Equipment and solutions for technical education and vocational training
ERM provides technical systems and services in the fields of education, robotics, manufacturing laboratories (FabLabs), energy and industry. Founded in 1990 in southern France, ERM first focused on industrial automation. Overtaken by its educational culture, ERM quickly became the precursor of introducing industrial production lines within technical training institutions. Upon request by these educational institutions, ERM then extended its offer to other areas, such as electronics, electrical engineering, power engineering and renewable energy.

Today, ERM has become a market leader in didactic solutions and systems for technological and vocational training in France, and is developing its export markets.

More than 1500 academic institutions are equipped with ERM technical teaching equipment in France: Secondary schools for vocational training, Vocational training centers, Universities, Universities of Technology, Major engineering schools, etc.

Abroad, many vocational training institutions are using our systems:

- French overseas territories: Guadeloupe, Guyana, Reunion, Martinique, Mayotte, New Caledonia, French Polynesia, Wallis & Futuna
- Africa: Algeria, Burkina, Cameroun, Gabon, Ivory Coast, Morocco, Mauritania, Senegal, Tunisia, …
- Asia: Vietnam, Korea…
- America: Mexico, Colombia…
- Europe: Belgium, Luxembourg, Romania, Hungary, Slovakia, Switzerland…
Instruments, tools and data acquisition: See pages I1 to I9
### NAO Humanoid Robot

**Features:**
- Audio (4 microphones and 2 loudspeakers)
- Video (2 HD cameras 1200 x 960)
- Inertial unit (3-axis accelerometer, and 2-axis gyrometer) and Sonars
- Sensors (pressure FSR, bumpers, tactile)
- Servo-motors (coreless motors with hall effect sensors)
- Grip (prehensile hands with 3 operable fingers)
- Intel Atom 1.6 GHz CPU with 1 GB RAM and 8 GB Micro SDHC (text-to-speech, Image and voice recognition...)
- WiFi and Ethernet modules
- Lithium-ion battery (90 minutes autonomy)

**Training activities:**
- History and development of robotics, present and future applications
- NAO technical specifications, Functional analysis and Heuristic diagram, Patents
- Kinematic, electronic and software architecture
- Materials and processes (NAO shell)
- Spatial and voice localizations, organ motion, gripping, balance, means of communication
- Ergonomics and design
- Controllers on NAO
- Localization algorithms (with sonar)
- Use of 8 pressure FSR pressure sensors for NAO balancing
- Development and testing of new algorithms (eg: sight, balance...) within the NAO community
- Project: Develop applications for NAO, invent missions for NAO
- Project: Design software architecture for activities (eg: NAO monitors a room)
- Project: Creation of behaviors with Choregraphe software or SDK for complex behaviors
- Project: Create a vehicle for NAO (using the Vehicle Kit with Bluetooth communication)

**Key points:**
- Motivating and fun for students, and a medium of communication for the institution
- Open environment (Software suite for programming and data logging...)

**Reference:**
- AR/H25-EA: NAO humanoid Robot with SDK, Choregraphe, Monitor, 10 licenses - AR/SW-WNAO: Webots software for NAO, 1 license - NA10: Accessory kit for training activities (weights, ultrasonic sensors, Wi-Fi router, IR Remote control...) - NA11: Training system for NAO Foot + Ankle control - NA12: "Foot + Ankle" mechanical set - AR/SW-CSDK-U: Software suite Choregraphe, Monitor, SDK, site license - AR/SW-WNA010: Webots software for NAO, 10 licenses

### Training system for NAO Foot + Ankle control

**Features:**
- Mechanical transmissions (gears, gear reducer...)
- Motors (DC motors)
- Sensors (magnetic position sensors)
- SPI electronic bus

**Training activities:**
- Studying a DC / DC static converter
- Studying correctors and frictions
- Friction identification
- Influence of a PI corrector
- Model of pitch behavior
- Impact of sensor position on control
- Studying inertia and pitch dynamics
- Model analysis and balance concept
- Kinematics: is the NAO ankle anthropomorphous ?
- LTI system: identification of step responses, optimizing a PID corrector
- Dynamics: dynamic optimization of a kick

**Key points:**
- Ideal resource to teach about design and servo control for biaxial systems
- Labview/Matlab/Sinusphy models to compare simulations with real measurements
- Disturbance accessories are supplied (weights, slopes)
- Viewer Software for communication with and control from a PC
- Solidworks 3D Model and electronic diagrams to study constructive and practical solutions

**Reference:**
- NA11: Training system for NAO "Foot + Ankle" control - PR09: USB Logic Analyzer (to see the frames running on the SPI electronic bus) – AQ10: USB Data Logger

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**Webots 3D simulation software**

**Choregraphe programming software**

**Labview / Matlab / SinusPhy models**

**Viewer**

**Engineering procedure**

**Frequency study (with Kp variable)**

**Trajectory follow-up**
NAOtronics - Exploration of technology solutions implemented in the NAO robot

Three training modules:
- NAOtronics Detection
- NAOtronics Motorization
- NAOtronics Communication

NAOtronics Motorization - Humanoid finger: studying the technologies used in NAO robot for motorization

Features:
- DC motor with reducer
- Servo motor
- Electric cylinder
- Humanoid finger
- Arduino and Raspberry Pi boards, to control the actuators
- Human-Machine Interface (LCD screen, keyboard...)

Training activities:
- Studying the mechanical connections, kinematics, mechanical transmissions, motors and control
- SED programming in Python on Raspberry Pi and Arduino on microcontroller
- Project: creating a 3 DOF motorized finger (based on a finger prototype made of ABS) replicating the exact movement of a human finger with tendons (strings) and able to dial a telephone number on a keyboard
- Prototyping 3D mechanical parts (mounting board, adaptors...)

Key points:
- Large variety of parts for different constructive solutions
- Delivered with the “answers” (one solution is completely explained and functional)

References:
- PR09: USB logic analyzer (to see frame circulation in SPI/I2C buses) – See Ermaboard page H7

NAOtronics Detection – Platform for the study of electronic detection technologies implemented in the NAO humanoid robot

Features:
- FSR (Force Sensor Resistor) pressure sensors
- MRE (Magnetic Rotary Encoder) position sensors
- Inertial measurement unit (3-axis accelerometer / 3-axis gyroscope)
- Ultrasonic (sonar) sensors
- Infrared (remote control command) sensors
- Mechanical contact (shock) sensors
- Capacitive (touch) sensors
- Sound (microphone) sensors
- Arduino UNO development pack

Training activities:
- Analysis of sensors in an inertial measurement unit: accelerometer and gyroscope (experimental initiation to sensors, physical phenomenon, communication protocol)
- Analysis of ultrasonic sensors for distance (experimental initiation to sensors, physical phenomenon, communication protocol)
- Analysis of FSR force sensors (experimental initiation to sensors, physical phenomenon, experimental comparison between two acquisition set)
- Analysis of MRE angular position sensors (experimental initiation to sensors, physical phenomenon, experimental testing of linearity and accuracy, influence of the XY position error)

Key points:
- Ideal training support for studying multi-physics technology solutions and developing skills and knowledge in a training module.

References:
- NA15+PR00+PR30+PR31+PR32: NAOtronics "Detection" pack - See Ermaboard page H7

NAOtronics Communication – Platform for the study of electronic communication technologies implemented in the NAO humanoid robot

Features:
- SPI/I2C communication
- RS485/CAN communication
- Ethernet communication
- WiFi communication
- Arduino UNO development pack

Training activities:
- Study and analysis of the main protocols
- Communication: analyzing/modelling and experimenting on the information chain
- Experimenting with different network technologies

Key points:
- Ideal training support for communication solutions in multi-technology systems
- Electronic diagrams for studying constructive solutions

References:
- PR00+PR10+PR11+PR18: NAOtronics "Communication" pack – PR09: USB logic analyzer (to see frame circulation in SPI/I2C buses) – See Ermaboard page H7

Key points:
- Ideal training support for studying multi-physics technology solutions and developing skills and knowledge in a training module.

References:
- NA15+PR00+PR30+PR31+PR32: NAOtronics "Detection" pack - See Ermaboard page H7

Key points:
- Ideal training support for communication solutions in multi-technology systems
- Electronic diagrams for studying constructive solutions

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Key points:
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Key points:
- Ideal training support for communication solutions in multi-technology systems
- Electronic diagrams for studying constructive solutions

References:
- PR00+PR10+PR11+PR18: NAOtronics "Communication" pack – PR09: USB logic analyzer (to see frame circulation in SPI/I2C buses) – See Ermaboard page H7
HexaCopter Drone - Studies and projects on a 6-propeller drone

**Features:**
- Flight control (gyroscope, accelerometer and air pressure sensor)
- Motorization & Energy (Lithium-ion polymer battery, 6 propellers with brushless motors)
- Video and image processing (video, OSD telemetry data)
- Communication (USB, Bluetooth and RF 2.4GHz)
- Flight navigation (compass, GPS)
- Servo-control (servo-controlled camera mount)
- Software for flight following and data acquisition

Drone in a safety enclosure for testing

**Training activities:**
- System study (components, operation)
- Energy chain analysis (motor consumption, motor / propeller torque according to weight)
- Analysis of the information and communication chain
- Control (drone position controlled with P parameter, with D parameter)
- Design and fabrication of a block plan (shielding) to increase GPS signal
- Impact of balancing mass flywheels, vibration generation and their consequences on the flight acquisition
- Data processing of locations saved by the GPS after a flight
- Comparative study of behaviors with several landing gears

**Projects:**
- Design and assemble a foldaway or demountable frame to make storage easier
- Design and assemble a rescue parachute
- Design a shield for the GPS antenna
- Improve the drone power
- Improve drone performances (masses and propellers balance, altimeter protection to improve measurements)

**Key points:**
- Safety enclosure for indoor tests
- Open solution for development projects
- Professional drone with many available spare parts

**Resources for projects**

Aerial imaging gimbal – Studies and projects on a 2-axis controlled gimbal mounted on a drone

**Features:**
- Inertial measurement unit (accelerometer and gyroscope)
- Motorization & Energy (brushless, DC and stepper motors, industrial motor controller board)
- Mechanical linkage solutions
- Video and image processing (camera)
- Real-time LabVIEW control (MyRIO board)
- Communication (CAN bus)

**Training activities:**
- Testing of gimbal performance
- Motorization impact on gimbal behavior
- Behavior pattern of the controlled pitch axis of the gimbal
- Impact of axis balancing on performance
- Image control and recognition
- Impact of control sampling frequency

**Key points:**
- Opportunity to compare different technologies and motor powers
- Image analysis and integration in the position control loop
- Opportunity to implement projects using a third motorized axis
- Control programming/modification in Python
- Two types of control: Embedded electronics Real-time industrial electronic platform, based on NI myRIO

**References:**
- NC10: Aerial imaging gimbal – NC10+NC09: Aerial imaging gimbal with real-time video camera – NC10+NC09+NC09: Aerial imaging gimbal with real-time electronic platform (NI myRIO board and controller for 2 brushless motors)
- NC10+NC15+NC09: Aerial imaging gimbal with video control camera and real-time electronic platform (NI myRIO board and controller for 2 brushless motors) – NC11: Gimbal with more powerful motors (Optional) – NC15: Video control camera – NC16: Third-axis motorization kit with brushless/DC/stepper motor controller (Optional) – NC00+NC09: Real-time electronic platform (NI myRIO kit and controller for 2 brushless motors)

**Projects:**
- Design of a third axis (mechanical linkage – brushless, DC or stepper motor - Arduino/Python electronics and programming)

**Software for data acquisition**

HexaCopter drone flight in Marseilles with route outlined on Google Earth

**Video control camera**

**myRIO Aerial imaging gimbal**

**Compatible with the "Motors & Motion Lab" bench**

**HX10:** HexaCopter drone with safety enclosure – **HX11:** Flight navigator with compass and GPS (Optional) – **HX12:** 2 axis-servo-controlled camera mount (Optional) – **HX13:** OSD Real-time video with telemetry data (Optional) – **HX15:** Behavioral model of the HexaCopter drone, developed with Scilab Xcos and Matlab – **PR00+PR20:** Ermaboard GPS kit

**References:**

**Resources for projects**

**Page H7**

www.erm-automatismes.com
Cable robot for lifting assistance and 2D/3D positioning – Studies and projects on a cable-driven robot

- **Features:**
  - Position, speed and load control
  - Motorization & Energy (brushless and DC motors, industrial motor controller board)
  - Measurement of loads and torques
  - Mechanical solutions for cross-winding (orderly cable rolling)
  - Video and image processing
  - Real-time LabVIEW control (myRIO board)
  - Communication (CAN bus)

- **Training activities:**
  - **SysML:** description: choice of motor, performance and efficiency
  - **Kinematics (connection modelling and maximum speed)**
  - **Statics (determining the direction of cable pull based on the two load sensors)**
  - **State graph (load control with self-calibration to assist in lifting a variable mass)**
  - **Studying the operation of brushless motors (phase control curves) and comparison with DC motors**
  - **Study of sensors** (hall effect, incremental optical encoder, load sensor based on strain gauge, on/off limit switch)
  - **Study of mechanical solutions for cross-winding**
  - **Analysis of position, speed and load control** (e.g., torque control, experimental and theory-based determination)
  - **Experimental optimization of control parameters (Autotune)**
  - **Integration of image analysis in control**
  - **Real-time LabVIEW programming**
  - **Study and configuration of a CAN bus**
  - **Generation and optimization of 1D, 2D or 3D trajectories of the gimbal compatible with the motorization**
  - **Project: Control development for solutions using 1 winding head (lifting assistance) or 3 winding heads (2D/3D positioning)**
  - **Project: Design of a gimbal**

- **Key points:**
  - **Product evolution (scenarios using 1 / 3 winding heads, same control)**
  - **Complex mechanics of winding heads (cross-winding)**
  - **Comparison of DC and brushless motorizations**
  - **The test area can be placed horizontally (application type: Stadium camera movement) or vertically (application type: Painting robot)**
  - **Dual use of the camera: analysis of dynamic performance (fixed camera facing the robot), target tracking (camera on the gimbal of the robot)**

- **References:**
  - **WR00+WR11:** Cable robot for lifting assistance (one brushless winding head) – WR10+NC00+NC01+WR11+WR11+WR11: Cable robot for 2D/3D positioning (three brushless heads) with real-time industrial electronic prototyping platform (NI myRIO with CAN board) – WR11: Winding head with brushless motorization – WR12: Winding head with DC motorization

---

**Tri’ode 6-axis platform – 6-axis platform for inertial measurement unit certification**

- **Features:**
  - Controlled mechatronic platform with 6 degrees of freedom
  - Inertial measurement unit (3-axis accelerometer, 3-axis gyroscope)
  - Digital servomotors with communication bus (SED)
  - Control/Command/Acquisition in LabVIEW

- **Training activities:**
  - **Description and analysis of the system in SysML**
  - **Information chain/Energy chain**
  - **Kinematic modelling and geometric configuration (direct and reverse)**
  - **Modelling of controlled systems**
  - **Configuration of a controller (compliance/PID)**
  - **Study of communication networks**

- **Key points:**
  - **TCS-based system that controls scooter tilt (patented)**
  - **Platform with 6 degrees of freedom** for qualifying and certifying an inertial measurement unit
  - **Practical exercises developed for training modules**
  - **Plenty of models and sizes (modelling engineer-like experimenting)**
  - **Open solution for Matlab/Scilab control**
  - **Programming is possible with Python/Arduino board**

- **Reference:**
  - **C110:** Tri’ode 6-axis platform – For other ranges and subsystems, contact us.

---

**Real-life setting: camera on a stadium**

- **Features:**
  - **Load control**

- **Training activities:**
  - **Servo motor configuration**

- **Platform with 6 degrees of freedom**

- **Integration of communication networks (determining the direction of cable pull based on the two load sensors)**

- **Experimental optimization of control parameters (Autotune)**

- **Integration of image analysis in control**

- **Real-time LabVIEW programming**

- **Study and configuration of a CAN bus**

- **Generation and optimization of 1D, 2D or 3D trajectories of the gimbal compatible with the motorization**

- **Project: Control development for solutions using 1 winding head (lifting assistance) or 3 winding heads (2D/3D positioning)**

- **Project: Design of a gimbal**

---

**Mounted on a real electric scooter**

- **Features:**
  - **TCS: Patented tilt control system**

- **Key points:**
  - **TCS-based system that controls scooter tilt (patented)**
  - **Platform with 6 degrees of freedom** for qualifying and certifying an inertial measurement unit
  - **Practical exercises developed for training modules**
  - **Plenty of models and sizes (modelling engineer-like experimenting)**
  - **Open solution for Matlab/Scilab control**
  - **Programming is possible with Python/Arduino board**

- **Reference:**
  - **C110:** Tri’ode 6-axis platform – For other ranges and subsystems, contact us.

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**6-axis certification test bench for inertial measurement unit**

- **Features:**
  - **Control/Command/Acquisition in LabVIEW**

- **Training activities:**
  - **Description and analysis of the system in SysML**
  - **Information chain/Energy chain**
  - **Kinematic modelling and geometric configuration (direct and reverse)**
  - **Modelling of controlled systems**
  - **Configuration of a controller (compliance/PID)**
  - **Study of communication networks**

- **Key points:**
  - **TCS-based system that controls scooter tilt (patented)**
  - **Platform with 6 degrees of freedom** for qualifying and certifying an inertial measurement unit
  - **Practical exercises developed for training modules**
  - **Plenty of models and sizes (modelling engineer-like experimenting)**
  - **Open solution for Matlab/Scilab control**
  - **Programming is possible with Python/Arduino board**

- **Reference:**
  - **C110:** Tri’ode 6-axis platform – For other ranges and subsystems, contact us.
**Motors & Motion Lab** – Platform for the study of DC, brushless and stepper motors from ERM systems

- **Features:**
  - DC motor with incremental encoder (NAO / Cable robot or other)
  - Brushless motor (Cable robot / Imaging gimbal or other)
  - Stepper motor (Cable robot or other)
  - Linear DC motor (Voice Coil)
  - USB, CAN and CANopen communication
  - Embedded electronic circuits for motor control and I/O management
  - Position, speed, torque control with P, PI, PID controllers
  - Software for the data acquisition and processing

- **Possible training activities:**
  - Theoretical study: Multiphysics modelling of electric motors
  - Comparison between simulation models and real motors
  - Interpretation of differences and model improvement proposals
  - Identification of electrical and mechanical characteristics by open loop control (constant speed and sinusoidal control)
  - System stability prediction by analyzing open-loop frequency response (open-loop Bode plot)
  - Impact and optimization of P, PI, PID controllers for speed, position and torque control
  - Using an optimization method for automated controllers (autotuning)
  - Analysis of CAN and CANopen communication protocols
  - Programming and setup of embedded electronic components

- **Key points:**
  - Advanced platform for analysis, modelling and experimenting on motorizations of our systems
  - Flexible and fast implementation of the software suite for configuration and testing (Ingenia Motion Lab)
  - Many experiments using flywheels and active motor load

- **References:**
  - MT10: Motors & Motion Lab (basic package with DC and brushless motor) – MT11: Linear DC motor (Voice coil) – MT12: Stepper motor – MT15: CAN/USB gateway for implementing a CAN/CANOpen bus

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**Didactic printer** – Didactic instrumented 3D printer

- **Features:**
  - 3-axis mechanics including motors, transmissions and guides
  - Extruder with temperature control
  - Control/command board with microcontroller
  - Instrumentation with additional sensors (accelerometer, displacement, etc.)
  - Software for the data acquisition and processing

- **Training activities:**
  - SysML description and analysis of the printer
  - Temperature control in the presence of disturbances
  - Kinematic and geometric study of the printer
  - Study of control and power
  - Axis control configuration and impact on the manufacturing of parts

- **Key points:**
  - Professional printer with instrumentation, for teaching use
  - Many adjustments and configuration (speed, PID temperature, motor parameters, etc.)
  - Dissymmetric control of extruder heating and cooling
  - G-Code Interpreter, with prior acceleration planning, for smooth and accurate movement
  - Transparent case for safe observation of movements

- **Reference:** OE/ALTO333: Didactic instrumented 3D printer
### ErmaBoard – Electronics prototyping platform (control circuits, communication, sensors, HMI, robotics, multimedia)

**Features:**
- Electronic control (microcontrollers, FPGA, ARM9...)
- Power supply (battery, solar cell)
- Communication (Ethernet, Bluetooth, RFID, Zigbee, GPS, WiFi, CAN...)
- Sensors (temperature, accelerometer, proximity...)
- Human-Machine Interface (LCD, keyboard, voice recognition...)
- Robotics/Mechatronics (relays, servomotors, mobile robot chassis...)
- Multimedia (MicroSD card, JPEG imager, MP3 decoder...)
- USB logic analyzer for the study of serial protocols

**Training activities:**
- Architecture of electronic control systems
- Principles of microcontrollers, FPGA and microprocessors (ARM9) operating principles as well as their applications
- Programming the microcontroller, FPGA, and microprocessor ARM9 with the provided libraries
- Communications protocols
- Prototyping electronic control systems
- Project 1: Design and fabrication of a 2-wheel robot controlled by:
  - a human-machine interface on LabVIEW,
  - a joystick (Nunchuk of the Wii console) and a LabVIEW or Arduino application,
  - the Wiimote accelerometer (Wii console) and a LabVIEW application
- Project 2: Design, fabrication and commissioning a firefighter robot
- Other projects are available

**Key points:**
- Electronic circuits compatible with modular systems
- Ideal for projects in the fields of electronics, information processing, communications and robotics
- Provides introduction to and practice of several programming languages (graphics or text)
- May be studied with the tutorial work provided, or as a resource for other instructional systems (e.g.: Prototyping a motor control unit with motorized hinges or a 4-wheel vehicle for NAO robot ...)

**Programming environment:**

<table>
<thead>
<tr>
<th>PR00</th>
<th>Arduino Uno (Atmel Atmega)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PR01</td>
<td>Arduino compatible ERM (PIC 18)</td>
</tr>
<tr>
<td>PR05</td>
<td>Raspberry Pi (ARM Cortex A7)</td>
</tr>
<tr>
<td>PR02</td>
<td>FoxBoard (ARM9)</td>
</tr>
<tr>
<td>PR03</td>
<td>FPGA Altera (Cyclone 4)</td>
</tr>
<tr>
<td>PR04</td>
<td>Bus Pirate (PIC 24)</td>
</tr>
</tbody>
</table>

**Electronic control**
- PR00: Arduino UNO development kit (Atmel Microcontroller)
- PR01: Arduino, compatible ERM (PIC18 Microcontroller Microchip)
- PR05: Raspberry Pi development kit (ARM microcontroller)
- PR02: Foxboard development kit (ARM microcontroller)
- PR03: FPGA development board
- PR04: Interface board for components on bus i2c, SPI, UART (no programming)
- PR08: Kit with lithium-ion polymer battery and solar cell
- PR09: USB logic analyzer – Protocol analyzer CAN, SPI, I2C, RS232

**Communication**
- PR10: Ethernet Kit
- PR11: Wi-Fi Kit
- PR12: USB device and USB host Kit
- PR13: Zigbee Kit
- PR14: Bluetooth Kit
- PR15: GSM Communications Module
- PR16: RFID Kit
- PR17: RF 868 MHz Kit
- PR18: CAN Communications Module
- PR20: GPS Kit
- PR21: NFC Kit

**Sensors**
- PR30: Sensor kit (temperature, brightness, infrared, capacitive sensing) with connectors
- PR31: Sensor kit with accelerometer, gyroscope, compass
- PR32: Sensor kit for distance, proximity and color detection

**Human-Machine Interface**
- PR42: Speech recognition kit
- PR43: RGB led matrix
- PR44: LCD color display

**Robotics**
- PR50: 4-relay board with opto-isolated control
- PR51: Servo and motor kit
- PR52: Chassis for 2-wheel robot with DC motor

**Multimedia**
- PR60: Storage on microSD card
- PR61: JPEG imager
- PR62: VGA Interface
- PR63: MP3 Decoder
- PR64: USB Webcam

**Project kits**
- PJ00: Project kit “Remote-controlled 2-wheel robot” (Project 1)
Robotic, Mechatronics & Connected objects

**ErmaBoard Sensors & Motors** – Pack for the study of motor control and sensor technologies

- **Features:**
  - Microcontrollers (Atmel/Arduino or Microchip PIC18)
  - Sensors (temperature, light, infrared, capacitive sensing, accelerometer, gyroscope, compass, distance, proximity, color detection, etc.)
  - Motors (DC, servomotor and stepper)
- **Training activities:**
  - Control of various motors (servomotors, DC, etc.)
  - Sensor setup (accelerometer, ultrasound, color detection, etc.)
  - Signal processing and impact of sampling frequency on measurement accuracy

**ErmaBoard RFID / Bluetooth / Zigbee** – Pack for the study of RFID, Bluetooth and ZigBee communication protocols

- **Features:**
  - Microcontrollers (Atmel/Arduino or Microchip PIC18)
  - Communication (RFID, Bluetooth and Zigbee)
- **Training activities:**
  - Study and comparison of Bluetooth, ZigBee and RFID communication principles
  - Study of electronic circuits and communication protocols
  - Signal recovery and analysis, frame decoding and protocol-related operations
- **Key point:** Economical solution for learning RFID, Bluetooth and Zigbee protocols

**ErmaBoard Wi-Fi & GSM** - Pack for the study of Wi-Fi and GSM communication protocols

- **Features:**
  - Microcontrollers (Atmel/Arduino or Microchip PIC18)
  - Communication (Wi-Fi and GSM)
- **Training activities:**
  - Study of the operation of GSM and Wi-Fi communication protocols
  - SMS sending application
  - Study of circuits and source code for using Wi-Fi and GSM cards
  - Wi-Fi Hotspot creation (Connectify software) and configuration (WPA2 encryption)
- **Key point:** Economical solution for learning Wi-Fi and GSM protocols

**ErmaBoard Ethernet** - Pack for the study of the Ethernet communication protocol

- **Features:**
  - Microcontrollers (Atmel/Arduino or Microchip PIC18)
  - Communication (Ethernet)
- **Training activities:**
  - Studying the components and architecture of an Ethernet network
  - Organization and communication protocols (frame analysis)
  - Network securing
- **Key point:** Economical solution for learning the Ethernet protocol

**ErmaBoard GPS** - Pack for the study of GPS geolocation

- **Features:**
  - Microcontrollers (Atmel/Arduino or Microchip PIC18)
  - GPS geolocation
- **Training activities:**
  - Study of GPS principles (triangulation methods, navigation, accuracy, etc.)
  - Study of electronic circuits and of the GPS sensor
  - Recovery and analysis of GPS reception signals, frame decoding and operation
  - Analysis of the impact that the number of satellite signals has on accuracy
- **Key point:** Economical solution for GPS learning

**Key points:**
- Large variety of assembly kits and parts for different constructive solutions
- Possibility of having up to 14 students in groups of 2 working on the project
- Large variety of assembly kits and parts for different constructive solutions
- Delivered with the “answers” (one solution is completely explained and functional)

**Fire fighter robot** – Multi-application assembly kit to design a fire fighter robot

- **Features:**
  - Electronic control (microcontrollers, ARM9...)
  - Power supply (battery)
  - Communication (RF 868MHz, WiFi)
  - Sensors (proximity, ultrasound, temperature...)
  - Motors (DC, servomotor)
  - Mechanics (chassis for mobile robot, VEX Robotics parts...)
  - Multimedia (cameras...)
- **Training activities:**
  - Designing a ¼ scale model of a fire fighter robot to study mechanics, electrical power and electronic controls
  - Designing 6 project kits and the architecture of the whole robot in 7 two-person teams
  - Designing and testing mechanical transmissions
  - Prototyping 3D mechanical parts
- **Key points:**
  - Designing and testing mechanical transmissions
  - Prototyping 3D mechanical parts
  - Possibility of having up to 14 students in groups of 2 working on the project
  - Project can be taken up and improved every year
  - Large variety of assembly kits and parts for different constructive solutions
  - Delivered with the “answers” (one solution is completely explained and functional)
  - Possibility of having up to 14 students in groups of 2 working on the project
  - Project can be taken up and improved every year

**Humanoid finger** – Multi-technologies project

- **Features:**
  - Sensors, microcontrollers, HMI
  - DC motor, servomotor, electric cylinder, mechanical transmissions
- **Training activities:**
  - Designing and testing mechanical transmissions
  - Designing a ¼ scale model of a fire fighter robot
  - Possibility of having up to 14 students in groups of 2 working on the project
  - Large variety of assembly kits and parts for different constructive solutions
  - Possibility of having up to 14 students in groups of 2 working on the project
  - Free training and testing mechanical transmissions

**References:**
- PR00+PR30+PR31+PR32+PR51: www.erm-automatismes.com

**Resources for projects:**
- ERMABOARD
- www.erm-automatismes.com

**ErmaBoard**
- HOTSPOT creation
- Designing a ¼ scale model of a fire fighter robot
- Designing and testing mechanical transmissions
- Prototyping 3D mechanical parts

**Key points:**
- Possibility of having up to 14 students in groups of 2 working on the project
Double flow Controlled Mechanical Ventilation system & Thermal regulations – Studying a Controlled Mechanical Ventilation system for low energy consumption buildings

**Features:**
- Double Flow CMV (heat exchanger, DC motors, regulation and RF control)
- Air flow circuits (pressure loss...)
- Data acquisition: temperature, pressure, air flow, hygrometry, rotation speed, power and consumption

**Training activities:**
- Analysis and simulation of performance constraints imposed by thermal regulations
- Comparison of mechanical ventilation systems and studying speed variation
- Studying mechanical ventilation systems seeking to reach low energy consumption levels
- Heat exchangers
- Regulation (e.g. Bypass for night-time ventilation)
- Studying the impact of ventilation on indoor air quality
- Designing and dimensioning ventilation systems for the proposed case studies

**Key points:**
- Use of the training system for the lab’s ventilation enabling real measurements
- Ideal for experiments with heat exchangers
- Emphasis on ventilation which is essential in the evolution of thermal solutions for buildings

**References:** VM30: Double flow CMV & Thermal regulations with the following sensors: pressure (x2), flow (x1), hygrometry (x1), temperature (x4) to be connected to a data logger – VM21: Portable instrument for operational, thermal and air flow data logging – VM23: Case with mechanical parts for the Double flow CMV – VM24: Hot and cool air generator for indoor use (without external air inlet) – VM26+PC22: Instrumentation for pressure (HP and LP) and temperature (8 sensors and 4-channel thermometer with display and PC acquisition) to study the hot and cool air generator VM24 – AQ10: USB Data logger – AQ11: Differential voltage probe for USB data logger – AQ12: AC current clamp for USB data logger

Air/Water heat pump with inverter & fan coil unit – Studying a reversible air/water heat pump with a high performance fan coil unit

**Features:**
- Thermodynamic domestic equipment (R410 refrigerating unit, inverter technology, electronic expansion valve)
- Thermal and electrical measurements (voltage, current, 12 temperatures, refrigeration and hydraulic pressure, water and air flow, electronic control signals)
- Heat exchangers (multitube-in-tube, finned tube)
- Variable flow (compressor, water circulator with PWM control, brushless motor fan)
- Hydraulic distribution (expansion valve, valve, bleeder...)
- Eco-designed fan coil unit
- Radio and/or KNX control

**Training activities:**
- Performance analysis and simulation of a building equipped with a air/water heat pump. Comparison with other heat generators.
- Functional analysis of a air/water heat pump

**Key points:**
- Energy savings for motors, exchangers and regulation
- Heat pump control (water logic, compensation, monitoring controls, ...) and fan coil unit control
- Refrigerating circuit, enthalpy chart, calculating the coefficient of performance (COP) of the heat pump
- Eco-design strategy of the fan coil unit
- Studying the "multitube-in-tube" stainless steel/copper exchanger
- Studying the Vortex flow meter (additional flow meter supplied)
- Electronic architecture of the heat pump controller
- Studying the fan coil controller (wire, KNX and PID control)
- Mechanical study of 3D components (compressor, 4V valve, circulator, motor-fan...)
- Project: Operate the fan coil unit with a KNX controller


**Key points:**
- Thermodynamic heating/cooling (heat pump) is widely used
- Actual dimensioning of the heat pump (5kW thermal power) and fan coil unit, for a low-energy house
- Many thermal and electrical measuring points
- Refrigerating, hydraulic and air flow circuits on the same system
- Executables with Labview and 3D Solidworks models of the parts are supplied


Monosplit reversible air-conditioner with inverter – Training system to study a monosplit reversible air-conditioner DC inverter using R410

- **Features:**
  - Thermodynamic residential equipment (R410 refrigerating unit)
  - Measurements (voltage, amperage, temperature, hygrometry, HP and LP manometers)

- **Training activities:**
  - Electric and thermal measurements, data acquisition and interpretation
  - Energy balance and air conditioning efficiency
  - Enthalpy chart, humid air chart
  - Inverter technology (speed regulation of the compressor)
  - Control: study of the regulator

- **Products advantages:**
  - Studying a monosplit reversible inverter air conditioner in real conditions
  - User-friendly data-acquisition of operating parameters on Labview

- **Reference:** MO20 Monosplit reversible air conditioner with inverter – AQ21 Data logger and tele-monitoring via Ethernet (embedded web server) – AQ10 USB data logger – AQ11 Differential voltage probe for USB data logger – AQ12 AC current clamp for USB data logger – PC22: 4-channel thermometer with PC acquisition and display (delivered with 8 thermocouple probes and PC acquisition software)

Solerm CESI – Solar water heater – Communication-capable instrumented domestic solar water heater

- **Domestic solar heater, installed in real operating conditions**
- **Exhaustive measurements** (flow and energy of the solar and sanitary circuits, insolation, temperature of panel, exchanger, water tank, faucet,... solar circulator pressure)
- **Real-time data access and acquisition by USB and/or Ethernet (embedded web server)**
- **Possibility of sharing data with other schools and institutions, by putting the data online through the web server**

- **Features:**
  - Thermodynamic residential equipment (R410 refrigerating unit)
  - Measurements (voltage, amperage, temperature, hygrometry, HP and LP manometers)

- **Training activities:**
  - Electric and thermal measurements, data acquisition and interpretation
  - Energy balance and air conditioning efficiency
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- **Products advantages:**
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Drinking water control and distribution – Trainer for level, flow and pressure control in drinking water systems and tanks

- **Features:**
  - Process measurements (water level in the tank by ultrasounds)
  - Tanks (water tank simulating a natural water reservoir, storage tank simulating a water tower)
  - Variable-flow pumps (circulator pump with brushless motor, compressor)
  - Valves (quarter-turn manual valves, solenoid valve for flow disturbance)
  - Control unit (Labview interface, variable speed drive)

- **Training activities:**
  - Functional analysis: drinking water storage and distribution systems
  - Measurement principles (physical laws, sensors, transmitters..)
  - Variable-flow pumps
  - Identification of a stable open-loop and closed-loop system
  - Unstable OL and CL systems
  - Simple water level control, responding to a set point change, responding to disturbances
  - Integrator level control
  - Pressure and flow control, split-range control
  - Energy savings in drinking water systems management

- **Key points:**
  - Ideal for studying process instrumentation, water level regulation, flow control and pressure regulation
  - Simple and complex regulation systems (split-range optional)
  - System based on an actual application (drinking water distribution with water tower)


ModuloSolaire - Modular system for off-grid solar study

**Features:**
- Electricity generation (solar panels: mono-crystalline, poly-crystalline, amorphous, thin-film)
- Energy storage (12V 13Ah batteries and digital-display charge regulator)
- AC/DC electrical distribution (12-230V 150VA inverter, circuit-breakers)

**Training activities:**
- Energy transformation, storage and distribution
- Measurements, efficiency study of the 4 types of solar panels
- Comparison of 4 different solar panels (mono, poly, amorphous, thin-film), 3 different regulators (PWM, MPPT) and 2 inverters (quasi-sine, sine)
- Project: Case study about supplying power to electrical loads (dimensioning of the parts)

**Key points:**
- Parts are connected with stackable plugs to offer maximum modularity

**References:**

OCS fuel cell – Study and projects on a fuel cell and related electronics

**Features:**
- 50W fuel cell, 10.2 to 15.3V, type PEMFC
- Thermocouple management electronics
- Hydrogen tank and charge solution
- DC-to-DC converters and hybridization modules

**Training activities:**
- Study of hydrogen storage and energy production
- Study of fluids and heat transfers
- Study of power electronics, signal processing and sensors
- Project: Design and implementation of a power supply system based on a fuel cell used independently, combined with a power storage buffer (stationary battery) or with another power source (photovoltaic, wind generator, etc.)

**Key points:**
- Labview measurement executable supplied (with AQ10 option)
- Compatible with “Modulosolaire” (modular system for the study of off-grid solar photovoltaics) and the ErmaBoard electronic prototyping platform
- Project implementation guide and resource file on the theory of fuel cells

**References:**

Resources for projects

Photovoltaic and wind generator kit – Studies and projects involving the production of solar photovoltaic and wind energy
- High capacity and wattage, programmable and communication-capable data logger
- System close to reality, possibility of installation in real-use conditions

3,5kW wind generator characterization bench – Studying a grid-connected 3.5kW wind generator
- Measurements (voltage and current in the energy chain, rotation speed, turning torque of the wind generator)
- Constructive solutions of wind generators (mechanical control of the rotation speed)
- Measurements and efficiency study of each part of the system: wind generator, regulator, inverter
- Effect of modifying the load curve of the inverter on power production by the wind generator

Software for calculation and dynamic simulation of photovoltaic systems

**Training activities:**
- Dimensioning, performance and efficiency of grid-connected and off-grid photovoltaic systems
- Simulation of shade impact
- Studying the impact of parameter variations

**Key points:**
- Case studies and training resources are provided

**Reference:**
- PL13: Software for calculation and dynamic simulation of grid-connected and off-grid photovoltaic systems

Resources for projects

Software for calculation and dynamic simulation of solar heating, photovoltaic and heat pump systems

**Training activities:**
- Dimensioning and efficiency of solar heating systems (domestic hot water and heating), photovoltaic systems (grid-connected) and heat pumps
- Fast time simulation with value display
- Studying the impact of parameter variations
- Energy balance

**Key points:**
- Case studies and training resources are provided

**Reference:**
- PL12: Software for calculation and dynamic simulation of solar heating, photovoltaic and heat pump systems

Resources for projects
Motorized shutter — Studying a motorized hinge and its remote control or home automation KNX

Features:
- Opening elements (doors, windows) with a motorized hinge
- Communication (wired, 868Mhz RF, home automation KNX)
- Control solutions (push button, clock, CTM, brightness sensor)
- Electromagnetic locks (shutter locking)
- Strain, voltage and amperage measurements

Training activities:
- Overall analysis (mechanics, RF remote control…), measurements (voltage, current, closing time, acoustics)
- Creativity, patent, anterity. Inventory of products with similar functions
- Functional analysis of the electronic circuits for hinge control (power, intensity control …)
- Studying the 868Mhz remote control (performances, range, transmission security, encryption)
- Motor control unit (torque, current requirements), study of H-bridges
- Network pollution, electro-magnetic field
- KNX protocol, frame measuring, configuration
- Electromagnetic performance measurements, closing effort, releasing effort, current requirements
- Overall energy balance, energy consumption of one cycle, thermal impact on the building
- Airtightness and sealing functions
- Mechanical solutions with digital 3D model, simulation of operation conditions
- Studying the complete chain (Energy, gears, torques) and its irreversibility
- Materials, methods for obtaining parts (aluminum and plastic molding, surfacing, milling)
- Projects: Addition of the Zigbee feature / System control development and integrating it into a KNX bus system, configuration, adding comfort features (clock, brightness sensor) / Electromagnetic lock design

Key points:
- Systems integrating building, electricity, electronics and communications technologies
- Modular and upgradeable system

References:
- GD10 Motorized hinge mechanical kit, sliding system and electromagnetic lock — GD11 Motorized hinge system with wired control, remote control, electromagnetic lock and system control — GD12 Home automation control with KNX (ErmaDomo) - AQ10 USB data logger - AQ11 Differential voltage probe – AQ13 Current clamp (AC and DC)

KNX ErmaDomo module — Home automation control unit with KNX and supervision

Features:
- Communication (USB / KNX Interface)
- Electrical distribution (modular KNX, KNX switches…)
- Sensors (KNX temperature and brightness)

Training activities:
- Scripting commands
- Addressing and configuration of KNX parts
- Frame reading on KNX bus
- Developing home automation supervision

Key points:
- Compatible with ERM products “Motorized shutter”, “Air/Water Heat Pump & Fan coil unit”
- KNX projects with ErmaDomo KNX peripherals (24Vdc actuators and fast connectors for easy wiring)
- This system may be used as the core of any KNX Home automation project (lighting…)

Reference: GD12 ErmaDomo KNX module (home automation remote control with KNX and supervision)
EnOcean wireless, battery-free home automation – Study and implementation of EnOcean wireless, battery-free home automation solutions

- **Features:**
  - Wireless communication using ultra-low power
  - Piezoelectric, thermolectric and solar microgenerators
  - Power micro-storage
  - Building security, fire detection
  - HVAC (heating, thermostat, ventilation)
  - Lighting control (light variator, light and occupancy sensors, etc.)
  - Access and opening control (window contact, EnOcean window handle, card/badge reader)
  - Supervision and home automation box

- **Training activities:**
  - Mechatronic study of EnOcean solutions (mechanics, electronics, communication)
  - Setup of EnOcean home automation installations (configuration and parametrization, supervision, etc.)
  - Configuration of a home automation box
  - Measurement of electricity consumption and analysis of savings made with EnOcean home automation
  - Mechatronic prototyping of EnOcean sensors or controllers
  - Prototyping of a home automation box with supervision application and configuration
  - Integration of EnOcean components in a KNX installation (via the KNX/EnOcean gateway)

- **Key points:**
  - Many study, design and implementation activities
  - Initiation to a booming home automation technology, adapted to both residential and tertiary sector
  - Complementarity between the EnOcean solution and KNX (EnOcean = proximity technology)
  - Compatible with the “KNX Eco-Energy” and “KNX ErmaDomo module” ERM products for advanced home automation scenarios

- **References:**
  - **EN00:** EnOcean starter kit – **EN01:** EnOcean developer kit – **EN02:** EnOcean thermal kit – **EN03:** EnOcean home automation box prototyping and supervision kit – **EN10:** EnOcean lighting kit (sensors and controllers) – **EN11:** Opening management kit (sensors and controllers) – **EN12:** Heat management kit (sensors and controllers) – **EN15:** EnOcean controller box (counter, lighting, sockets) – **EN16:** KNX/EnOcean gateway module – **EN17:** Wi-Fi / Ethernet / EnOcean home automation box

- **Additional references:**
  - **P02:** Mechatronics project kit “Mobile element/Tilt in DMX mode for LED lighting or camera” (With ErmaBoard prototyping platform)

- **Reference for measuring units and signal analysis:** See technical datasheet

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**Performance and Entertainment Technology** - Lighting, sound, effects and displacement systems in show business

- **Features:**
  - Communications bus (DMX)
  - Lighting (halogen, LED) and lighting control (dimming, color-changing, zooming)
  - Lighting effects (motorized moving head)
  - Sound equipment (HF microphone, amplifier, speakers...)
  - Lifting and transfer of objects (AC and DC motors, PID loop control)
  - Stage control interfaces (DMX console, USB/DMX controller and programming software for 3D stages)
  - Ceiling frames (made of aluminium wire mesh)

- **Training activities:**
  - Situation scenario and introduction to show business technology
  - Measurements (voltage, current, power, communication frames, luminous flux, acoustics, positions, speed...)
  - Studying PID loop control for hoists and lateral displacement systems
  - Installing, connecting and networking equipment
  - System adjustment and configuration
  - Diagnostic and maintenance
  - Software configuration for stages

- **Key points:**
  - Modular system of a common, friendly and technical application
  - Many mechanical and energy studies
  - Ideal for projects (lighting, performance comparison of motors)

- **References for the basic configuration:**
  - DM10+AQ14 Stage controllers (DMX console and USB/DMX controller and programming software for 3D stages), power box with 2P+T plugs and measuring unit for control signals and power - DM16 4-channel DMX power block/dimmer, provided with PAR56 halogen projector - LE11 PAR 56 LED color-changing projector controlled by DMX - LE12 PAR 56 halogen projector with Fresnel lens - LE10 DMX motorized moving head - LF11 DMX lifting system, 10kg (DC motor) – CX11: Ceiling frame (3m) made of aluminium to suspend projectors and actuators

- **Additional references for projects:**
  - DM12 DMX splitter – DM18 W-DMX wireless connection - LF10 DMX system to open/close a curtain (DC motor) - LF12 DMX lifting system, 20kg (AC motor) - LE13 Projector stand - AU10 HF sound system - CX10 Square ceiling frame (2x2x2m) made of aluminium to suspend projectors and actuators – **PJ02:** Mechatronics project kit “Mobile element/Tilt in DMX mode for LED lighting or camera” (With ErmaBoard prototyping platform)

- **Reference for measuring units and signal analysis:** See technical datasheet

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**Resources for projects**

**USB/DMX controller and a measuring unit**

**Resources for projects**

**EnOcean starter kit**

**EnOcean controller box (EN15)**

**Home automation & supervision box**

**EnOcean controller box**

**Magnetometer**

**Solar energy**

**Heating**

**DMX Lifting system (LF11)**

**Mechatronics project kit “Mobile element/Tilt in DMX mode for LED lighting or camera” (PJ02)**
Blower door – Introduction to building airtightness testing

- **Features:**
  - Adjustable aluminium door frame and panel with viewing window
  - Fan, variable fan speed and pressure control
  - Tubing
  - Pressure and flow gauge (connected or wireless)
  - Smoke puffer for diagnosing air leakage sites
  - Software for airtightness test results including leakage areas, estimated natural and design infiltration rates and estimated savings of air-sealing.

- **Training activities:**
  - Building airtightness testing (leak detection...)
  - Studying commonplace leaks (windows/doors, plugs...) impact on the airtightness of a building
  - Implementation of standardized tests (LCB...) with calculation of air permeability and surface of leakage area
  - Project: Conduct airtightness testing within the school

- **Key points:**
  - Tutorial work is supplied

- **References:**
  - BW10: Blower door with accessories and software
  - BW11: Smoke generator for blower door

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Thermal infrared camera & Test bench – Introduction to infrared thermal imaging

- **Key points:**
  - Test bench for a better comprehension of infrared thermal imaging fundamentals, to be used as a complement to other machines and equipment
  - Tutorial work is supplied

- **References:**
  - Flir industrial infrared camera (consult us)
  - NS12: Test bench for heat conductivity and emissivity, with 6 bars (painted PVC, aluminium, steel and brass, raw aluminium, galvanized steel)
  - NS14: Insulating materials (Optional), wood, wood wool, glass wool, polystyrene, polyurethane.

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Earthquake simulator - Experiments on building behavior in earthquake-like conditions

- **Features:**
  - Shake table with vibration generator (frequency: 3 to 30Hz)
  - Modular parts representing several building techniques (pole, beam, bracing, floor, wall, vibration absorber)
  - 4 accelerometers
  - Software for control and data acquisition
  - USB camera (optional)

- **Training activities:**
  - Building resistance to earthquakes (according to its shape, support, reinforcement mechanisms, weight distribution...)
  - Examples of experimental protocol (questioning, hypotheses, building designs, observation, interpretation)
  - Parameters modification (frequency and magnitude)
  - Determining characteristics (magnitude, frequency, stiffness)
  - Comparative study of structures according to weight

- **Key points:**
  - Adjustable vibrating frequency (3 to 30Hz) and amplitude with the PC interface
  - Modular and easy to set-up system
  - Shake table faithfully replicating seismic vibrations
  - Measurements and data acquisition with the Labview interface on PC

- **References:**
  - SQ10 Earthquake simulator and datalogger with 4 MEMs accelerometers
  - SQ11: HF USB camera with software to capture accelerometer measurements via image analysis
Coffee maker using Nespresso® capsules

- **Features:**
  - Water circuit with tank, pump, safety valve
  - Electric resistance for immediate water heating, triac controlled
  - Mechanical sub-system for capsule piercing
  - Electronic circuit for control, with PIC microcontroller

- **Training activities:**
  - History of coffee makers and the Nespresso coffee maker, coffee maker market, TRIZ interactive matrix
  - Functional analysis, patents
  - Materials and design
  - Eco-design of the capsule, recycling process

- **Other possible training activities:**
  - Electronic card for the coffee maker with PIC and triac

- **Key points:**
  - Consumer product
  - “Dismantled” coffee maker on a stand with a manometer on the water circuit, digital output for water temperature, load resistance and flowmeter voltage data

- **References:**
  - NS10: Coffee maker trainer with measurements
  - NS11: “Commercial” coffee maker (Optional)
  - NS12: Test bench for heat conductivity and emissivity
  - NS13: Eco-design case for coffee maker using capsules
  - AQ10+AQ11: USB data logger (Optional)

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Conductivity and emissivity test bench – Study of thermal transfer, thermal properties and emissivity of materials

- **Features:**
  - Materials (conductivity and thermal insulation)
  - Thermal measurements (thermal camera...)

- **Training activities:**
  - Visualization of thermal conductivity and thermal transfer on bars made of different materials
  - Visualization of thermal emissivity on bars with different surface treatments

- **Key points:**
  - Test bench for a better comprehension of infrared thermal imaging fundamentals
  - Study of materials (PVC, aluminium, brass, steel, wood, polystyrene...)
  - Ideal for using an infrared camera

- **References:**
  - NS12: Test bench for heat conductivity and emissivity, with 6 bars (painted PVC, aluminium, steel and brass, raw aluminium, galvanized steel) – NS14: Insulating materials (Optional), wood, wood wool, glass wool, polystyrene, polyurethane – OA10: 4-channel thermometer with datalogger - All Flir thermal cameras

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Manual silicone moulding kit – Prototyping of moulded parts

- Making silicone moulds, then moulding two-component polyurethane and low-melting-point alloy parts in a silicone mould
- Efficient and low-cost prototyping

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Zortrax M200 3D Printer

- Good quality and speed, for a cost-effective use
- Build volume: 200 x 200 x 185 mm
- Free Z-Software suite
- Totally autonomous with LCD display and SD card.
**Materials, Structures, Mechanics & Eco-design**

**Materials characterization equipment** – Test bench for mechanical testing of materials (5 or 20kN) with data acquisition

- **Technical specifications:**
  - Manual or automatic dual column machine with motor driven positioning
  - Test load of up to 20kN and test run of up to 614mm
  - PC data acquisition: Force/Time (20Hz) and Force/Displacement (6Hz)

- **Training activities**
  - Basic test bench: tensile, compression and Brinell hardness testing
  - Optional: flexure, shear, impact
  - Metal comparison, designing parts...

- **Key points:**
  - Simple and sturdy system for training activities
  - Data accuracy 10N (for 20kN dynamometer) and 0.1N (for 500N dynamometer)

**References:** EM00/EM05 Materials characterization equipment 20kN/5kN including basic test bench with force (20kN/5kN) and displacement datalogger, software, accessories for compression (20kN, 60mm plates), tensile (5kN) and Brinell hardness testing (5mm ball – 2.5 to 7.5kN), and samples of materials (backpack loops, straps...) – EM01 500N force sensor to be connected to the datalogger, for testing brittle materials - EP00 Test samples for hardness – EM02 Measuring magnifier for Brinell pattern cavity - EM10 Tools for 3-point flexure tests, up to 20kN, adjustable supports from 4 to 150mm – EP10/EP11 Test samples for flexure – EM20 Tools for tensile testing, up to 20kN, 35mm opening for all products and standard flat panels – EM22 Self-fastening tools for tensile testing, up to 5kN, 5mm opening for all products - EM23 Tools for tensile testing, up to 20kN, 35mm opening (excluding inserts) for all products, with inserts for standard flat and cylindrical test samples – EM24 Tools for tensile testing, up to 20kN, for standard flat and cylindrical specimens only – EP20/EP21 Flat/cylindrical test samples for tensile testing – EM30 Tools for shearing tests, up to 20kN – EP30 Test samples for shearing – EM40 Tools for impact tests, 8mm diameter, up to 20kN – EP40 Test samples for impact

**Example of curves with the acquisition software**

- Tensile test
- Shearing test

- **Resources for projects**

**Materials and structures test bench** – Studying materials and structures resistance

- **Contents and technical specifications of the basic configuration (EW10):**
  - Electric cylinder (2500N) with incremental encoder for displacement measurement
  - Digital comparator for displacement measurement
  - 3 force and torque sensors (with associated device)
  - Mounting bases
  - Tension clamping jaws
  - Simple (semi-cylindrical) fulcrums, pivots and fittings
  - Ceiling-mount with distribution plates
  - Controller and datalogger (force and displacement) with software
  - Set for simple tests (support beams, Portal frames, Truss).
  - Safety enclosure for testing (EW09 version)

- **Training activities:**
  - Static studies of beam bending (simple with two fulcrums, simple with fittings at one end, simple with 4 points of which two are fulcrums)
  - Static studies of traction
  - Static studies of compression
  - Static studies of support beams (two forces and momentum applied to a solid...)
  - Static studies of portal frames and truss (vertical force applied to a solid)
  - Studying frames made of wire mesh, e.g. rail bridge
  - Studying arches, e.g. rail bridge
  - Studying the structure of buildings, e.g. metal building with flat roof
  - Studying the structure of buildings, e.g. metal building with slanted roof
  - Studying an mountain bike crankset with pedals
  - Distortion of a mountain bike rod, subjected to 3 concurrent forces

- **Key points:**
  - Test control and measurements (force, displacement and constraint) on PC interface
  - Huge test enclosure (LxBxH=1500x700x1000mm) enabling tests on 3D structures
  - Possibility of combining forces applied by two cylinders
  - Tensile, compression, bending, torque and torsion measurements
  - Many available mechanical parts and frames (standard or optional)
  - Possibility of performing tests safely on any structure

- **Reference: EW09:** Materials and structures test bench with safety enclosure - EW10: Materials and structures test bench – EW11: Device to measure torsional momentum – EW12: Extra electric cylinder with displacement and force sensor and simple (semi-cylindrical) fulcrum for tests – EW13: Extra displacement sensor (digital comparator) to be placed anywhere on the tested structure – EW14: Extra force sensor with flat base and simple (semi-cylindrical) fulcrum and pivot

**SW10:** Modular portal frame with 4 strain gauges and datalogger to measure distortion in the structures – SW11: Test model to study complex structures (“Trestle bridge” and “Arch bridge”) – SW12: Test model to study a complex structure “Industrial metal building with 3 spans” – SW13: Test model to study cranksets with pedal and rods on mountain bikes – SW14: Beam for tension coefficient experiments

**PC interface for control and measurements**

- Measuring torsional momentum

- **Resources for projects**

**Example of curves with the acquisition software**

- Tensile test
- Shearing test

- **Complex structures (depot, bridge...)**

- **eg: Testing 3 concurrent forces**

- **eg: Truss testing**

www.erm-automatismes.com
TangoKit – Test bench for materials and structures

- **Technical specifications:**
  - Electric cylinder for tensile, flexure and compression 2.5 kN
  - Travel speed 100 mm/m
  - Travel 100 mm
  - Cylinder adjustable in height
  - Work-bench 1000 x 160 mm
  - Maximum height of the tested sample 300 mm
  - Displacement accuracy 0.05 mm
  - Force sensor 5 kN, resolution 0.1 N
  - USB connection
  - «Oscar» software for data logging and processing

- **Training activities:**
  - Studying beams
  - Studying structures
  - Studying tensile strengths
  - Studying compression
  - Materials comparison

- **Key points:**
  - Possibility to measure tensile strength and compression with the same bench
  - Compact design
  - Many mechanical parts and frames (standard or optional)

- **References:**
  - TK10: TangoKit test bench for materials and structures, with frame, electric cylinder 2500N, 3 simple (semi-cylindrical) fulcrums, software – TK11: Extra displacement sensor (digital comparator) – TK12: Device to measure torsional momentum – Test samples: consult us

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**Industrial command prototyping platform** - Prototyping of control parts based on a real-time NI myRIO core and industrial motor controller boards

- **Features:**
  - Real-time LabVIEW control (myRIO board)
  - Communication (CAN bus)
  - Motorization & Energy (industrial controller for brushless, DC and stepper motors)
  - Load measurement
  - Video and image processing
  - Inertial measurement unit (accelerometer and gyroscope)

- **Training activities and projects:**
  - Real-time programming in LabVIEW
  - Motor controller board configuration
  - Study and configuration of a CAN bus
  - Experimental optimization of control parameters via autotune
  - Integration of image analysis in a control system
  - Project: System control design or upgrade (position, speed and load control)

- **Key points:**
  - The solution is open to development projects on your existing systems
  - Examples of applications with LabVIEW files provided (Aerial imaging gimbal, Cable-driven robot)
  - Compatible with C-Series boards from National Instruments (for upgrades and projects)

- **References:**
**Data acquisition & Instrumentation**

**USB NI 6210 data logger** – Temperature datalogging, 0/10V sensors, 0 to 500V voltage, amperage, constraint

- **Specifications:**
  - 8 Analog Inputs ±10V (14 bits, 48kS/s)
  - 8 Digital Inputs/Outputs
  - Two 32-bit counter/timers
  - Software configuration for thermocouples
  - Isolated input channels by external conditioners
  - User-friendly datalogging software (datalogging, display and analysis)

- **Types of measurable data and conditioners:**
  - 0/10V sensors (without conditioner)
  - AC and DC voltage: 0/500V (with AC and DC voltage input conditioner)
  - AC and DC amperage (with AC and DC amperage conditioner)
  - Other sensors (with conditioners)

- **Key points:**
  - May be used on ERM systems and any other didactic system
  - User-friendly data logging software: Sysma WinATS (software in French)
  - Possible interface with Labview (executable files supplied for ERM systems, Labview software)
  - Possible use of Labview Signal Express, free data logging software
  - Wide range of adjustable sensors and conditioners

- **References:**
  - AQ10 USB data logger – AQ11 Differential voltage probe for USB data logger – AQ12 AC current clamp for USB data logger – AQ13 AC+DC current clamp for USB data logger – AQ08 Sysma WinATS data logging software – Many conditioners and sensors are available (See the product’s technical data sheet)

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**Acquisition and control unit with NI 6009 input/output cards**

- **Specifications of the USB acquisition and control unit:**
  - 8 analog input channels ±10V (14 bits, 48kS/s)
  - 2 analog output channels 0-10V (12 bits, 150 S/s)
  - 12 digital I/O
  - 32-bit counter
  - User-friendly acquisition software (data logging, visualization and analysis)

- **Types of measurable data and conditioners:**
  - 0/10V sensors (without conditioner)
  - 0/500V AC and DC voltages (with AC/DC voltage conditioner)
  - AC and DC current (with AC/DC current conditioner)
  - Other sensors (with conditioners)

- **Key points:**
  - Practical and cost-effective solution for interfacing your systems with LabVIEW
  - May be used with ERM systems, and any other training system
  - Possible use of LabVIEW Signal Express (free acquisition software)
  - Wide range of available sensors and measurement conditioners

- **References:**
  - DI15: Acquisition and control unit with NI 6009 input/output cards – AQ11: Differential voltage probe for the USB data logger – AQ12: AC current clamp for the USB data logger – AQ13: AC+DC current clamp for the USB data logger – Many conditioners and sensors are available (contact us)

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**Data-logging and tele-monitoring unit**

- **Technical specifications:**
  - Data-acquisition and logging box for any type of measurement
  - 16 universal analog entries (0/10V, 4/20mA with external shunt, PT1000, PT100, CTN...)
  - Data export via USB, RS232 and Ethernet
  - Tele-monitoring software (49 variables, Web server, history, alerts...)

- **Training activities:**
  - Implementation of acquisition and tele-monitoring of thermal engineering systems
  - Study of industrial communication solutions

- **Key points:**
  - Many I/O and communication possibilities

- **Reference:** MO21: Data logger and tele-monitoring via Ethernet

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**High-speed USB cameras** - Image analysis and study of physical phenomena

- **Specifications:**
  - USB video camera (96fps or 500fps)
  - Camera configuration software and examples of video processing on LabVIEW

- **Training activities:**
  - Analysis of motion, speed and acceleration (studying free fall, a pendulum, etc.)
  - Analysis of fluid motion and flow (fluid mechanics)
  - Image analysis (camera configuration, filters, shape recognition, etc.)

- **Key point:** Easy to install and configure

- **References:**
  - SQ11: 96fps USB camera with configuration software and examples of LabVIEW image analysis applications – SQ12: 500fps USB camera

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**Resources for projects**

**LabVIEW**

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