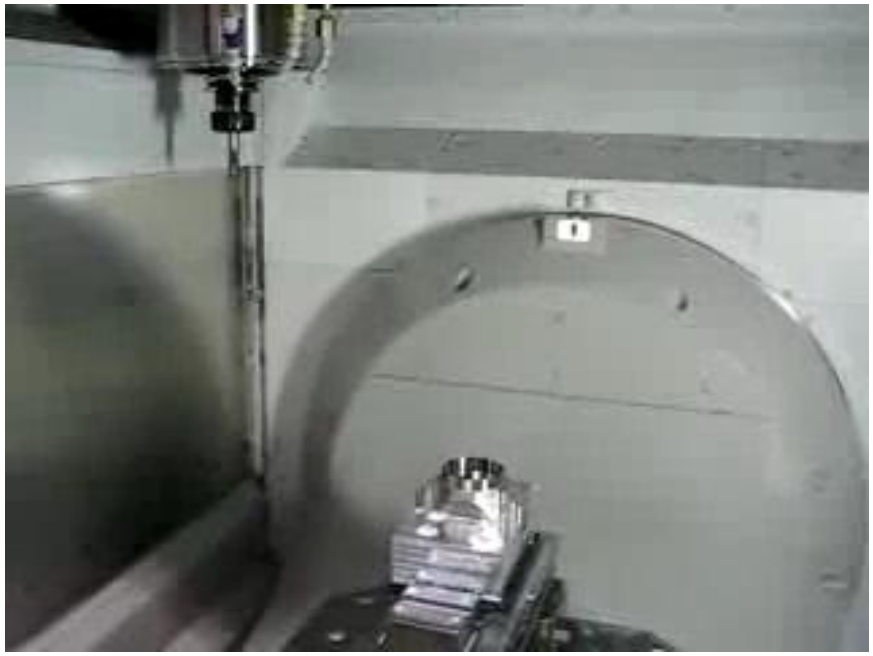
Switchboard with CAN Bus Gateway

Mechatronics Systems

-Manufacturing Applications-

CNC Machining





Advantages

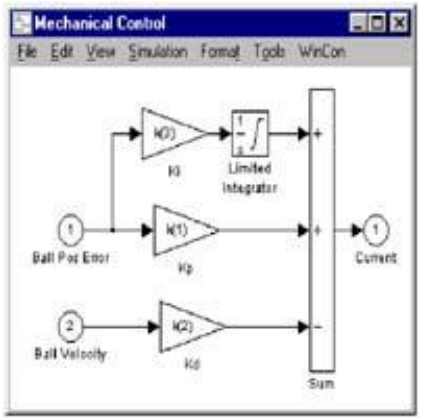
- Deliver the highest accuracies
- Can create very complex shapes

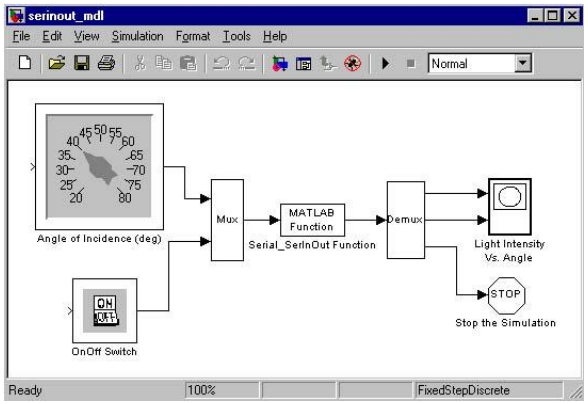
Elements of Mechatronics—Control Interface/Computing Hardware

- Control interface/computing hardware elements
  - A2D, D2A, I/O, DAQ,
- Control interface hardware
  - communication of sensor signal to the control computer and communication of control signal from the control computer to the actuator
- Control computing hardware implements a control algorithm, which uses sensor measurements, to compute control actions to be applied by the actuator.

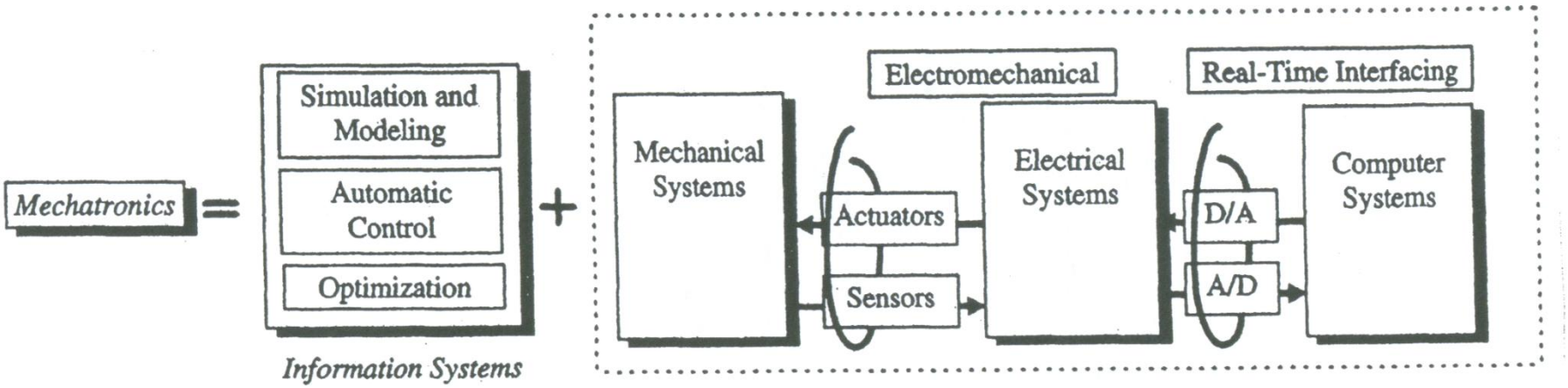
Elements of Mechatronics—Computer/Information System

- computer-aided dynamic system analysis, optimization, design, and simulation
- virtual instrumentation
- rapid control prototyping
- hardware-in-the-loop simulation
- PC-based data acquisition and control





Key Elements of Mechatronics



Controllers - Embedded Systems

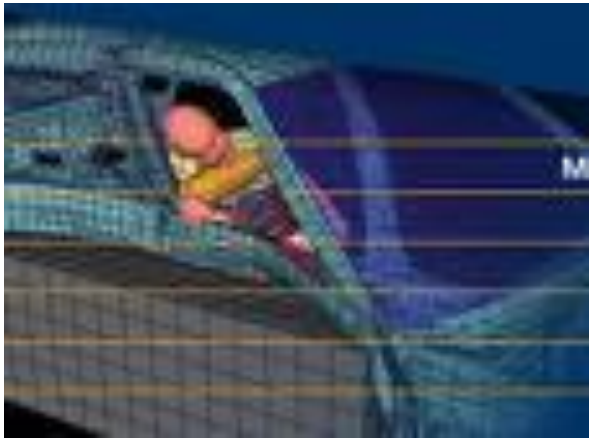
- A combination of hardware and software which together form components of a Mechatronics system.

- An embedded system is designed to run on its own without human intervention, and may be required to respond to events in real time.

Embedded Systems in Automotive Applications

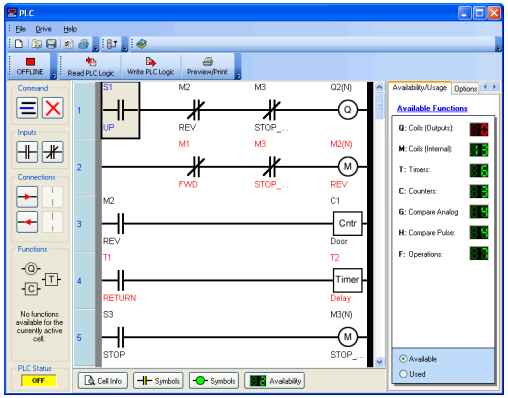
- Entertainment
- Anti skid braking
- Heads-up monitoring
- Back-up collision sensor
- Navigation
- Tire pressure sensing
- Adaptive control
- Satellite services radio/GPS
- Auto parking



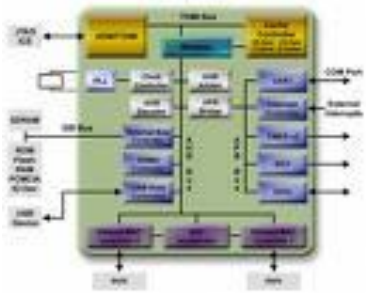


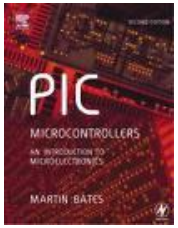
PLC and Microcontrollers















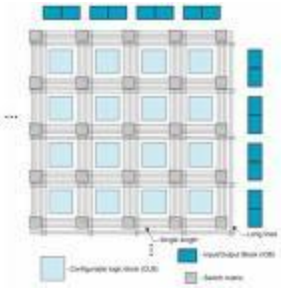


Hardware, Software, and Firmware

Hardware is the name given to the physical devices and circuitry of the computer.

Software refers to the programs written for the computer.

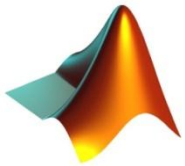
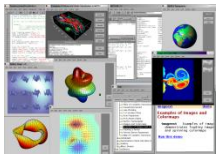
Firmware is the term given to programs stored in ROMs or in Programmable devices which permanently keep their stored information.







Engineering Software

Matlab



Labview



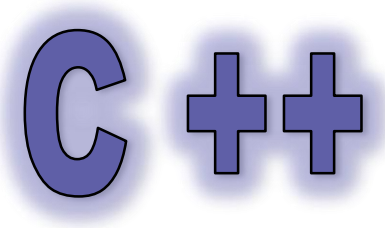
HP-VEE



IDL



Mathematica







Linux





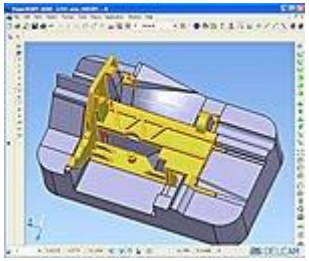
Qt



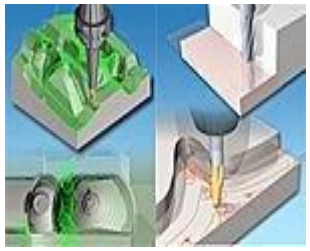
Mathcad



Autocad



PowerSHAPE

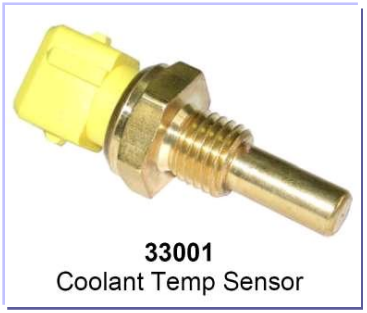


PowerMILL



CopyCAD

Sensors

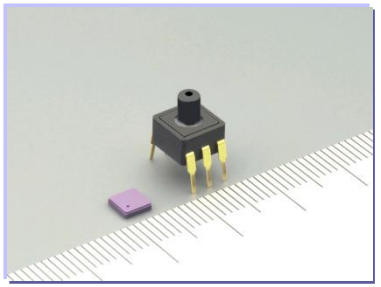


















Actuators





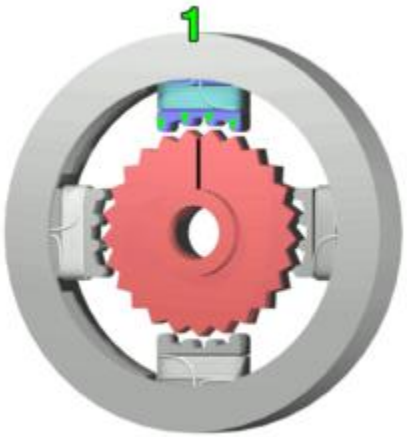


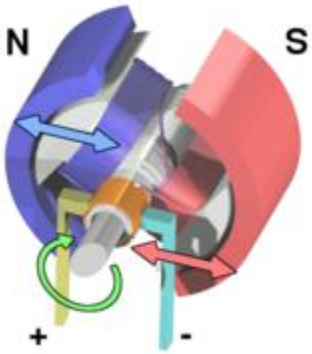


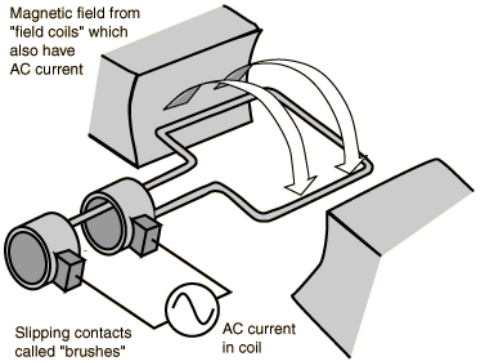




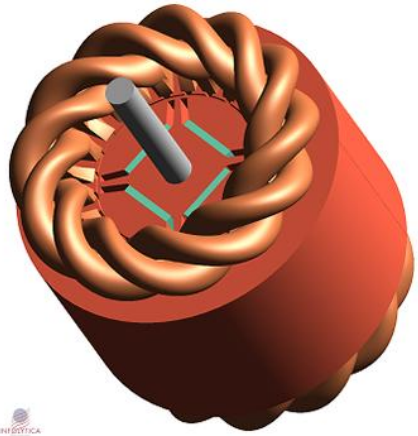


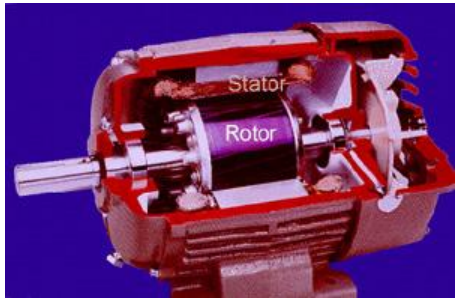












Stepper, AC and DC Motors

Measuring Instruments



Oscilloscope



Function generator



GPIB Interface



Digital multi-meter



Switch

PC-based Measurement and Control





Pc Board

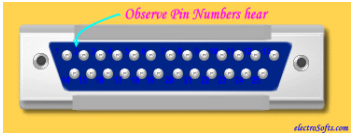




CAN BUS



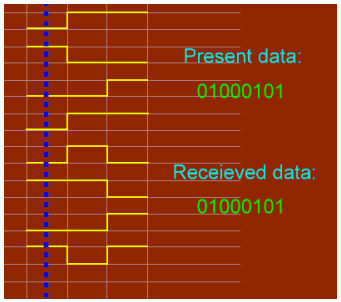


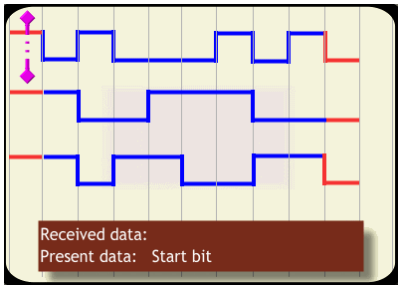


Serial/paralell



GPIB





Railway Knowledge Areas

A – Appraisal of Mechatronics

- Basics of Mechatronics systems
  - Electrical Systems
  - Basic Electronics
  - Introduction to Pneumatics & Hydraulics
- Introduction to PLC control
- Introduction to Microprocessor Control

B – Practical Railway Systems

Coaching :

1) CDTS system (Controlled Discharge Toilet System)
2) WSP System in LHB Coaches
3) PLCs used in various control systems such as BioToilets
4) EP (Electro Pneumatic) brakes in rolling stock of HHP DEMU

Freight & Others:

5) Wheel Impact Load Detection
6) Electronic In-Motion Weighbridge systems
7) CNC Machine Systems
8) Distributed Powering
9) Roadside Monitoring Technologies for Heavy Haul

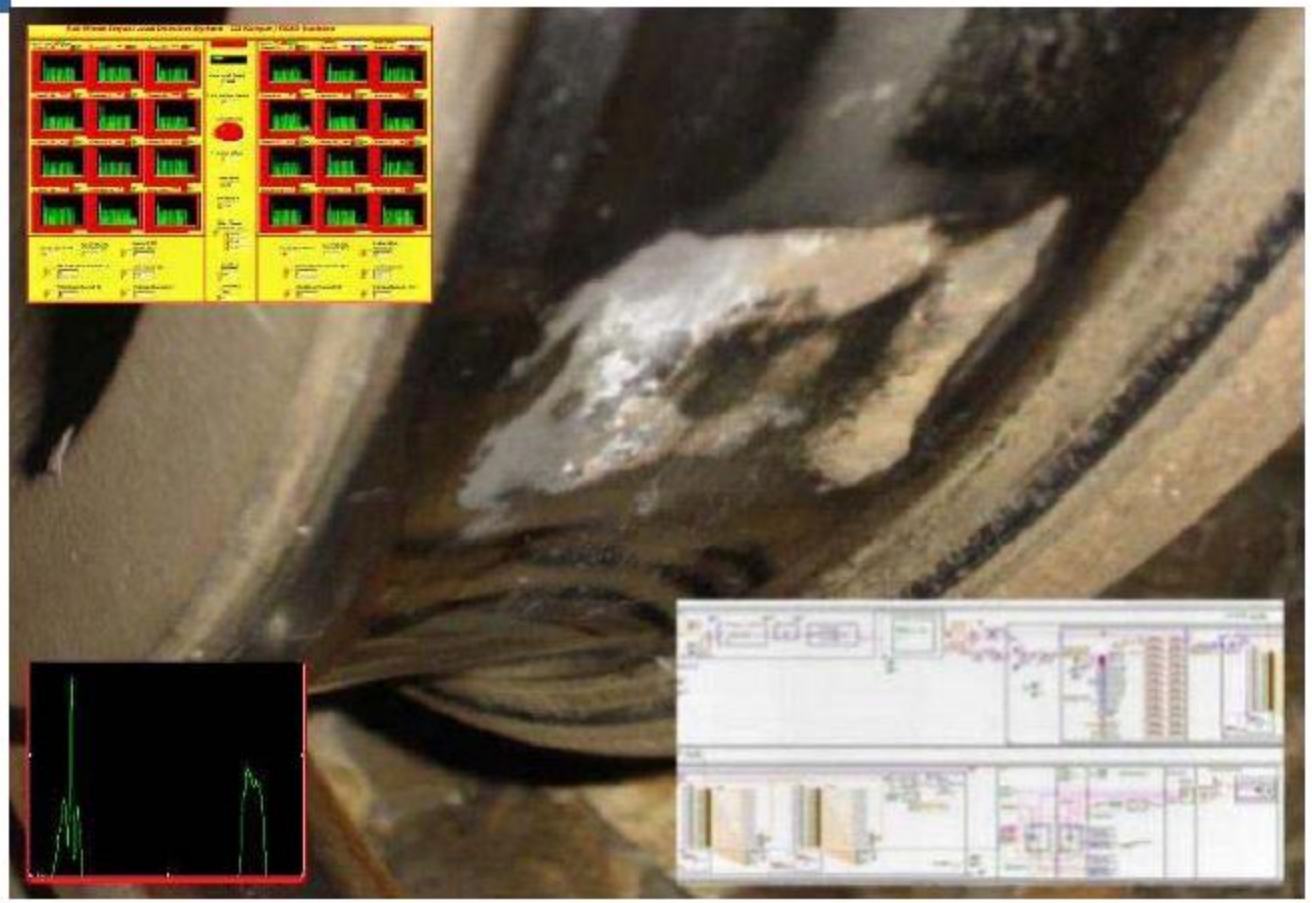
Indian Railways Projects under Development



Indian Railways

- Wheel Impact Load Detection System (WILD)
- Derailment Detection Devices
- Measuring Wheel Technology
- Onboard Diagnosis
- Bogie Design

Indian Railways



Wheel Impact Load Detection System (WILD)

Indian Railways

Wheel Impact Load Detection System (WILD)

A prototype automated system for On-Line estimation of Wheel Impact Loads and detection of Wheel Flats of running trains has been developed.

The Instrumentation System consisting of both Hardware and Software components has then been rigorously field tested at Ajgain Railway Station, near Lucknow for more than two years.

Strain-Guage Technology has been employed and data is collected over 24-channels along a rail length of five meters. Intelligent software algorithms and codes have been developed and embedded into the hardware processors.

For more Details visit site: *Wheel Impact load Detection System (WILD)*

Indian Railways

Derailment Detection Devices



Derailment Mechanism



Laboratory Tests



Lab Brake Mechanism



Placement of Sensors

Indian Railways

Derailment Detection Devices

This project envisages development of On-Board equipment for sensing derailment possibilities of rolling stock. Development includes appropriate instrumentation and signal processing strategy and its integration with the existing brake mechanism for minimizing losses due to dragging of derailed vehicle. Presently there is no instrumentation on Indian Railways for detecting derailment possibilities.

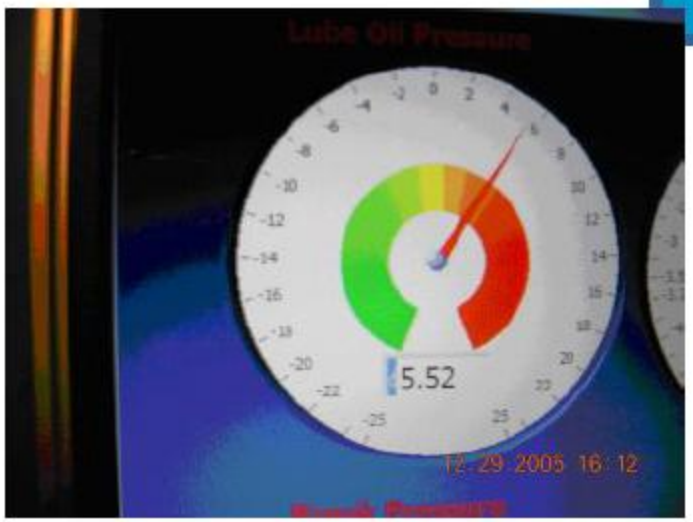
For more Details visit site: *Technology Mission on Railway Safety (TMRS)*

Indian Railways

Onboard Diagnosis



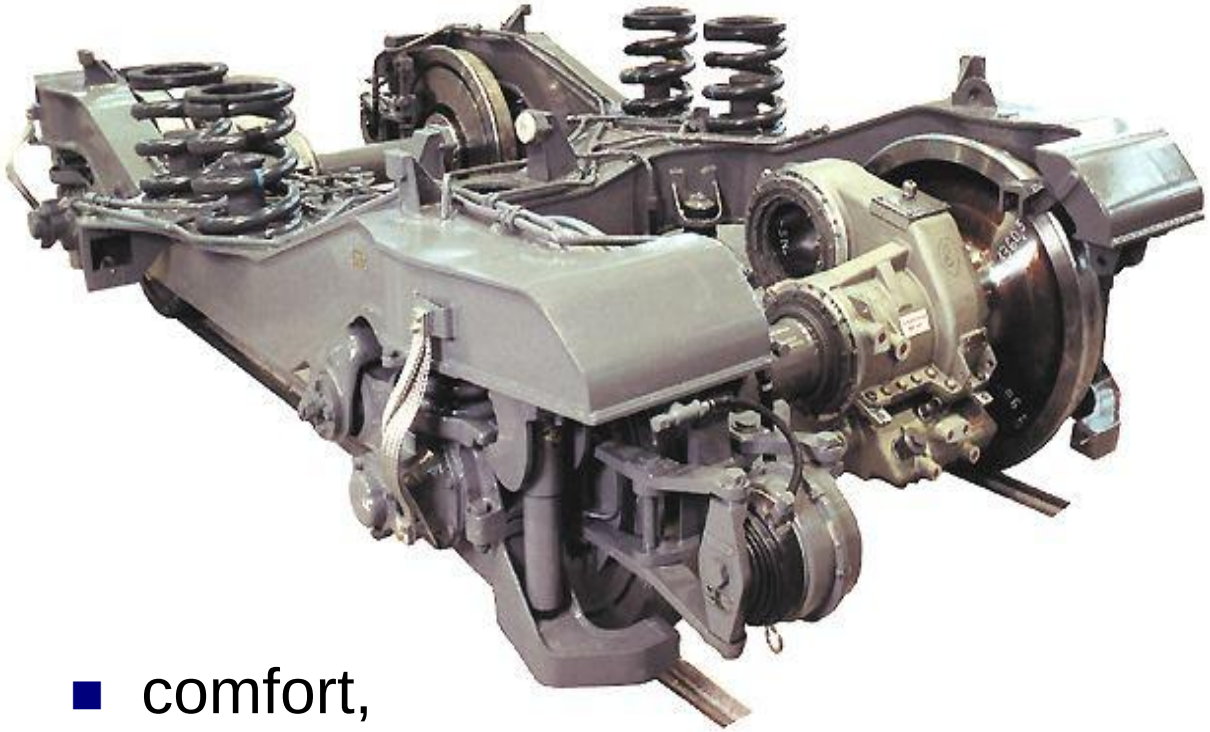
Pressure Transducer



Brake Pipe Pressure Indicator

- **Future developments aim to Improve:**
  - Performance
  - Energy use and environmental performances
  - Comfort
  - Safety and Security
  - Reduction in investment and maintenance costs
  - Interoperabilty

Railways around the World …







- comfort,
- speed,
- stability and
- safety.
- The bogies frame has a guaranteed 30-year lifespan.

Coaching – under trials

- Microprocessor based RMPU
- Passenger Information System
- LED Destination Boards
- Bio-Toilets, Vacuum Toilets
- RO Filtration System
- Automatic Doors
- Early Fire / Smoke Detection System

Coaching - Future

- Bearing Temperature Monitoring
- Bogie Vibration Monitoring
- Water Pump, level control
- On-board entertainment and information system on back of reclining chairs in CCs
- On-line information systems

Knowledge Required

- Mechanics
- Pneumatics
- Hydraulics
- Controls – Microprocessor / PLC
- Electricals - Power

Problem Areas

- Fundamental concepts – Control Systems
- Proper knowledge of Instruments
  - Appropriate Tool
  - Appropriate Technique
  - Calibration
- Safety
- Handling sensitive assemblies
- Cabling & Wiring
- ESD, EMI, Transients
- Training Facilities

Thank you