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Margherita Robba • Laura Rua

MechPower

English for Mechanics, Mechatronics and Energy

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MechPower

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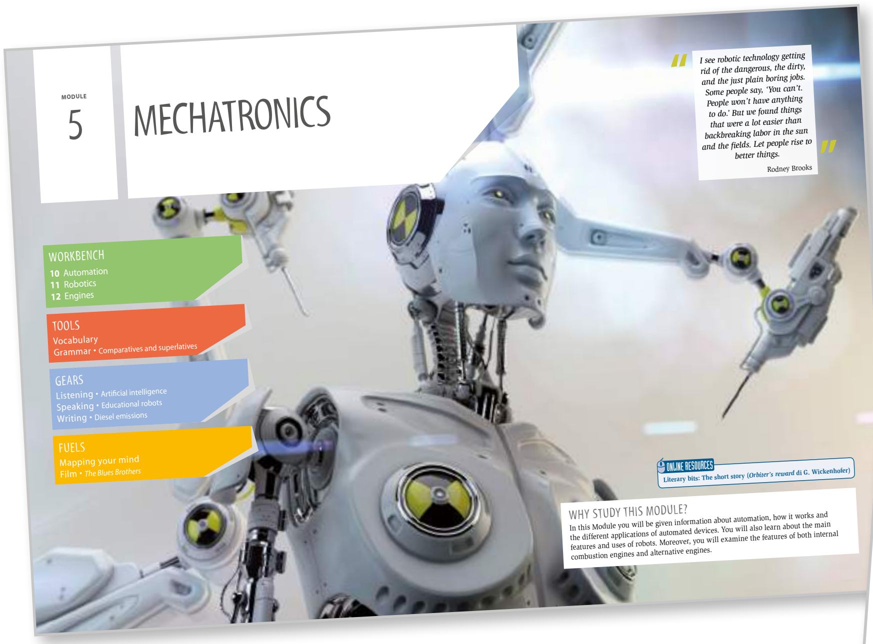
PRESENTAZIONE

L'ARGOMENTO

MechPower è un manuale rivolto in particolare agli studenti dei corsi a indirizzo **Meccanica**, **Meccatronica**, **Energia** e più in generale, a coloro che hanno l'esigenza di utilizzare la lingua inglese come strumento di studio e/o di lavoro in questo settore.
Grazie alla ricchezza del materiale proposto, ***MechPower*** – concepito per promuovere un apprendimento attivo basato sui contenuti (*content-based learning*) – offre la possibilità di scegliere gli argomenti sia in base ai programmi delle materie di indirizzo, sia in base al livello di competenza linguistica degli studenti.
I contenuti sono stati ordinati secondo criteri di graduale complessità concettuale e linguistica (B1, B1+, B2) e vengono esplorati utilizzando le quattro abilità in modo omogeneo ed integrato. I brani, autentici o appositamente pensati per il profilo di apprendente a cui il corso è indirizzato, offrono un assortimento di stili, registri e livelli di difficoltà, e sono tratti da fonti diverse: giornali e riviste, libri e manuali, materiale promozionale e siti web.


MODULE 5
MECHATRONICS

"I see robotic technology getting rid of the dangerous, the dirty, and the just plain boring jobs. Some people say, 'You can't. People won't have anything to do.' But we found things that were a lot easier than backbreaking labor in the sun and the fields. Let people rise to better things."
Rodney Brooks

WORKBENCH
10 Automation
11 Robotics
12 Engines

TOOLS
Vocabulary
Grammar • Comparatives and superlatives

GEARS
Listening • Artificial intelligence
Speaking • Educational robots
Writing • Diesel emissions

FUELS
Mapping your mind
Film • The Blues Brothers

ONLINE RESOURCES
Literary bits: The short story (*Orbiter's reward* di G. Wickenhofer)

WHY STUDY THIS MODULE?
In this Module you will be given information about automation, how it works and the different applications of automated devices. You will also learn about the main features and uses of robots. Moreover, you will examine the features of both internal combustion engines and alternative engines.


HISTORY OF MATERIALS AND MACHINES 1

ORIGINS OF METALWORKING

Answer these questions.
a. What do you know about the first steps in metalworking?
b. Have you ever thought about the way ancient people used to lift or to move weights?
c. Who does the word "lever" make you think of?
d. Do you know when the Industrial Revolution took place?

axe: *ascia*
to beat out: *eliminare martellando*
blacksmith: *fabbro, maniscalco*
cast iron: *ghisa*
to forge: *forgiare, fucinare*
ore: *minerale*
to smelt: *sciogliere*
to span: *espandersi*
spearhead: *punta della lancia*
to spread: *diffondere*
wrought iron: *ferro battuto*

Modern life is possible because we have metals and we know how to use them. They support our buildings and bridges, allow us to fly, sail and move about, and are fundamental in industry and trade. In the ancient past, metals were unknown. When they were discovered and man learned how to work them, people's lives changed.
Metalworking is a science, an art, a hobby, an industry and a trade. Its historical roots span cultures, civilisations, and millennia. The history of metals can be traced back to almost nine thousand years ago, in the Near East. Apart from gold and silver, the first metal to be used was copper, followed by bronze, but iron was the key to civilisation.
In the past, fire, air, earth and water were considered the four elemental substances of our world and only the blacksmith was able to work all four. His material, the black ore, was part of the earth, and water was essential to cool his heated iron and give temper to this red-hot metal. Once ironworking had developed, the tribes armed with iron swords and iron spearheads conquered those armed only with bronze weapons. The people with iron axes and knives built houses more quickly and lived more comfortably than those who had not yet learned how to make iron and steel from the ferrous ore so abundant in most parts of the world. In time, ironmasters developed new techniques and learned to transform useless cast iron into wrought iron by re-smelting it in a deep fire, burning out excess carbon and beating out the impurities.
As time progressed, metal objects became more common and more complex. The need to further acquire and work metals grew in importance. Skills related to extracting metal ores from the earth began to evolve, and metalsmiths became important members of society. Iron and steel were as essential to the progress of man in ancient times as they are today in the space age. This need spread the art of forging iron all over the civilised world and as one region developed a new technique, it spread to other lands through the twin activities of war and trade. The knowledge of working and dominating the black metal was gradually an integral part of the developing civilisation of the ancients, that is why it is very difficult nowadays to discover exactly how, where and when any one particular technique was developed.

14 Module 1 WORKBENCH

OBIETTIVI DEL TESTO

MechPower si propone di:

- far acquisire le competenze necessarie per comprendere testi che presentano termini, espressioni, strutture sintattiche e modalità discorsive specifiche del linguaggio settoriale;
- migliorare le capacità di ricezione e produzione orale e scritta, anche tramite attività tipo Preliminary e First per il conseguimento rispettivamente del livello B1 e B2 del CEFR, e di attività tipo IELTS per quanto riguarda l'ambito dell'inglese accademico;
- arricchire il patrimonio lessicale sia con il lessico tecnico che generale;
- consolidare abitudini grammaticali corrette e approfondire alcune strutture;
- stimolare l'interesse e la partecipazione attiva degli studenti, dando spazio alla loro esperienza personale e a problematiche di attualità;
- contribuire a sviluppare sensibilità per un utilizzo corretto e consapevole delle nuove tecnologie negli ambiti specifici.

LA STRUTTURA

MechPower è diviso in sette Moduli, ognuno dei quali è ripartito in quattro sezioni:

1 **WORKBENCH** (**Contents Section**) – Divisa in **Unità**, contiene testi e attività che riguardano i contenuti specifici della specializzazione già affrontati in L1. Ogni unità è suddivisa in brevi **Capitoli** su due pagine – teoria ed esercizi – per favorire non solo uno studio più parcellizzato, ma anche la scelta antologica da parte dell'insegnante. I testi vengono affrontati in modo graduale, attraverso esercizi di *warm-up*, esplorazione del lessico specifico, comprensione scritta e orale, globale e specifica, reimpiego dei termici tecnici e produzione scritta e orale.
Brevi box permettono di ampliare le conoscenze sugli argomenti:

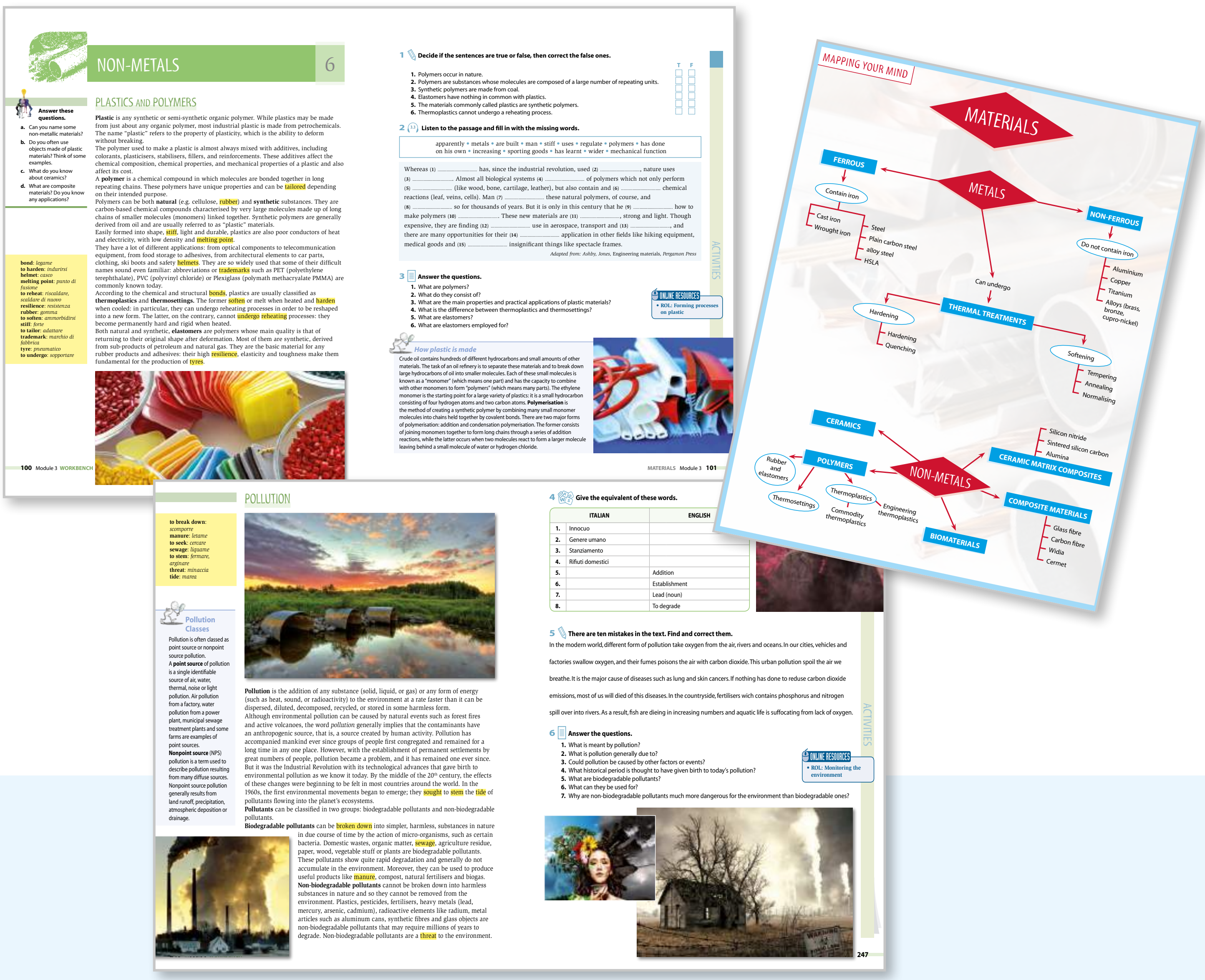
 per approfondimenti generali;

 per analisi di fatti e dati;

 per curiosità;

 per approfondimenti culturali;

Un ricco **apparato iconografico** correda i brani di lettura, per ognuno dei quali è previsto un esauriente **glossario**.



2 **TOOLS** – Si occupa dei contenuti della disciplina ponendo particolare attenzione all'arricchimento **lessicale** e **strutturale**.

3 **GEARS** – Offre testi e attività di consolidamento dei contenuti appresi per sviluppare le abilità di **Listening**, **Speaking** e **Writing**.

4 **FUELS** – Propone una mappa (**Mapping your Mind**), strumento utile per rappresentare la rete di relazioni tra i vari argomenti del Modulo, e **clip di opere cinematografiche** che offrono spunti di riflessione e svago su aspetti contenutistici del Modulo.

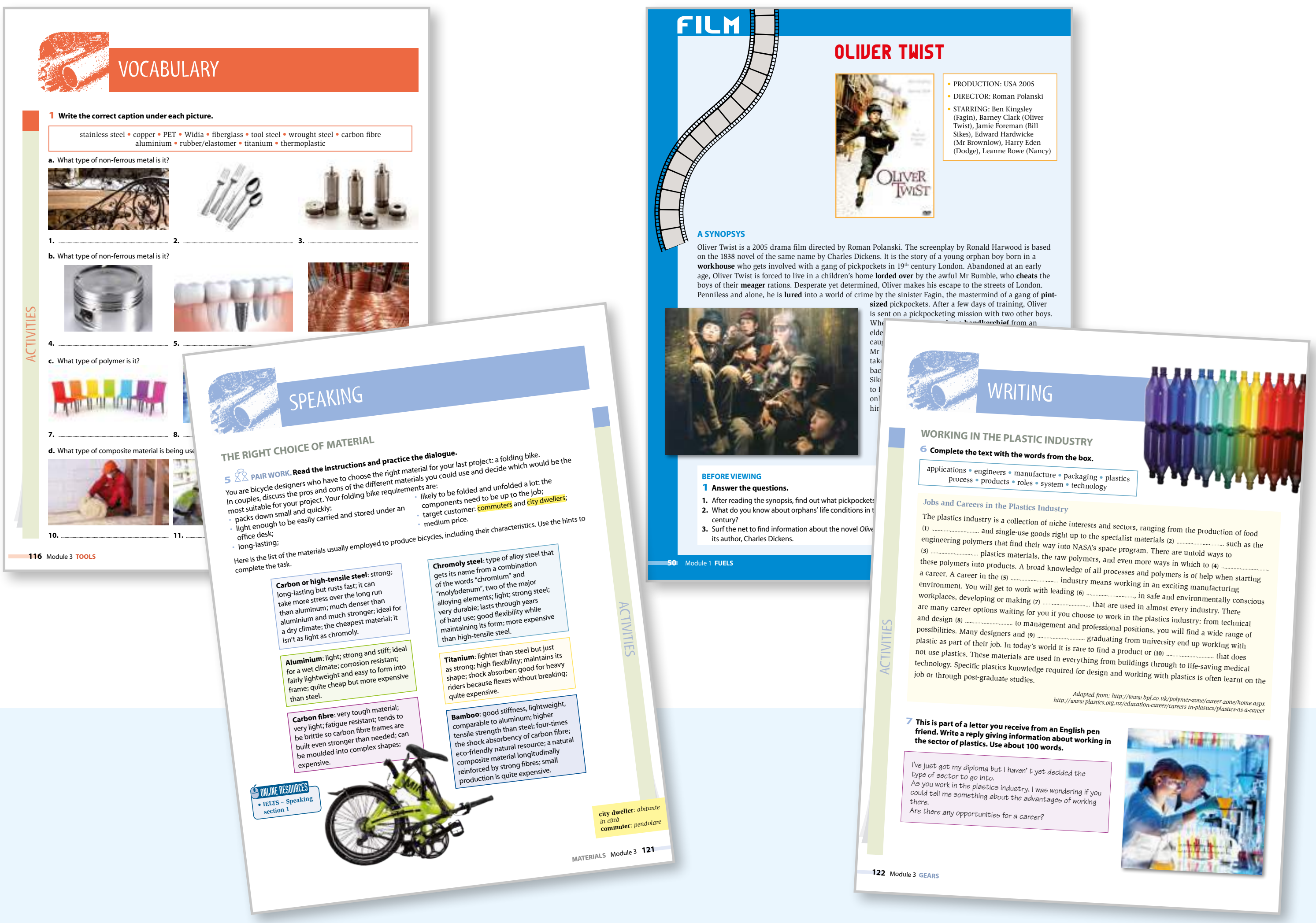
TEACHER'S GUIDE

Programmazione didattica per modulo • Soluzioni degli esercizi • Audioscript delle attività di ascolto • Note didattiche • Schemi per unità • Prove di verifica formative per ogni Unità e sommative per Modulo • Domande per il Colloquio dell'Esame di Stato • Compiti di realtà.

ONLINE RESOURCES

Disponibili sul sito www.edisco.it:

- **file audio formato MP3 delle attività di ascolto**
- **attività extra per recupero e approfondimento**
- **una sezione dedicata alla sicurezza sul luogo di lavoro**
- **approfondimenti di civiltà**
- **agganci letterari.**



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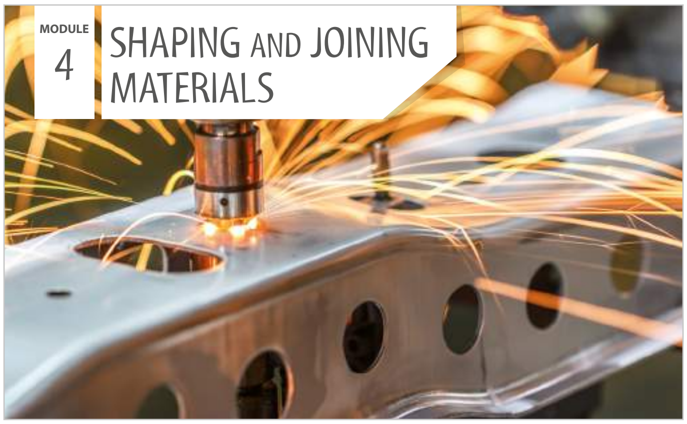

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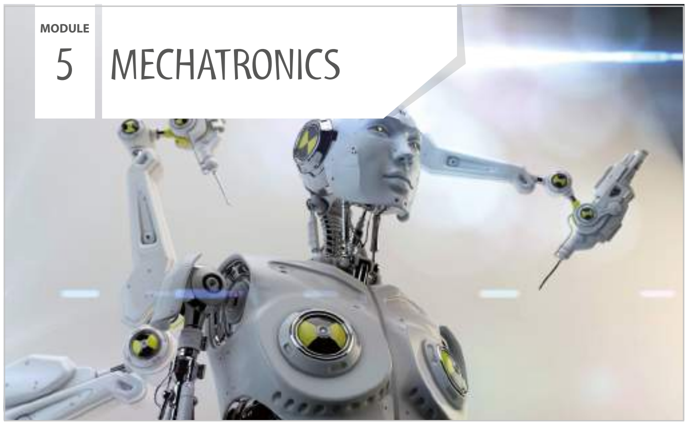

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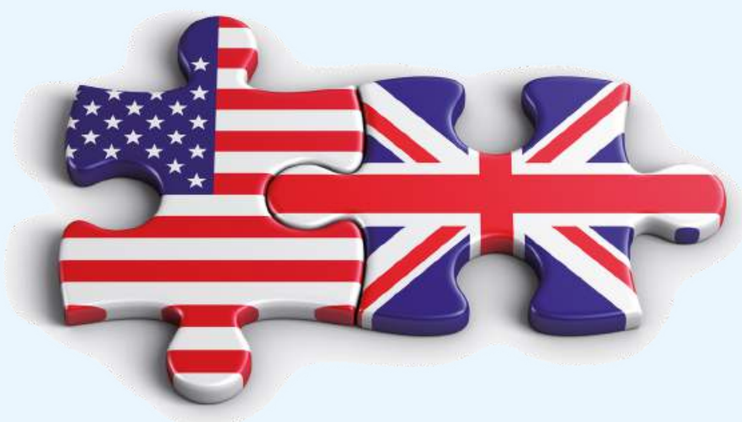

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- Climate, flora and fauna
- History: the first invasions
- History: the Middle Ages
- History: the Renaissance
- History: the Age of Revolutions
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MODULE

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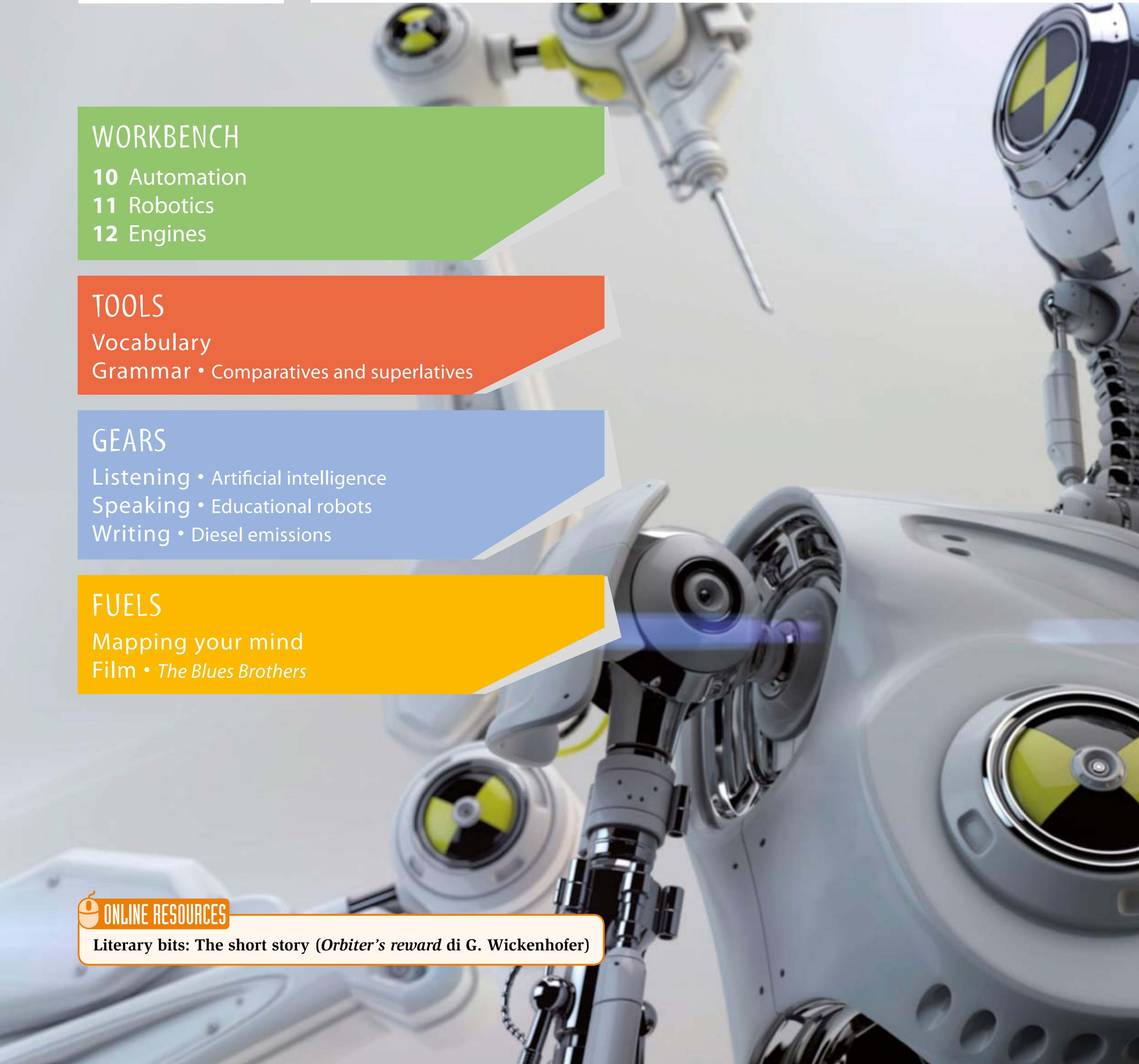

WORKBENCH

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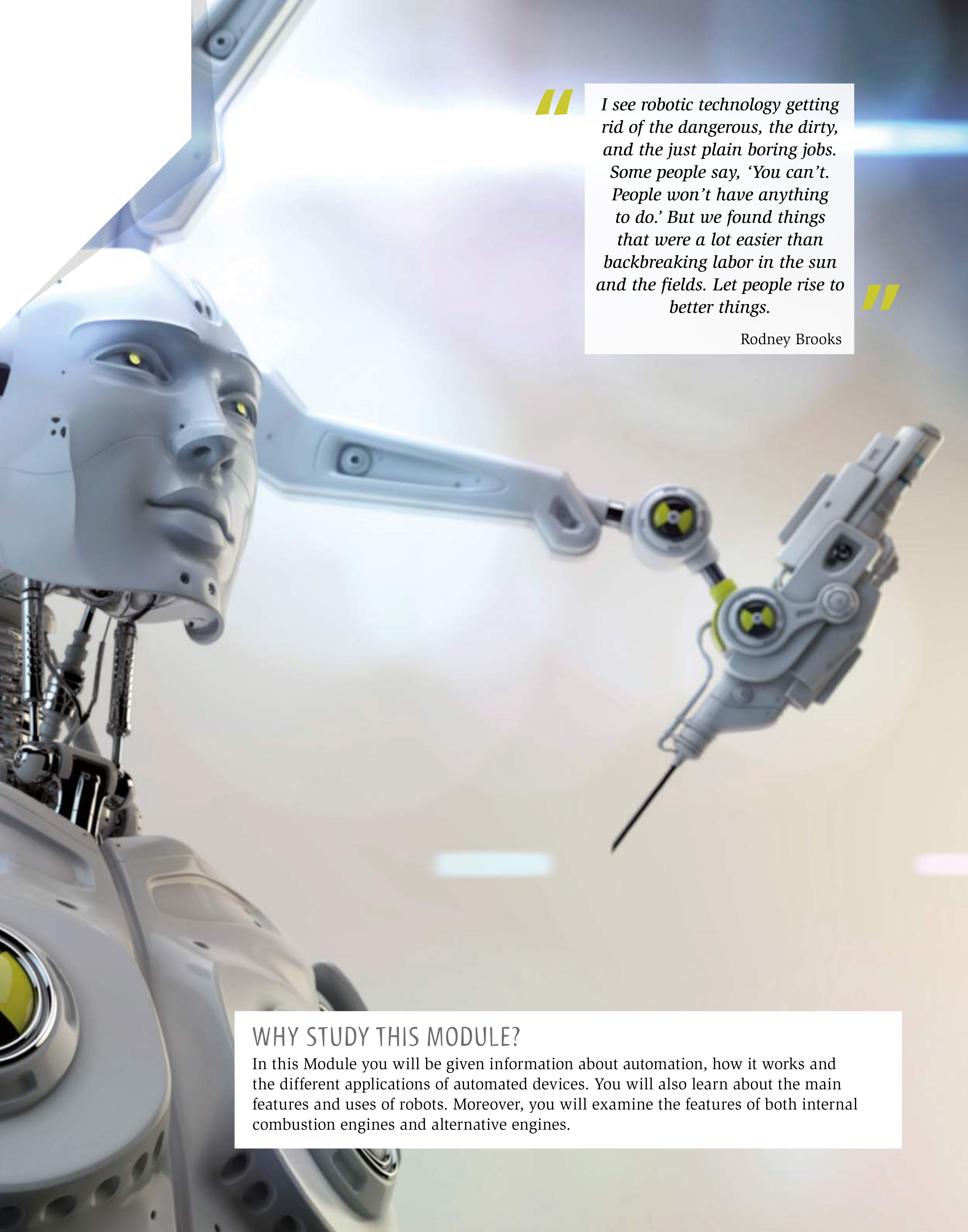

> *I see robotic technology getting rid of the dangerous, the dirty, and the just plain boring jobs. Some people say, 'You can't. People won't have anything to do.' But we found things that were a lot easier than backbreaking labor in the sun and the fields. Let people rise to better things.*
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> Rodney Brooks

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AUTOMATION 10

Answer these questions.

a. What does the word mechatronics make you think of?

b. Can you guess where the word mechatronics comes from?

c. Can you think of an advantage of mechatronics?

d. And what about its disadvantages?

anti-lock brakes: *anti bloccaggio freni*
to broaden: *ampliare*
dashboard: *cruscotto*
embedded: *incorporato*
to ensure: *assicurare*
to lock up: *bloccare*
smoothly: *senza difficoltà*
therefore: *quindi*
tyre gauge icon: *spia della pressione dei pneumatici*

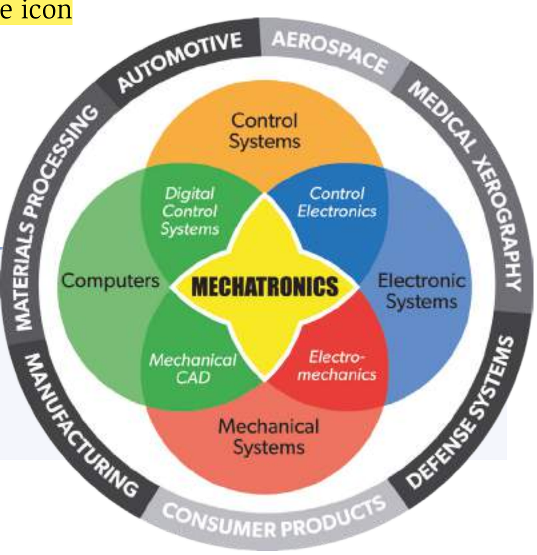
WHAT IS MECHATRONICS? DEFINITION AND OBJECTIVES

Mechatronics is a multidisciplinary field of science that includes a combination of mechanical engineering, electronics, computer engineering, telecommunications, systems and control engineering. The role of a mechatronics engineer is to unite various principles from all the above engineering disciplines to create more economic, reliable, and simplified systems. In many industries today, engineers have to work in cross-discipline, collaborative teams in order to ensure that the complex, highly integrated systems they are designing will run smoothly.

The term "mechatronics" was coined in 1969 by Tetsuro Mori, the senior engineer of the Japanese company Yaskawa, to describe the synergy that exists between electrical control systems and the mechanical machines they regulate. Originally, mechatronics just included the combination of mechanics and electronics, therefore the word is a combination of mechanics and electronics; however, as technical systems have become more and more complex, the definition has been broadened to include more technical areas. Industrial robots are a primary example of mechatronics systems, as they incorporate computing, electronics, and mechanics in performing routine tasks.

Mechatronics engineers build automated systems for industry: they normally act as the link between technicians and engineers, and work from the conception of a project to its completion. They design, build, maintain and repair automated equipment, and program equipment control systems. They are able to meet a variety of needs within industry, so they carry out mechanical maintenance and equipment building and they also deal with equipment for information gathering, components, sensors and regulating units. Mechatronics technicians install, set-up, repair and adjust machine components and manage equipment control systems, including their programming.

To understand the concept of mechatronics, one can simply think about today's automobiles. The average car today has between 25 and 50 central processing units that control mechanical functions. A driver support system (DSS) such as the anti-lock brakes system is designed with mechatronics; the electronic control system takes over the braking function when sensors recognise that one or more wheels are locking up. A pneumatic tyre pressure monitoring system is also designed with mechatronics: each tyre has a sensor inside that sends data to an onboard electronic control system. If the pressure on one tyre is low, the embedded software in the control system sends an alert to the vehicle's dashboard and a tyre gauge icon lights up. Even an automobile's air bag is designed with mechatronics: a micro-electrical machine (MEM) in the front of the automobile will deploy an airbag when sensor data indicate rapid deceleration.



Aliases for Mechatronics Engineering

Mechatronics engineering is an emerging field, but it has been around in one form or another for some time. Mechatronics engineers have been cleverly disguised as many of the following: Automation Engineer, Control System Engineer, Data Logging Engineer, Instrumentation Engineer, Project Engineer, Software Engineer, Systems Engineer, and Service Engineer.

1 Decide if the sentences are true or false. Correct the false ones.

	T	F
1. Mechatronics is a science which includes a series of disciplines.	☐	☐
2. The role of a mechatronics engineer is to prevent all the engineering disciplines from mixing up.	☐	☐
3. Mechatronics engineers have to work in independent sectors.	☐	☐
4. The term *mechatronics* was coined by an experienced engineer.	☐	☐
5. The word *mechatronics* is a combination of the terms mechanics and robotics.	☐	☐
6. A robot is one of the first examples of a mechatronics system.	☐	☐
7. Mechatronics engineers only deal with the project of a system.	☐	☐
8. Engineers are indispensable members of company staff.	☐	☐

2 (5.1) Listen to a passage on "A Mechatronics Engineer's Job" and complete the sentences with the missing information.

As a Mechatronics engineer, in your job, you might be expected to:

1. Develop new solutions to industrial problems using .... and computer technology.

2. Design and build completely new products by integrating ....

3. Build and test .... introducing automation to improve existing processes.

4. Maintain and improve previous industrial and .... and designs.

5. Design, develop, maintain and manage high .... for the automation of industrial tasks.

6. Apply mechatronics or .... to the transfer of material, components or finished goods.

7. Apply advanced ...., which are usually computer-driven.

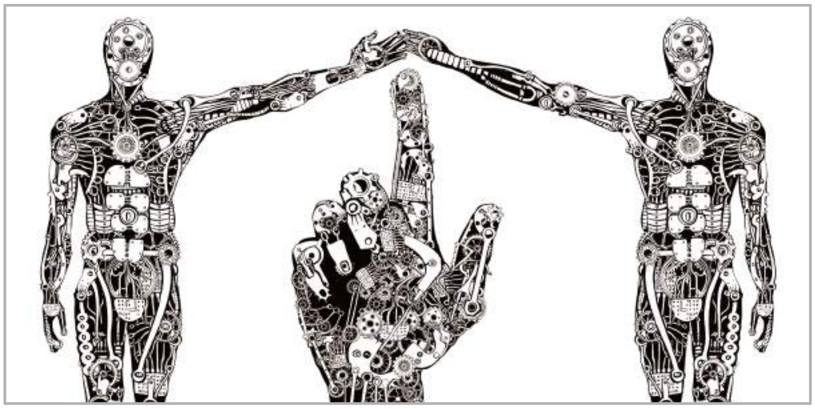
8. Apply electronic and mechanical processes and computers to tasks where the use of .... may be dangerous.

9. Study the feasibility, cost implications and .... of new mechatronics equipment.

10. Carry out modelling, ... of complex mechanical, electronic or other engineering systems using computers.

3 By using the suggestions in the previous activity and what you have read so far, write an email according to the prompts.

A friend of yours has sent you an email asking you to explain simply and briefly the different tasks of a mechatronics engineer. Answer his email, use about 150 words.



ACTIVITIES

AUTOMATION PROCESSES

to exert: *esercitare*
feedback: *riscontro*
to imply: *implicare*
regardless of: *indipendentemente da*
to run: *eseguire(qui)*
set range: *gamma impostata*
thereby: *quindi*
thus: *così*

Mechatronics and automation are becoming increasingly important interconnected disciplines in today's digital society: new products have been designed applying mechatronics principles and have been accomplished by means of automation processes. Automation or automatic control can be defined as the technology by which a process or procedure is performed without human assistance. Automation has been achieved by various means including mechanical, hydraulic, pneumatic, electrical, electronic devices and computers, usually in combinations. Complicated systems, such as modern factories, airplanes and ships, generally use all these combined techniques. The benefits of automation include: labour savings, savings in electricity costs, savings in material costs, and improvements in quality, accuracy and precision.

The advanced type of automation that has revolutionised manufacturing, aircraft, communications and other industries, is the **feedback control**, which is usually continuous and involves taking measurements using a **sensor** and making calculated adjustments to keep the measured variable within a set range.

Fundamentally, there are two types of control systems: open loop control, and closed loop or feedback control.

In **open loop control**, the control action from the controller is independent of the process output. A good example of this is a central heating boiler controlled only by a timer, so that heat is applied for a constant time, regardless of the temperature of the building. The control action is the switching on/off of the boiler. The process output is the building temperature.

In **closed loop control**, or **feedback control**, the control action from the controller is dependent on the process output. In the case of the boiler analogy, this would include a thermostat to monitor the building temperature, and thereby a feedback signal to ensure the controller maintains the building at the temperature set on the thermostat. The feedback principle implies that the system has the capacity for **self-correction**: it makes control decisions based on the continuous feedback of information from the plant or process under control. Through sensing devices, the **feedback loop** continuously senses and measures data from the output and compares it to the fixed standard of the input, which is the reference value; thus, the system takes whatever **pre-programmed** action is necessary to maintain the measured quantity within the limits of acceptable standards. Without feedback, automated systems would be unable to exert sufficient control over the quality of the process output or make adjustments to its controlled actions. Only a few programmed commands are executed with simpler **open-loop** systems without feedback for controlling the proper execution of the programmed operation. A washing machine, for example, is an open loop control system as the operation of a washing machine does not depend on the cleanness of the clothes, but rather on the preset time.

ONLINE RESOURCES

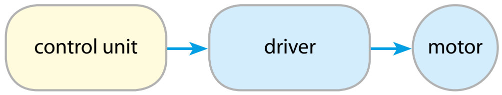
- **Computers and automation**

Computers can perform both open loop control and feedback control, often combined together. Process control computers can process data from a network of PLCs (Programmable Logic Controllers), in order to implement, analyse data, create real time graphical displays for operators and run reports for operators and engineers.

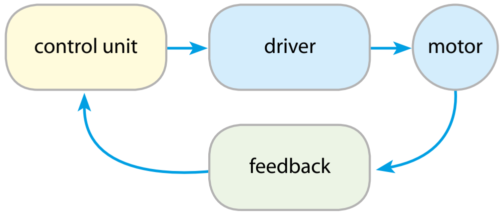
4 Find the English terms for these Italian words.

1. Ottenere ....
2. Risparmio ....
3. Migliorie ....
4. Quindi ....
5. Assicurare ....
6. Impianto ....
7. Rilevare ....
8. Qualunque ....

Open loop control system



Closed loop control system



5 Read the text and fill in the blanks with the words in the box.

alerted • required • objective • customers • signals • malfunctions • detecting • hazards • sensors • made

Decision-making Capacity in Feedback Control Systems

Programmable machines in automated systems often possess a **decision-making capacity**, which is contained in the **control program** and includes the following features:

- **Error detection and recovery**. This concerns decisions that must be (1) .... by the system in response to (2) .... and errors: the system itself sets up corrective actions without human intervention.
- **Safety monitoring**. It is important for (3) .... malfunctions which involve safety (4) .... Errors are identified by (5) .... and the system takes the most appropriate actions: operations may be stopped or the maintenance personnel (6) ....
- **Interaction with humans**. This capacity is largely (7) .... nowadays. An automatic bank teller, for example, must receive instructions from (8) .... and act accordingly.
- **Process optimisation**. Minimising cost is an important (9) .... in manufacturing: the automated system might use adaptive control to receive appropriate sensor (10) .... and other inputs and make decisions to drive the process towards the optimal state.

6 Write the questions for these answers.

1. ....?
   Open loop and closed loop control systems.
2. ....?
   It means that the control action from the controller is independent of the process output.
3. ....?
   The feedback control system is aimed at checking if a specified action has been correctly carried out.
4. ....?
   It is the control of production processes based on the continuous comparison between input reference values and output process data.
5. ....?
   The feedback principle implies the capacity to self-correct through controlled adjustments.
6. ....?
   Unlike closed-loop systems, open-loop systems do not use feedback control and thus they cannot correct or compensate variations in the output process.

SENSORS

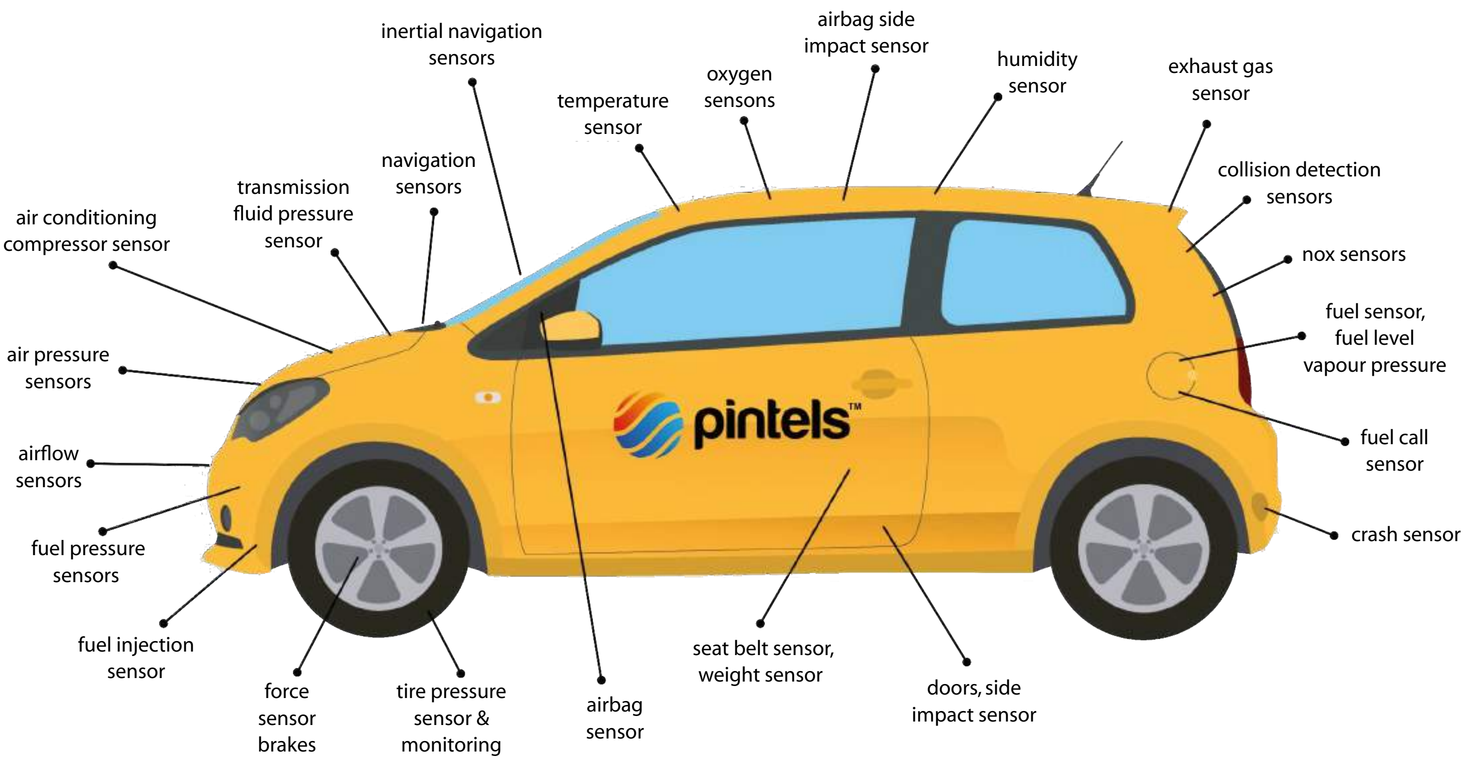
to grip: *tenere saldamente*
to handle: *maneggiare*
to pick up: *sollevare, raccogliere*
rejection: *rifiuto, scarto*
transducer: *trasduttore*
worktable: *tavola porta pezzi*

Sensors are vital components of virtually every industrial automated process: they are essential for data acquisition, monitoring, communication and computer control of machines and systems. They are devices that sense and measure the environment, producing a measurable response (signal) to a change in a physical condition or in a chemical concentration. Sensors are traditionally used in manufacturing to control and restrict the movements of the worktable of machine tools; they are also fundamental for controlling advanced and intelligent robots.
Sensors can be **analogue** or **digital**: the former operate with variables represented by continuously measured voltages or quantities: the signal produced is proportional to the measured quantity. The latter have numeric or digital outputs that can be directly transferred to computers. Because they convert one signal into another, sensors are also referred to as **transducers**.

According to their method of sensing, they are usually grouped as tactile or visual sensors. **Tactile sensing** is the continuous sensing of variable contact forces. Tactile sensors are employed in robots dealing with fragile parts, such as glass bottles and electronic devices: they are capable of measuring and controlling the force applied to the object being handled. In **visual sensing,** cameras sense the presence and shape of an object optically: a microprocessor processes the image which is then measured and digitised. Machine vision is capable of on-line identification and inspection of parts, with rejection of defective ones. With visual sensing capabilities, robots are able to pick up parts and grip them, while giving the object proper orientation and location.
The sensors usually employed in manufacturing are classified as **mechanical**, **electrical**, **magnetic** and **thermal**, but they can also be **acoustic**, **ultrasonic**, **chemical**, **optical** and **radiation** sensors.

Car sensors

The highest rates of growth for sensors have been in the automotive sector. This is due to a spectacular rise in electronic functions in motor cars that started in the seventies. Today, entirely new electronic functions are available. These innovations are driven by the need for manufacturers to produce an attractive range of products as well as to meet more stringent safety, environmental and economic demands. Generally speaking, there are at least from 15 to 30 sensors in a car today, which are mainly for engine operations, brakes, safety, and emission controls.



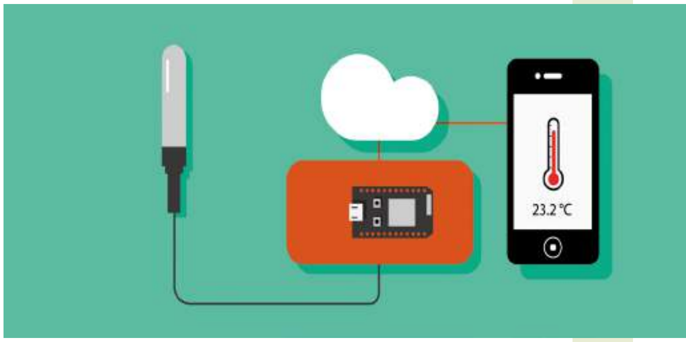
7 5.2 **Listen to the passage about sensors and decide if the sentences are true or false. Correct the false ones.**

	T	F
1. A sensor is a device that responds to some type of input signal.	☐	☐
2. The input signal comes from the surrounding environment.	☐	☐
3. The input signal is always detected in digital form.	☐	☐
4. The output signal must be converted from an analogue form to a digital form.	☐	☐
5. The output signal must be human-readable.	☐	☐
6. The output signal can be transmitted over a network.	☐	☐
7. An oxygen sensor in a car's emission control system detects the gasoline/oxygen ratio.	☐	☐
8. The car oxygen sensor detects the gasoline/oxygen ratio by means of a mechanical signal.	☐	☐

8 **Match each definition to its sensor.**

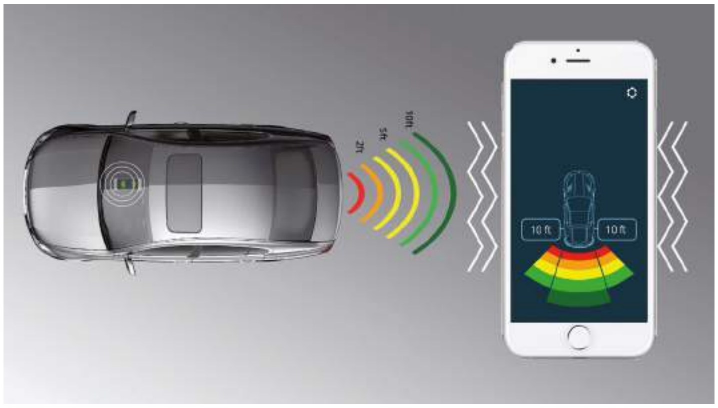
1. Measuring voltage, current, charge and conductivity.
2. Measuring the modulation of surface acoustic waves to sense a physical phenomenon.
3. Measuring the detectable presence, concentration, or quantity of a given analyte.
4. Measuring the distance to an object by using sound waves.
5. Measuring temperature, thermal conductivity and specific heat.
6. Measuring light intensity.
7. Measuring the presence and sometimes the intensity of radiation.
8. Measuring quantities such as position, shape, velocity, force, torque, pressure, vibration, strain and mass.
9. Measuring magnetic field, flux, and permeability.

HOW SENSORS ARE CLASSIFIED	WHAT SENSORS ARE FOR
Mechanical	
Electrical	
Magnetic	
Thermal	
Acoustic	
Ultrasonic	
Chemical	
Optical	
Radiation	



9 **Answer the questions.**

1. What are sensors? What are they for?
2. How are sensors typically employed in manufacturing?
3. What is the difference between analogue and digital sensors?
4. Where are tactile sensors used? Why?
5. What is visual sensing used for?
6. How are sensors usually classified in manufacturing?



PROGRAMMED COMMANDS IN CNC SYSTEMS

to accomplish: *realizzare/svolgere*
to alter: *cambiare*
coded: *codificato*
consistency: *precisione*
to debug: *individuare e correggere errori*
to edit: *modificare*
knowledgeable: *ben informato*
to plot: *tracciare, riportare in scala*
remarkably: *notevolmente*
turning point: *punto di svolta*

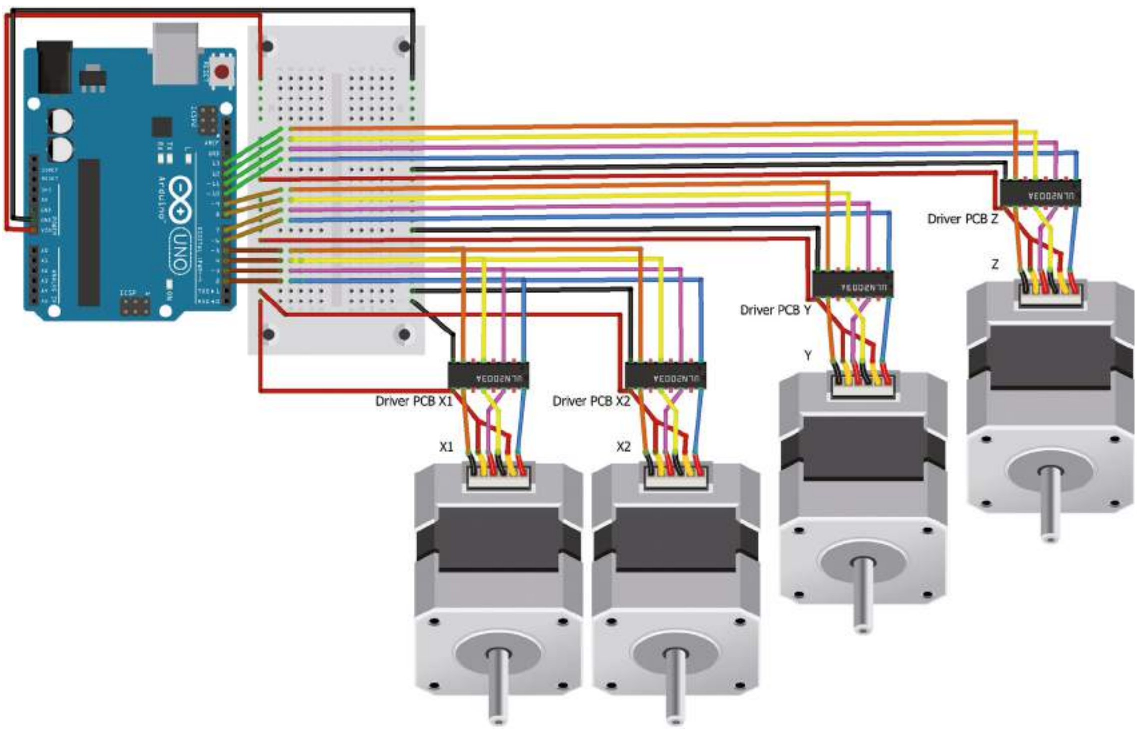
The turning point in automation was the introduction of machinery equipped for **numerical control** systems in the late 1940s. Numerical control is the **programming control system** for automatically operated machine tools and other manufacturing units. **NC** programs are coded instructions, written in a standard language, directly inserted into the NC system connected to the machine tool, which interprets and transforms them into precise commands for its components. Today's fundamental advances in automated manufacturing – such as **adaptive control**, **robots**, **CAD/CAM** or **CIM** systems – have developed around the NC concept.

Numerical control gradually gave way to **computer numerical control (CNC)**, a system in which a minicomputer or microprocessor is an integral part of the control panel of a machine. CNC automation has remarkably improved manufacturing consistency and quality levels. It has reduced the frequency of errors due to human intervention and it has increased accuracy, flexibility and versatility in the production process. The ever-increasing use of CNC in industry has created a need for personnel who are knowledgeable about and capable of preparing the programs which guide the machine tools to produce parts according to the required shape and accuracy.

The programmed instructions in CNC systems determine the set of actions that must be accomplished automatically. Relatively simple automated systems rely on programmed commands consisting of a limited number of well-defined actions that are performed continuously and repeatedly in the proper sequence, with no deviation from one cycle to the next. In more complex systems, the number of commands could be quite large, and the level of details could be significantly greater. In relatively sophisticated systems, the program can change the sequence of automated actions in response to variations in raw materials or other operating conditions. The programming commands are in fact generally combined with **feedback** systems. CNC machine tools can be readily adapted to different jobs by altering the control program. Editing and debugging programs, reprogramming, plotting and printing the shapes of specific parts are becoming simpler and simpler operations. When several CNC machine tools are connected to a large central computer storing and processing data, they are said to be under **direct numerical control (DNC)**.

NC

The invention of numerical control has been due to the pioneering works of John T. Parsons in the year 1940, when he tried to generate a curve automatically by providing coordinate motions to some milling cutters. In the late 1940s, he conceived the method of using punched cards containing coordinate position system to control a machine tool. The machine was directed to move in small increments and generate the desired finish. In the year 1948, Parsons demonstrated this concept to the US Air Force, who sponsored a series of project at the laboratories of Massachusetts Institute of Technology (MIT). After lots of research MIT was able to demonstrate first NC prototype in 1952 and the next year they were able to prove the potential applications of the NC.



10 Decide if the sentences are true or false. Correct the false ones.

	T	F
1. Programmed commands deal with specific machining operations.	☐	☐
2. NC systems operated machine tools are connected to a central processing unit.	☐	☐
3. A wide variety of machine tools can be equipped with CNC systems.	☐	☐
4. NC machines are more flexible than CNC machinery: they can readily be adapted to different jobs.	☐	☐
5. In CNC systems, the term versatility refers to the possibility of editing and debugging programs, reprogramming, plotting and printing the shapes of specific parts.	☐	☐
6. CNC is a system which does not exert control over the movements and positions of the machine components.	☐	☐
7. DNC includes the use of a central computer, serving as a control system over a number of CNC machines.	☐	☐
8. The programming commands in CNC machines are generally combined with open loop systems.	☐	☐

11 PAIR WORK. Read the passage and then talk about the advantages and disadvantages of numerical control equipment.

ADVANTAGES

- **Flexibility**
  NC machines can be quickly reprogrammed to produce different items.
- **Production of difficult geometries**
  NC equipment can machine complex shapes that would be prohibitively expensive with conventional manual machines. It allows engineers to design products that would otherwise be uneconomical.
- **Repeatability**
  NC machines can make high numbers of parts exactly the same, without deviation. A good machinist with a manual machine tool could not achieve the same accuracy: no two parts would be exactly alike and they would not easily meet the product specifications.
- **Reduction of warehousing costs**
  Spare parts are no longer stored in a warehouse: NC machines are quickly and easily set up to start production of the replacement parts as required. Investment is reduced, capital is not tied up in the warehouse and it is not subjected to a property tax; spare parts do not become obsolete and engineers can change the design any time they desire.
- **Lower operator skill requirement**
  NC operators do not direct the operation of the machine tool: they simply load/download the workpiece or push the buttons to start or stop operations. They do not require the same skills as the machinists of manual machine tools, so they are easier to find and train. Their salaries are not high.

DISADVANTAGES

- **Large investment**
  NC equipment has high initial costs and machinery must be kept continuously busy to pay off: sometimes they must run two or three shifts per day and at weekends. Small firms cannot afford the investment, especially if they rely on small-quantity production with simple geometry.
- **Skilled programmers required**
  NC systems need trained personnel responsible for programming commands, setting up and running production. High skilled programmers are not easy to find. Salaries are high.
- **High maintenance costs**
  NC machines can be very complex and need special and continuous maintenance: production cannot be stopped for long repairs. Maintenance personnel must be experts on both mechanical and electrical systems: a difficult combination of skills to find. Salaries are high.

to pay off: *essere redditizio*
shift: *turno*
spare part: *ricambio*
tied up: *vincolato*
warehousing costs: *costi di immagazzinaggio*

ACTIVITIES

ROBOTICS 11

Answer these questions.

a. What does the word "robot" make you think about?

b. Robotics is a new science: in your opinion, which sciences have contributed to its development?

c. Have you ever seen a robotic arm in action?

alignment: *allineamento*
avenue: *strada, via*
broadly speaking: *in generale*
cleanliness: *pulizia*
common sense: *buonsenso, pensiero pratico*
to encompass: *comprendere*
fairly: *abbastanza*
to overlap: *sovrapporsi*
to oversee: *supervisionare*
portmanteau: *sincrasi, fusione di due parole diverse*
reliably: *in modo affidabile*

WHAT IS A ROBOT?

Robotics is a branch of engineering that involves the conception, design, manufacture, and operation of robots. This field overlaps with Electronics, Computer Science, Artificial Intelligence, Mechatronics, Nanotechnology and Bioengineering. For many people, a robot is a machine that imitates a human, like the androids in *Star Wars*, *Terminator* and *Star Trek*. Even though these robots capture our imagination, such robots still only inhabit Science Fiction. Scientists still haven't been able to give a robot enough "common sense" to reliably interact with a dynamic world.

So, what exactly is a robot? Actually, there is no standard definition for a robot. For example, a general one from the Cambridge Dictionary, is: "a machine controlled by a computer that is used to perform jobs automatically". The term **robot** comes from a Czech word, *robota*, meaning "forced labour": this definition describes the majority of robots fairly well. Most robots are designed for heavy, repetitive manufacturing work. They handle tasks that are difficult, dangerous or boring for man and are employed when requirements of speed, precision, and cleanliness exceed what man can accomplish. That's why industrial robots are increasingly used in a variety of industries and applications.

There are some essential characteristics that a robot must have:

- **sensing**: sensors – for example: light, contact, proximity, pressure, limit, infrared, chemical, taste and hearing sensors – are fundamental to allow the robot to sense its surroundings and perform its task;
- **movement**: a robot needs to be able to move either some of its parts or around its environment;
- **intelligence**: here, programming enters the picture since robots perform their actions thanks to a series of coded commands and instructions.

Engineers and scientists have analysed the evolution of robots, marking progress according to generations, broadly speaking:

- a **first-generation robot** is a simple mechanical arm. These machines have the ability to make precise motions at high speed, many times, for a long time. They can work in groups if their actions are synchronised, but must be constantly supervised, because if they get out of alignment, the result can be a series of bad production units;
- a **second-generation robot**, which came into common use during the 1980s, is equipped with sensors such as: pressure, proximity and tactile sensors, radar, sonar, lidar, and vision systems; they can stay synchronised with each other, without having to be constantly overseen by an operator;
- a **third-generation robot** encompasses two major avenues of evolving smart robot technology: the autonomous robots, which can work on their own, and the insect robots, so-called because of their dimensions, able to move on almost any type of terrain, swim and fly.

Lidar

RADAR, short for Radio Detection and Ranging, uses radio waves to compute velocity and/or range to an object. LIDAR, portmanteau for light/radar and short for Light Detection and Ranging, uses a laser that is emitted and then received back in the sensor. Lidar technology is being used in robotics for the perception of the environment as well as object classification.

1 Write:

1. The sensors mentioned in the text.
2. The systems that can be assembled on a robot.

2 Match the words to the right definition.

1.	To accomplish	☐	a.	Existing or acting independently from other things or people.
2.	Android	☐	b.	A process of change and development.
3.	Artificial Intelligence	☐	c.	To detect the presence or occurrence of something.
4.	Autonomous	☐	d.	To succeed in doing something.
5.	Branch	☐	e.	A job to do.
6.	Command	☐	f.	A robot that looks like a person.
7.	Evolution	☐	g.	Work hard and with great effort.
8.	To Interact	☐	h.	To happen at the same time and speed.
9.	Labour	☐	i.	An area of Computer Science that deals with giving machines the ability to seem as if they have human intelligence.
10.	To sense	☐	j.	A part of an area of knowledge or study.
11.	To synchronise	☐	k.	To act together.
12.	Task	☐	l.	Order.

3 (5.3) Listen to this text on Capek and Asimov and answer the questions.

1. When was Capek's *R.U.R.* published?
2. What genre of literary tradition did Capek create in Czechoslovakia?
3. What does the word *robota* mean?
4. Who made the word *robot* famous in the world?
5. What did Asimov write?
6. What type of robots did Asimov describe?
7. What would the robots do in the human world?
8. According to Asimov's three laws, what mustn't a robot do?

4 Find the questions for these answers.

1. ....?
   Robotics is a branch of engineering that involves the conception, design, manufacture, and operation of robots.
2. ....?
   It is a robot that imitates a human.
3. ....?
   It is "a machine controlled by a computer that is used to perform jobs automatically".
4. ....?
   Sensors allow the robot to sense its surroundings and perform its task.
5. ....?
   They are three, depending on the period they were developed and their evolution.

ACTIVITIES

ROBOTIC ARMS

to bump into: *scontrare, urtare*
controller: *unità di controllo*
end effector: *terminale, attuatore terminale*
to grip: *stringere*
joint: *snodo*
pliers: *pinze*
stepper motor: *motore passo-passo*
teach pendant: *tastiera di programmazione pensile*

Robotic arms are normally used in industry and perform tasks repeatedly based upon predetermined movements and specifically located objects; besides start and stop commands, more complex actions are executed based upon sensor processing and vision systems.

An industrial robotic arm includes five main parts: controller, drive, arm, end effector, and sensor.

The **controller** is the «brain» of the robotic arm and allows the parts of the robot to operate together. It works as a computer and allows the robot to be connected to other systems, too. The controller runs a set of instructions written in code by the operator. The program is usually input with a teach pendant, a wired or wireless handheld device: the robot is set to "learning" or "teach" mode and the pendant is used to control the robot step by step.

The **drive** is the engine or motor that moves the links – the sections between the joints – into their designated positions. The robot's capacity to move its parts, its speed, strength and dynamic performance is provided by the drive system used to power it. Common robotic drive systems are electric drives – for example: servomotors or stepper motors – hydraulic and pneumatic drives.

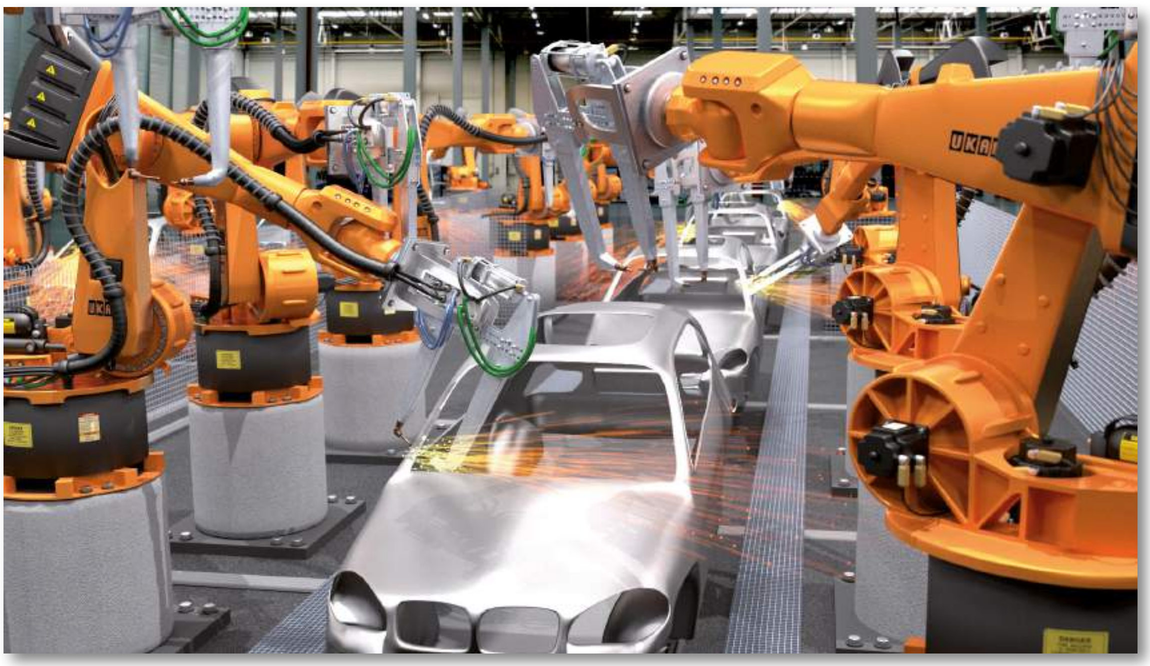
The **arm** can vary in size and shape and is the part that positions the end effector. Each of the joints – shoulder, elbow, wrist – gives the robot a degree of freedom (DOF). A simple robot with three degrees of freedom can move in three ways: up /down, left/right, and forward/ backward. Many industrial robots in factories today are six-axis robots.

The **end effector** connects to the arm and functions as a hand. This part comes in direct contact with the material the robot is manipulating. Some variations of an end effector are drills, pliers, spray painters, vacuum pumps, magnets, and welding torches. Some robots are capable of changing end effectors and can be programmed for different sets of tasks.

The **sensors** allow the robotic arm to receive feedback about its environment. The sensor collects information and electronically sends it to the controller. For example, a built-in pressure sensor tells the computer how hard the robot is gripping a particular object. This keeps the robot from dropping or breaking whatever it is manipulating. Sensors can make two or more robots work closely together, preventing them from bumping into one another. Vision sensors allow a pick and place robot to differentiate between items to choose and items to ignore.

The teach pendant

A teach pendant is a device which can be used to control a robot remotely. Using a teach pendant, you can work with a robot without being in front of a fixed terminal. Several features are included: the device usually has an emergency stop button, so that operations can be immediately shut down if there is a problem. It has a display which can be used to see and edit commands, to look through the history of commands given to the robot, along with a keyboard for command input.



5 Find the English term for these Italian words.

1. Elaborazione ....
2. Cablato ....
3. Dispositivo ....
4. Modalità ....
5. Assegnato ....
6. Forma ....
7. Grado ....
8. Differenziare ....

6 Decide if the sentences are true or false. Correct the false ones.

	T	F
1. A robotic arm is generally made up of four parts.	☐	☐
2. The controller allows the robot to be connected to other systems.	☐	☐
3. The program is usually input with a keyboard.	☐	☐
4. Servomotors and stepper motors are hydraulic drives.	☐	☐
5. A simple robotic arm has six DOFs.	☐	☐
6. Robotic arms can use different end effectors.	☐	☐
7. Sensors are one of the five fundamental parts composing a robotic arm.	☐	☐
8. A pick and place robot can distinguish the objects to pick if equipped with vision sensors.	☐	☐
9. The robot's speed, strength and dynamic performance is provided by the controller.	☐	☐
10. Robotic arms look like human arms.	☐	☐

7 Read the text and choose the best word for each gap.

Pick and Place Robots

Robotic pick and place **(1)** .... speeds up the process of picking **(2)** .... up and placing them in new **(3)** ...., increasing production rates. With many end-of-arm-tooling **(4)** .... available, pick and place robots can be customised to fit specific **(5)** .... requirements. Moving large, small, heavy, or hard-to-handle products can be an easy **(6)** .... to automate in the factory line. The robots can be easily programmed and tooled to provide **(7)** .... applications if required. An increase in **(8)** .... with a pick and place robot system offers long-term **(9)** .... to companies. With the **(10)** .... in technology and affordability of robots, more pick and place robotic cells are being installed for automation applications.

Adapted from: www.robots.com/applications/pick-and-place

1.	**a.** computer	**b.** automation	**c.** communication	**d.** component
2.	**a.** factors	**b.** details	**c.** members	**d.** parts
3.	**a.** locations	**b.** districts	**c.** stations	**d.** sections
4.	**a.** opportunities	**b.** privileges	**c.** options	**d.** preferences
5.	**a.** direction	**b.** production	**c.** management	**d.** formulation
6.	**a.** effort	**b.** mission	**c.** task	**d.** burden
7.	**a.** multiple	**b.** indiscriminate	**c.** similar	**d.** same
8.	**a.** crop	**b.** amount	**c.** input	**d.** output
9.	**a.** preserves	**b.** savings	**c.** funds	**d.** amounts
10.	**a.** steps	**b.** possibilities	**c.** advancements	**d.** upgradings

Pick and place robotic arm

ACTIVITIES

INDUSTRIAL ROBOTS

alongside: *a fianco*
bead: *a goccia, a filo*
conveyor: *nastro trasportatore*
dot: *punto*
feeding: *rifornimento*
mind-numbing: *noioso*
ongoing: *continuo*
overall: *complessivo, totale*
reach: *portata*
reliability: *affidabilità*
repeatability: *ripetibilità*
sensing: *percezione*
thereby: *così, in tal modo*
upfront: *anticipato*
to upgrade: *aggiornare*

Standard robot models are now mass-produced, making them more available to meet the ever-increasing demand.
Industrial robots are able to significantly improve product quality: applications are performed with precision and superior repeatability on every job. This level of reliability can be difficult to accomplish any other way. Robots are regularly upgraded, but some of the most precise robots used today have a repeatability of +/-0.02mm. The disadvantages of integrating robots into a business are the significant upfront costs. Also, ongoing maintenance requirements can add to the overall cost. Yet, the long-term ROI (Return On Investment) makes manufacturing robots the perfect investment.
Industrial robots may be used in many fields:

- **material handling robots** can automate some of the most tedious, mind-numbing, and unsafe tasks in a production line. The term material handling includes a variety of product movements on the manufacturing area, such as part selection, transferring of the part, packing, palletising, loading and unloading, and machine feeding;
- **welding robots** are the most employed robotic application in manufacturing because they offer efficiency, reach, speed, load capacity and enhanced performance for welding parts of all shapes and sizes. This segment mostly includes spot welding and arc welding;
- **assembly robots** put parts together and move faster and with greater precision than a human. They can be equipped with vision systems and force sensing. The vision system guides the robot to pick up a component from a conveyor, reducing or eliminating the need for a precise location of the part, and visual sensing allows the robot to rotate or move a piece to make it fit with another piece;
- **dispensing robots** are used for painting, gluing, applying adhesive, and spraying: they offer greater control over the placement of fluids, including arcs, beads, circles and repeated timed dots;
- **material removal robots** can refine product surfaces, using abrasive methods to smooth out steel to precise spot removal even for extremely small parts. They are used since many manufacturers finish their products through grinding, cutting, deburring, sanding or polishing.

Robots also increase workplace safety. A generation of **cobots** – the contracted term for "collaborative robot", that is to say, machines which work hand in hand with human beings, sharing the work process and supporting and relieving the human operator – is now available on the market to work safely alongside human workers thanks to advances in sensor and vision technology, and computing power. Should an employee get in their way, the robot will stop, thereby avoiding an accident.

Cobots

Classic industrial robots carry out their work following a fixed program, without regard for the people working around them. Accidents are prevented using fences and cages. Cobots are so safe that they can literally work hand in hand with people. Cobots can hand components to human co-workers, who execute the more precise assembly or quality control tasks; they fulfill tasks that could be risky for people, such as safely transporting sharp, pointed or hot workpieces, or dangerous bolting work, leaving technicians free to focus on less arduous aspects of production. They immobilise at the slightest touch thanks to sophisticated sensors to prevent any danger to nearby people. Closed areas and safety fencing are no longer needed.

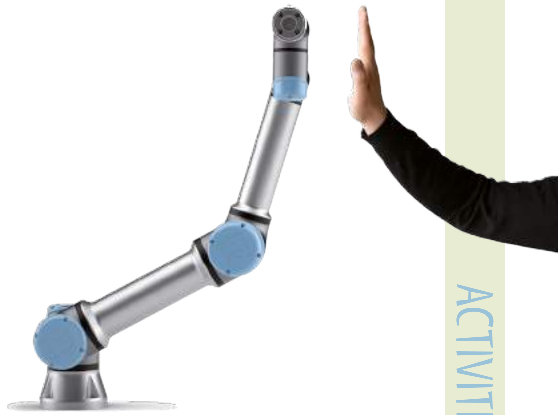
ONLINE RESOURCES
- **IELTS – Academic reading 2 – Robot at work**

8 Complete the chart with the missing information.

TYPE OF ROBOT	TASK PERFORMED	ADVANTAGES
Cobots	*Hand components to human co-worker, transport sharp, pointed or hot pieces.*	
Welding robots		
Assembly robots		
Dispensing robots		*Greater control over the placement of fluids, including arcs, beads, circles and repeated timed dots.*
Material removing robots		

9 Answer the questions.

1. What are the advantages offered by industrial robots?
2. Are there any disadvantages in the introduction of robots in an industry? Can these disadvantages be compensated in some ways?
3. Define the term *material handling*.
4. What does the word *cobot* mean?
5. What happens if a human worker gets in a cobot's way?
6. What are dispensing robots used for?



10 Complete the text with these words.

accuracy • advantages • arm • expensive • limited • make • protects • quality
sparks • speeding • times • wasted

Robot Welding vs Manual Welding

There are several (1) .... to automating a factory with welding robotics, including faster, consistent cycle (2) ...., no break in production, and better weld (3) .... A robot welder can move from one weld to the next quickly, (4) .... up the entire process. The cost of manual welding can be (5) ...., it requires time, skill and concentration and it is also dangerous. Welding is a very dangerous application: flashes, fumes, (6) .... and heat make manual welding a hazardous job. Robotic welding (7) .... workers and reduces costs. Even the most skilled welders (8) .... mistakes. However, with welding robotics, everything is regulated, including power and wire. The (9) .... of robot systems means there is less (10) .... material and time. Robots can be helpful when access to a part is (11) .... or difficult to reach: manufacturers have created designs that allow for a slender robotic (12) .... to reach smaller areas.

Adapted from: //www.robots.com/articles/viewing/what-are-the-advantages-of-robot-welding-over-manual-welding

ACTIVITIES

WHY A ROBOT?

to defuse: *disinnescare*
electro-optical: *elettro-ottico*
fatigue: *stanchezza*
footage: *filmato*
in harm's way: *in pericolo*
to keep up with: *stare al passo con*
to rove: *girovagare*
sunken: *affondato*
surgeon: *chirurgo*
to withstand: *resistere a*

About 90% of all robots used today are industrial robots because they are useful in industry for a variety of reasons. In today's economy, a business needs to be efficient to keep up with market competition. Installing robots is often a way that allows business owners to be more competitive, because robots can perform their tasks more efficiently than people, they never get sick or need to rest, they can work 24 hours a day, 7 days a week. Moreover, human performance might degrade over time while robots operate without fatigue and stopping.

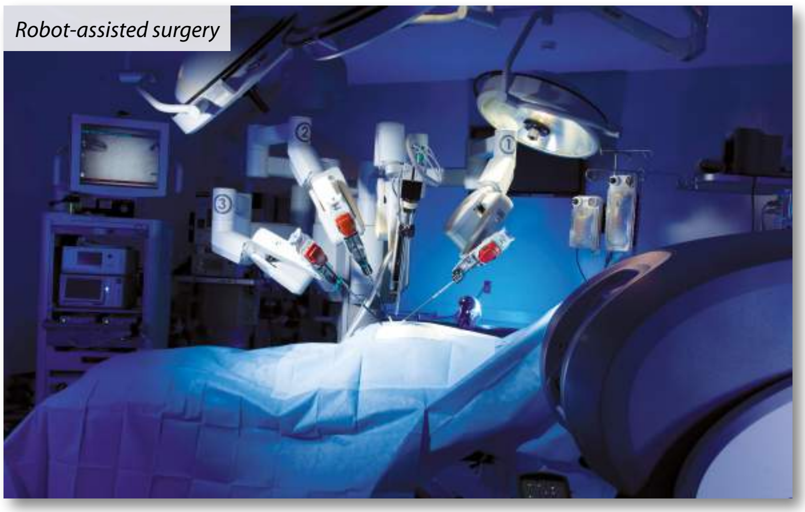
These are some of the fields where, and reasons why, industrial robots are used:

- Most industrial robots work in auto assembly lines assembling cars, mainly because they are very precise: they always drill exactly in the same place, they always tighten bolts with the same amount of force, no matter how many hours they have been working.
- Manufacturing robots are very important in the computer industry, where they assemble microchips on circuit boards.
- In medical laboratories, robots handle potentially hazardous materials, such as blood and urine samples and very high precision robots can assist surgeons with delicate operations. Robots provide improved diagnostic abilities, a less invasive and more comfortable experience for the patient and the ability to do smaller and more precise operations with a minimally invasive surgery, by using miniaturised surgical instruments, which fit through a series of small incisions.
- Activities in environments that pose great danger to humans, such as locating sunken ships, cleanup of nuclear waste, prospecting for underwater mineral deposits and active volcano exploration, are ideally suited to robots, too.
- Remote-controlled, wireless, lightweight bomb-defusing robots are capable of detecting a variety of bombs without putting the operator in harm's way; moreover, they help bomb disposal experts find and deactivate explosive devices. These robots can send video footage back to the operator at a safe distance, thereby enabling a situation to be assessed prior to moving forward or entering a structure, potentially safeguarding lives.
- In the military field, tele-operated robots built with infrared and electro-optical cameras can explore caves, buildings and other potential enemy locations.
- Solar-powered robotic rovers are created to rove over the surface of other planets, to find information, to collect and analyse samples and to take pictures. Rovers have to withstand high levels of acceleration, high and low temperatures, pressure, dust, corrosion, and cosmic rays, remaining functional without repair for the required period of time.

The Industrial robots market

The global industrial robots market was valued at USD 42 billion in 2017, and is expected to reach USD 73 billion by 2023. The industrial robotics market is dominated by Japan, the USA, Germany, South Korea and China. China is likely to be the leading demand generator for the industrial robots in the next five years.

Remote-controlled bomb defusing robot



Robot-assisted surgery

11 Find the Italian words for these English terms.

1. Competition	....	**6.** Circuit board	....
2. Owner	....	**7.** Surgery	....
3. To get sick	....	**8.** To assess	....
4. To tighten	....	**9.** Sample	....
5. Performance	....	**10.** Cave	....

Duct cleaning robot

12 Match the beginning of each sentence with the correct ending.

1.	The majority of robots used today	☐	**a.**	can detect explosive devices.
2.	Rovers have to remain	☐	**b.**	might degrade over time.
3.	To keep up with the market competition,	☐	**c.**	less invasive than traditional surgery.
4.	Bomb-defusing robots	☐	**d.**	robots assemble microchips on circuit boards.
5.	Industrial robots work in auto assembly lines	☐	**e.**	a modern business needs to be efficient.
6.	Human performance	☐	**f.**	incisions are very small.
7.	Robotic surgery is	☐	**g.**	are suitable for robot exploration.
8.	With robotic surgery,	☐	**h.**	are industrial robots.
9.	Dangerous environments	☐	**i.**	because they are very precise.
10.	In the computer industry,	☐	**j.**	functional without repair for a needed period of time.

13 (5.4) Fill in the gaps with the words in the box. Then, listen and check.

autonomous • brushes • burning • chemicals • command • environments
hazardous • remote • secure • spills

Robots: the Perfect Employees

Since the advent of robots, work has been shared between man and machine. But, as robots become more technologically advanced and ...., they learn how to do jobs faster and better than humans. Duct cleaning is done best by a robot, which can actually fit into these (2) .... and tight spaces. Robots provide a more effective and efficient cleaning than manual (3) .... It's also safer for industrial and institutional markets to use robots, because workers are not exposed to harmful (4) .... Duct cleaning robots are used in hospitals and government buildings that may have hazardous or contaminated (5) ...., as well as embassies and prisons for a shorter and more (6) .... cleaning.
Robots play a critical role in fixing oil (7) ...., too. Underwater robots are used to explore the well site and interact with the problematic equipment. Engineers use (8) ....-operated vehicles that dive to great depths and stay submerged for much longer than any human ever could. These robots are remote-controlled submarines that are operated by humans sitting in the (9) .... centre.
Robots have become increasingly important for investigating and researching hazardous and dangerous environments. These robots are capable of entering an active volcano to collect data or a (10) .... building to search for victims.

Adapted from: //www.webdesignschoolsguide.com/library/10-things-we-couldnt-do-without-robots.html

ACTIVITIES

MOBILE ROBOTS

bipedal: *bipede*
evenly: *uniformemente*
to slip: *scivolare*
smooth: *liscio, piatto*
to tackle: *affrontare*
track: *cingolo*

Robotic arms are relatively easy to build and program because they only operate within a confined area, while building a robot able to move around is far more difficult. Mobile Robotics is the science which aims at creating mobile robots which can move around in a physical environment. Mobile robots are generally controlled by software and use sensors and other devices to identify their surroundings.
The first obstacle is to give the robot a working locomotion system. Wheels are the best solution to move on smooth ground, while tracks offer constant contact with the ground preventing slipping, and the evenly distributed weight helps the robot tackle a variety of surfaces. Most mobile robots have a built-in balance system, which tells the computer when it needs to correct its movements. However, problems arise when designers build legged robots: bipedal locomotion is rather unstable and difficult to implement in robots. To create more stable robot walkers, designers commonly look at the animal world, specifically insects: six-legged insects have exceptionally good balance and they adapt well to a wide variety of soils and surfaces.
The two main types of mobile robots are the **non-autonomous** and the **autonomous** ones. The former have a remote control which can communicate with the robot through an attached wire, or using radio or infrared signals, the latter can explore, make decisions and actions based on what they perceive in their environment without any external guidance. The key components of the autonomous action include three key concepts: **perception**, **decision**, and **actuation**. For a robot, perception means sensors, such as laser scanners, stereo-vision cameras, bump sensors, force torque sensors, infrared and ultrasound sensors, and spectrometers. The decision-maker is usually a computer which makes decisions based on what its mission is and what information it receives along the way; for example, the robot can decide to stop if it notices an obstacle or if it detects a problem with itself. Robots can have all kinds of actuators, and a motor of some kind is usually at the heart of the actuator.
Technology is fast developing and mobile robots combine the progress in physical robotics with **Artificial Intelligence**, the technology designed to learn and self-improve, typically used to solve complex problems that are impossible to tackle with traditional code. Research in AI focuses on the development and analysis of algorithms that learn and/ or behave intelligently with minimal human intervention: an algorithm is "trained" to respond to a particular input in a certain way by using known inputs and outputs.

The intellectual roots of AI, and the concept of intelligent machines, may be found in Greek mythology. Intelligent artifacts appear in literature since then, with real (and fraudulent) mechanical devices actually demonstrated to behave with some degree of intelligence. For example, the Greek myths of Hephaestus, the blacksmith who manufactured mechanical servants, and the bronze man Talos incorporate the idea of intelligent robots.

Curiosity, *Mars Rover*

14 Find the words in the search puzzle.

actuation • autonomous • decision • explore • intelligence • mobile • perception • sensor • signal • software

e	p	r	i	g	c	a	r	t	o	e	o	d
e	e	e	n	c	l	e	e	o	t	e	t	o
n	n	e	r	a	w	t	f	o	s	e	u	i
n	i	e	n	c	e	c	i	m	u	n	g	e
o	e	g	d	s	e	x	p	l	o	r	e	c
i	i	t	e	o	t	p	e	r	m	e	n	s
s	s	a	c	t	u	a	t	i	o	n	c	c
i	e	a	o	p	e	t	e	i	n	n	e	g
c	o	c	l	i	n	l	e	o	o	i	a	t
e	c	n	e	g	i	l	l	e	t	n	i	i
d	i	s	e	b	u	o	o	t	u	o	i	r
l	o	d	o	e	n	g	l	r	a	t	u	u
i	c	m	b	c	l	s	x	s	e	b	p	t

15 Choose the correct word.

The Force Torque Sensor

A force torque sensor (1) ***detects/discerns/discovers*** the different forces that are applied on the robot wrist or (2) ***engine/tool/weapon*** in the 3 geometric axes (X-Y-Z). The sensor also recognises the torque applied (3) ***above/out/around*** the 3 different axes, which basically means that the sensor (4) ***suggests/feels/accepts*** what is going on in all axes. By doing so, the sensor gives feedback to the robot and can (5) ***refuse/reject/adapt*** its motion to feel the minimum of force that is applied to it. (6) ***Once/already/after*** the sensor is feeling an acceptable amount of force torque, the robot can continue its (7) ***motion/change/passage*** without risk. Notice that some sensors can measure force on a specific (8) ***pivot/axis/stem*** for a specific application. Most robotic (9) ***applications/purposes/misuses*** require a multi-axis or 6-axis FT sensor to give feedback to the robot about the tool itself, which can be controlled along 6 axes (3 translations + 3 rotations). A 6-axis FT sensor (10) ***pretends/means/denotes*** that the sensor can measure both the force and torque along the 3-axis (x-y-z).

Adapted from://blog.robotiq.com/bid/72422/Robot-Force-Torque-Sensor-An-Introduction
//blog.robotiq.com/bid/72444/Robot-Force-Torque-Sensor-How-does-it-work

16 Answer the questions. Write about 50 words for each answer.

1. What are the means to make a robot move?
2. What is an autonomous robot?
3. What is AI?

ONLINE RESOURCES

- Animal-like robots

ACTIVITIES

ENGINES 12

GENERAL CHARACTERISTICS

Engines come in several different varieties, with various parts, depending on the type of vehicle: for example, a truck engine is different compared to the engine of a regular car, due to the amount of power required. Today, many vehicles make use of the **reciprocating internal combustion engine**: developed in the 19th century, this type of engine – so called because of the to-and-fro motion of the piston transformed into rotary motion – still remains a popular choice and it continues to benefit from the technological advances in engineering.

Many of the automotive engines used today are four-stroke internal combustion engines that use either petrol or diesel as a fuel. These engines get their name "four-stroke" from the four distinct phases that occur in the engine during operation. The engine **displacement** is the volume displaced by all the pistons inside the cylinders in a single movement from the top dead centre (**TDC**) to the bottom dead centre (**BDC**).

The **engine block** is an important part: it has the required number of holes for the **cylinders**, whose diameter is called the **bore** of an engine. The **piston** is a cylindrical structure with a flat surface, called the **crown**, at the top and is the component that moves up and down in the cylinder. In order to prevent friction and leakage, **grooves** are made on the circumference of the piston, where piston **rings** are placed.

The **connecting rod** has an "I" shape structure: one end is connected to the piston and the other one to the **crankshaft**, which is designed in such a way so as to convert the linear (up and down) motion of the piston into a rotational motion. The **crankcase**, often called the **oil sump**, is a casing which is bolted to the engine block: it retains lubricating oil, which is pumped to the different engine parts. The **engine head** has an opening for air to flow into the engine cylinder, and an exhaust opening, from where the burned gases are expelled. The **valves – intake and exhaust** – operated by the **camshaft**, allow fuel and air to enter the combustion chamber of the cylinder and later let the exhaust fumes out. They are composed of a stem and a head, which faces the engine cylinder: consequently, when there is high pressure in the cylinder, the valve head is pressed against its seat in the engine head, thus maintaining the right level of pressure.

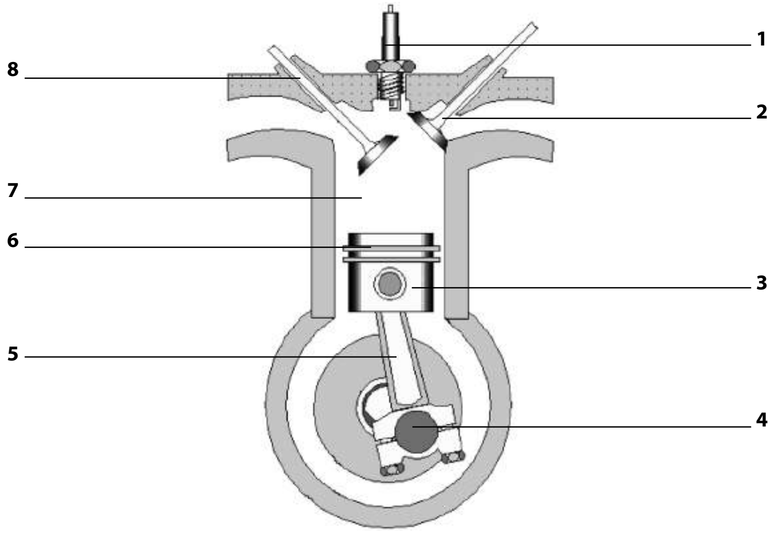
Answer these questions.

- **a.** What types of engines do you know of?
- **b.** Can you explain the basic principle of how a car engine works?
- **c.** Can you mention some of the problems linked with the use of fuel-driven engines?

bore: *alesaggio*
bottom dead centre: *punto morto inferiore*
camshaft: *albero a camme*
connecting rod: *biella*
crankcase: *basamento, carter motore*
crankshaft: *albero a gomiti, albero motore*
displacement: *cilindrata*
engine block: *blocco motore*
groove: *gola, scanalatura*
oil sump: *coppa dell'olio*
reciprocating: *a movimento alternativo*
ring: *fascia elastica, segmento*
spark plug: *candela*
top dead centre: *punto morto superiore*

A spark plug is an electrical device that fits into the cylinder head of a petrol engine and ignites the air/fuel mixture by means of an electric spark, causing a controlled explosion in the engine. It also works as a heat exchanger by pulling unwanted thermal energy away from the combustion chamber and transferring the heat to the engine's cooling system.

1 Label the parts in the drawing.



2 Match the terms with their definition.

1.	Crankshaft	☐	**a.**	A material whose combustion is used to release heat energy.
2.	Piston	☐	**b.**	The inner diameter of the cylinder.
3.	Combustion	☐	**c.**	A device screwed into the cylinder head and used to provide an electric discharge.
4.	Fuel	☐	**d.**	Part of the lubrication system, it forms the lower enclosure of the engine.
5.	Reciprocating	☐	**e.**	The burning of gas, liquid or solid material to produce heat or light.
6.	Ring	☐	**f.**	The change in volume of the combustion chamber that takes place as the piston moves from one extreme to the other.
7.	Connecting rod	☐	**g.**	It fits closely inside the cylinder where it moves up and down.
8.	Cylinder	☐	**h.**	A sealing device fitted around the piston to prevent leakage.
9.	Spark plug	☐	**i.**	The device to which connecting rods are attached and whose movements it transfers.
10.	Displacement	☐	**j.**	The chamber of an engine in which a piston moves.
11.	Bore	☐	**k.**	Moving backwards and forwards in a straight line.
12.	Oil sump	☐	**l.**	It transmits linear or rotary motion from one mechanism to another.

3 Fill in the gaps with the words in the box.

how • means • rise • transmission • vehicle • wheels

The Crankshaft

When a piston engine is used to propel a (1) ...., one of the first engineering problems encountered is (2) .... to gain the rotary power necessary to drive the (3) .... from an engine which produces linear power as its pistons (4) .... and fall. The problem is solved by (5) .... of a crankshaft. This shaft, connected to both the piston assemblies and the (6) ...., converts the vertical movement of the pistons to drive, so that it can be transmitted to the road wheels.

Adapted from: //www.uniquecarsandparts.com.au/how_it_works_crankcase

ACTIVITIES

THE FOUR-STROKE PETROL ENGINE

conversely: *al contrario, nel verso opposto*
manifold: *collettore*

Chemical energy

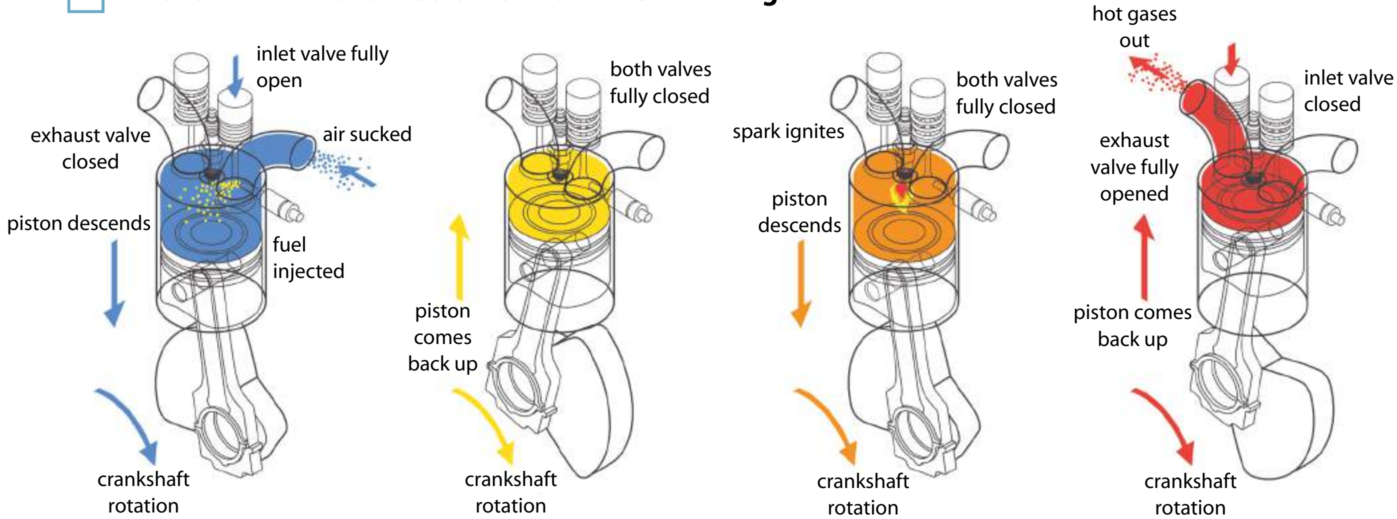
If a gas is heated, energy is added to the gas molecules. As the gas molecules move faster, they also collide with the piston more often. These increasingly frequent collisions transfer energy to the piston and move it against an external pressure, increasing the overall volume of the gas. In an internal combustion engine, the expansion of the high-temperature and high-pressure gases produced by combustion applies direct force to pistons, transforming chemical energy into useful mechanical energy.

In an internal combustion engine, the piston completes a cycle of 4 strokes while turning the crankshaft twice. A stroke refers to a piston travelling full in either of the directions. The four-stroke engine was first employed by the German Nikolaus Otto in 1876, hence it is also known as the Otto cycle. The four strokes of a petrol engine are: intake, compression, combustion – also called power or ignition – and exhaust.

1. **Intake**: the piston in the cylinder moves downwards from TDC to BDC. In this stroke the intake valve is open while the piston pulls an air-fuel mixture into the cylinder by producing vacuum pressure into the cylinder through its downward motion.
2. **Compression:** the piston moves from BDC to TDC. In this stroke both the intake and exhaust valves are closed, therefore the fuel-air mixture is compressed. At the end of this stroke the explosive mixture is ignited by a spark, emitted by the spark plug firmly screwed into the cylinder head, which causes further increase in pressure and temperature in the chamber. At the end of this stroke the crankshaft, via the connecting rod, has completed a full 360 degree revolution.
3. **Combustion**: with both valves still closed, the piston is forced downwards to BDC because of the very rapid combustion of the fuel which causes a sharp increase in the cylinder pressure. In this stroke the piston is driven towards the crankshaft, the volume is increased, and the pressure falls as work is done by the gas on the piston.
4. **Exhaust:** the piston moves back upwards and the exhaust valve is open while the piston expels the exhaust gases out of the chamber. At the end of this stroke the crankshaft has completed a second full 360 degree revolution. When the piston is at the top of the cylinder, the cycle repeats itself.

The top dead centre is the position of an engine's piston when it is at the very top of its stroke, when it has moved to a position where the cylinder volume is a minimum. Conversely, the bottom dead centre is the point at which the piston is nearest to the axis of the crankshaft. In a vertical engine, this is the lowest point that the piston reaches. During the intake stroke, depending on the different systems used, the mixture of petrol and air can be mixed prior to entering the cylinder, pre-mixed in the intake manifold, or air alone can come in via the intake manifold, while the petrol is injected directly into the cylinder.

4 Write the names of the strokes under each drawing.



1. .... **2.** .... **3.** .... **4.** ....

5 Complete the chart with the missing information.

	STROKE	INTAKE VALVE	EXHAUST VALVE	OPERATION PERFORMED
1.	Intake			
2.		closed	closed	
3.				Combustion of the mixture
4.				

6 Watch the video "4 Stroke Engine Working Animation", then, also referring back to the text, answer the questions.

https://www.youtube.com/watch?v=Pu7g3uIG6Zo

1. When the piston completes a cycle, how many times does the crankshaft turn?
2. Why is the 4-stroke engine also known as "Otto cycle"?
3. What happens to the piston during the intake stroke?
4. What is the function of the intake valve?
5. During the compression stroke, what is the position of the valves and why?
6. Where is the spark plug located?
7. What happens during the combustion stroke?
8. What happens when the exhaust valve opens?
9. What is the bottom dead centre?
10. What methods are used to produce the air/fuel mixture?

Crankshaft

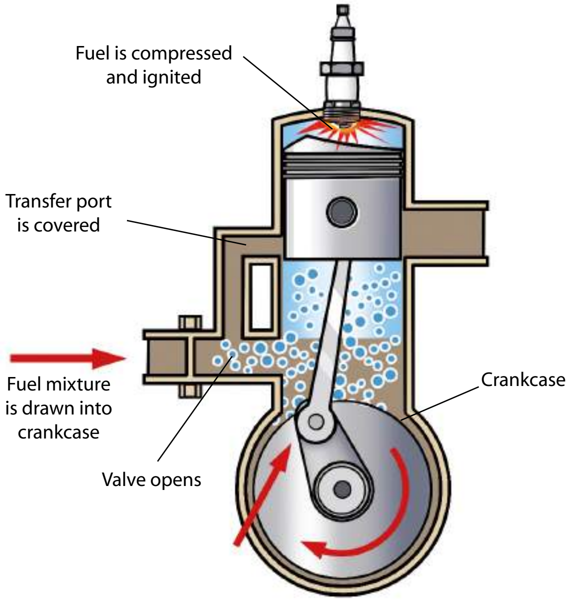
THE TWO-STROKE PETROL ENGINE

chainsaw: *motosega*
cut-out: *taglio*
to double back: *tornare indietro*
exhaust pipe: *tubo di scappamento*
exhaust port: *luce di scarico*
intake port: *luce di aspirazione*
reed valve: *valvola lamellare*
to scavenge: *evacuare*
transfer port: *luce di travaso*

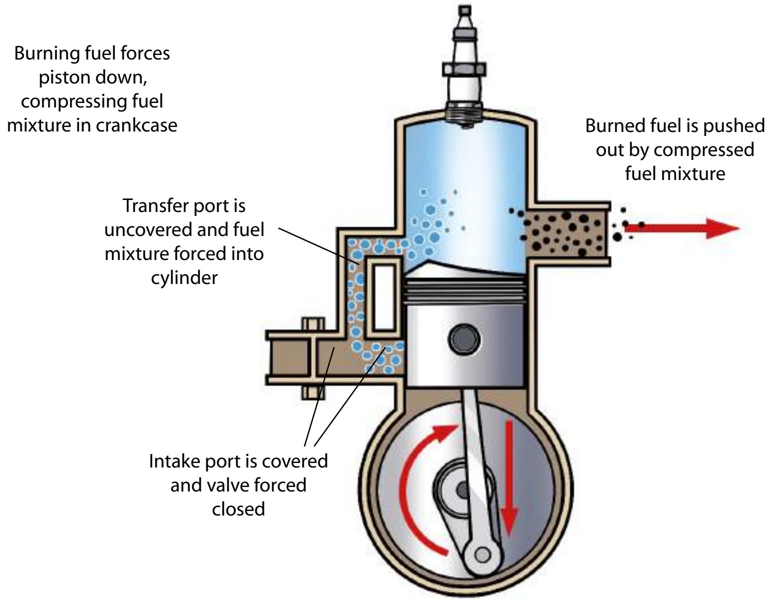
Sir Dugald Clerk was a Scottish engineer who designed the first successful two-stroke engine in 1878, introducing the Otto-styled compression in his engine. The Otto Cycle was patented in 1876 and Clerk patented his two-stroke engine in 1881, without infringing the Otto's patent as it was a four-stroke one.

While most modern motorcycles no longer use two-stroke engines, many scooters and a lot of outdoor power equipment – such as chainsaws and snow-blowers – still do. Like other types of engines, a two-stroke engine has a crankcase that surrounds and protects all other parts of the engine: a **crankshaft**, a **connecting rod** and a single **piston**. These three parts are the only moving parts, and all power produced is a direct result of their action. It has no valves controlled by a camshaft, but an **intake port** – a **reed valve** –, an **exhaust port**, a **cylinder** and a **spark plug**. In this type of internal combustion engine, one power cycle is completed with two strokes of the piston during one rotation only of the crankshaft.
Most two-stroke engines are of the crankcase compression type to force the fuel/ air mixture from the carburettor into the cylinder. The intake – or inlet – port leads into the bottom of the cylinder which is open to the crankcase: higher up the cylinder, on the opposite side, are another set of ports leading to the **exhaust pipe**. A **transfer port** leads back up to the cylinder from the crankcase, entering at a slightly higher level than the intake port, but a little lower than the exhaust port. During the upstroke, the piston uncovers the intake port and allows the fuel/air mixture to rush into the crankcase, underneath the piston. Sometimes there is a cut-out in the side of the piston through which the mixture can pass to reach the crankcase.
When the piston reaches the top of the cylinder, the compressed fuel/air mixture is fired by a spark plug, forcing the piston down on the power stroke. As the piston descends, it compresses the fuel/air mixture in the crankcase and it also uncovers the exhaust port, closely followed by the transfer port. The exhaust gases start to escape as the exhaust port is uncovered and are further forced out by the fuel/air mixture coming in from the transfer port under slight pressure from the crankcase.
To help scavenge the exhaust gases out of the cylinder, the top of the piston is often shaped to deflect the incoming mixture upwards. The mixture then doubles back when it strikes the cylinder head, flows down the exhaust port side and pushes the exhaust gases out, until the exhaust port is closed.
Lubricating oil is mixed with the fuel or injected directly into the crankcase by a pump from a separate tank.

ONLINE RESOURCES
- **Parts of a motorcycle**



Upstroke



Downstroke

7 Watch the video "Two-stroke Engine – How it Works!", then find the English term for these definitions.

https://www.youtube.com/watch?v=Z6YC3I54so4

1. The electrical device which fits into the cylinder head and ignites the gas: ....
2. The part of an engine that contains the crankshaft: ....
3. Something made by combining two or more ingredients: ....
4. The act or process of moving or turning around a central point: ....
5. To press or squeeze something so that it is smaller or fills less space: ....
6. An opening in the body of the cylinder: ....
7. To cause something that is moving to change direction: ....
8. A repeating series of events or actions: ....
9. To remove combustion products from an internal combustion engine cylinder on the return stroke of the piston: ....

8 5.5 Listen and fill the gaps.

Lubrication in 2-stroke Engines

In most engines, the (1) .... and sump contain the oil to lubricate the engine's (2) .... parts. But with a crankcase compression two-stroke, the crankcase cannot do this because it is needed for initial (3) .... of the fuel and air.
The solution is to mix the (4) .... oil with the fresh charge of fuel and air. However, because of this, a two-stroke can produce a lot of (5) .... This is due to the fact that the intake and exhaust ports are open (6) .... for some of the time, allowing some unburnt fuel/air mixture down the exhaust (7) .... and out to the atmosphere.

Adapted from: https://www.howacarworks.com/technology/how-a-two-stroke-engine-works

9 Choose the correct word.

2-stroke vs 4-stroke

Advantages of a 4-stroke engine:

1. More torque: in general, 4-stroke engines always make (1) ***extra/extraordinary/other*** torque than 2-stroke engines at low RPM- (2) ***revolt/ reformation/ revolution*** per minute. Actually, 2 stroked ones give higher torque at higher RPM, but it has a lot to do with fuel efficiency.
2. More fuel efficiency: 4-stroke engines have (3) ***bigger/greater/stronger*** fuel efficiency than 2-stroke ones because the fuel is (4) ***absorbed/consumed/exhausted*** once every 4 strokes.
3. Less pollution: as (5) ***power/function/force*** is generated once every 4 strokes, and as no oil or lubricant is added to the fuel, a 4-stroke engine produces less pollution.
4. More (6) ***constancy/durability/persistence***: we all know that the more the engine runs, the quicker it wears out. As 2-stroke engines are designed for high RPM, they have a shorter life.

Advantages of a 2-stroke engine:

5. Simple design and construction: it doesn't have (7) ***pipes/valves/flaps***, it simply has inlet and outlet ports which make it simpler.
6. More powerful: in 2-stroke engines, every alternate stroke is a power stroke while in 4-stroke ones the power stroke gets (8) ***brought/dropped/delivered*** only once every 4 strokes. This gives a significant power boost.
7. Position does not matter: a 2-stroke engine can work in any position as lubrication is done (9) ***about/ through/though*** the means of fuel.

Adapted from: //mechstuff.com/differences-advantages-disadvantages-of-4-stroke-2-stroke-engine/

THE FOUR-STROKE DIESEL ENGINE

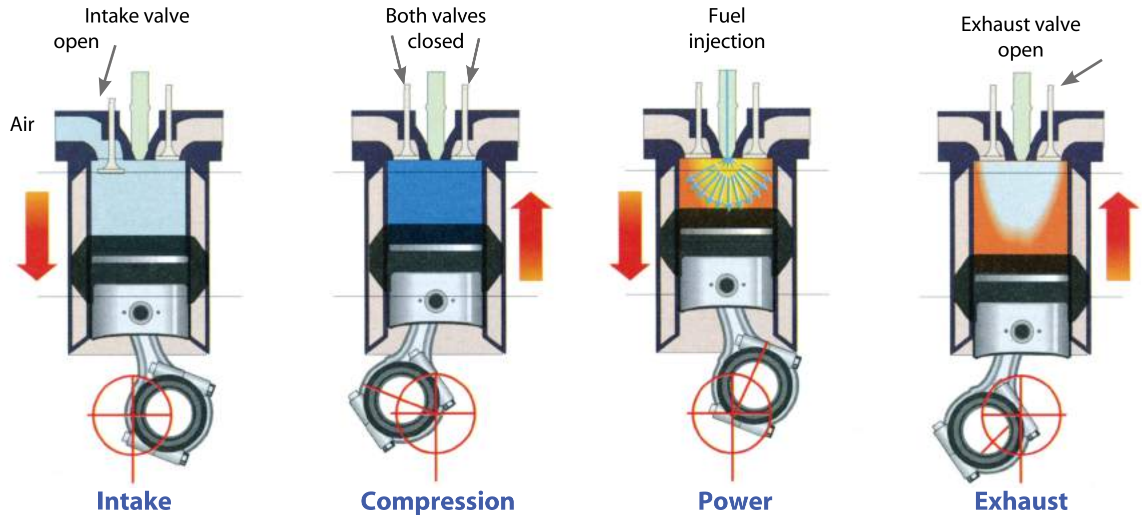
to clog up: *intasare*
glow plug: *candeletta*
nozzle: *ugello*
ratio: *rapporto*
reliability: *affidabilità*
to retreat: *arretrare*
steadily: *costantemente, regolarmente*

Both diesel and petrol engines convert chemical energy from fuel into mechanical energy through a series of explosions. The way these explosions happen is the major difference between the two engines.
The major difference between the petrol and the diesel engine is that the former relies on spark ignition and the latter on compression ignition, so the spark plug is replaced by an injection pump. More specifically, the combustion process in the diesel engine is started by spontaneous ignition of the fuel when it is injected into a highly compressed charge of air which has reached approximately a temperature of 760 degrees. Compression is much higher in a diesel engine (14:1 to 25:1) than in a petrol engine (8:1 to 12:1): higher compression ratios lead to higher thermal efficiency and better fuel economy.
Diesel engine combustion also tends to occur at constant pressure rather than at constant volume, as in a petrol engine. This means that, in the diesel engine, the combustion pressure continues to rise steadily as the piston retreats and the cylinder volume increases, whereas in the petrol engine, the combustion process is so rapid that there is very little movement of the piston while it occurs and, thus, very little increase in cylinder volume.
Originally, manufacturers installed little glow plugs because, diesel fuel being less volatile than petrol, it is easier to ignite it if the combustion chamber is preheated. Now, higher injection pressures and improved fuel management techniques provide enough heat to ignite the fuel without glow plugs. However, the plugs are still present for emissions control: the extra heat they supply burns the fuel more efficiently.
On its way, the fuel passes through fuel filters whose task is particularly important: diesel fuel has to be cleaned before it reaches the fuel injector nozzle, otherwise the fuel contamination could clog up the minuscule holes of the nozzle.
One of the most significant advantages of a diesel engine compared to a petrol one is that it is capable of converting approximately 45-50% of the fuel energy to power, while the majority of petrol engines approximately only convert 30% of the petrol energy.
Diesel engines are appreciated for their reliability, long life and fuel economy. Besides cars, they are largely employed in heavy trucks, ships and locomotives, mainly thanks to the high torque they develop at very low RPM, which is needed to move heavy loads.

Fuels

Conventional diesel and petrol are both produced from mineral oil, but the refining methods vary. Diesel is in principle easier to refine than petrol, but it contains more pollutants that must be extracted before it can reach the same levels of emissions as petrol. On the one hand, per litre, diesel contains more energy than petrol, the vehicle's engine combustion process is more efficient and CO_2 emissions are lower than petrol. On the other hand, diesel engines emit a complex mixture of air pollutants, including both gaseous and solid material. The solid material in diesel exhaust is known as diesel particulate matter (DPM), made up primarily of carbon, ash, metallic abrasion particles, sulfates and silicates.

10 Look at the drawings and complete the passage on the four-stroke diesel cycle.



First stroke. The piston moves (1) .... and (2) .... is drawn into the cylinder (3) .... the intake (4) .... while the (5) .... one is closed. This is the (6) .... stroke.

Second stroke. With both valves (7) ...., the ascending piston (8) .... air into the restricting space inside the cylinder. This compression process (9) .... air temperature remarkably and, at the end of the piston's journey (10) ...., the compression ratio is so high that the air can reach a temperature of more than 700°. Such a high temperature causes the

(11) .... ignition of the fuel, injected in the cylinder at the very end of this

(12) .... stroke.

Third stroke. The injected (13) .... burns explosively and releases the expanding (14) .... thus providing the thrust for pushing the piston (15) .... again, as in the petrol engine. This is the (16) .... stroke.

Fourth stroke. Finally, the burnt gases are expelled from the (17) .... through the exhaust valve and the (18) .... can start again. This is the (19) .... stroke.

11 Decide if these sentences are true or false. Correct the false ones.

	T	F
1. Diesel engines employ spark plugs to cause combustion.	☐	☐
2. Ignition is caused by high pressure and temperature in diesel engines.	☐	☐
3. A charge of fuel and air is compressed in the cylinder of diesel engines.	☐	☐
4. Petrol engines are comparable to diesel ones in terms of efficiency and fuel economy.	☐	☐
5. Diesel and petrol engines have the same compression ratios.	☐	☐
6. Diesel fuel is less volatile and flammable than petrol.	☐	☐
7. If the combustion chamber is preheated, diesel fuel burns better.	☐	☐
8. Fuel filters are unnecessary in diesel engines.	☐	☐
9. Diesel engines convert more fuel energy to power than a petrol engine.	☐	☐
10. Diesel engines develop high torque at low RPM.	☐	☐

12 Write about three of the differences between a diesel engine and a petrol one. Use about 100 words.

ACTIVITIES

FUEL INJECTION SYSTEMS AND TURBOCHARGERS

intercooler: *interrefrigeratore*
narrow: *stretto*
reversed: *rovesciato*
sheer: *grande*
snail-shaped tube: *alloggiamento a forma di chiocciola*
tough: *duro, resistente*

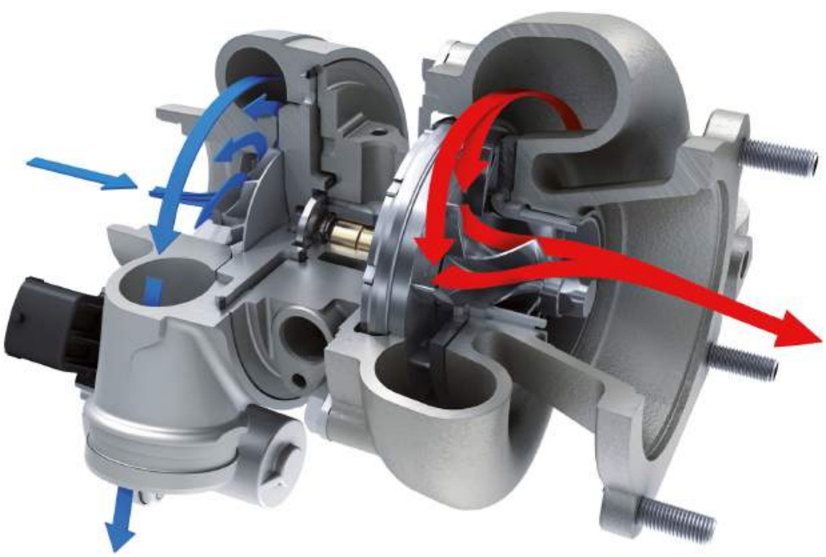
The Venturi effect

The purpose of a carburettor is to effectively mix air and petrol to achieve the correct mixture. One component of the carburettor body is the **venturi**, a condensed portion of a pipe. Discovered by Giovanni Venturi, the **Venturi effect** is the decreased pressure experienced when passing through a smaller portion of a pipe where the diameter decreases. The speed of the vapour increases and its pressure will decrease in this smaller portion of the pipe. The lower pressure in the venturi will attract fuel from the fuel bowl into the pipe.

Traditionally, the fuel/air mixture is controlled by the carburettor, an imperfect instrument: a single carburettor supplying a four-cylinder engine cannot give each cylinder precisely the same mixture, because some of the cylinders are further away from the carburettor than others.
Today, the majority of cars are being fitted with fuel-injected engines, where the fuel is delivered by a fuel injector whose task is to spray an intermitted, timed and carefully measured quantity of fuel. The **fuel injection** system in petrol-engined cars is usually indirect, petrol being injected by the injectors into the inlet manifold rather than directly into the combustion chambers, because this ensures that the fuel is well mixed with the air before it enters the chamber. Many diesel engines, however, use direct injection, in which the diesel is injected directly into the cylinder filled with compressed air, while others use indirect injection, in which the diesel fuel is injected into the specially shaped pre-combustion chamber which has a narrow passage connecting it to the cylinder head.
The electronic fuel injection system (EFI) is controlled by a complex electronic control unit (ECU), basically a miniature computer. This computer is fed with information from sensors mounted on the engine. These measure factors such as air pressure and temperature in the air intake, engine temperature, accelerator position and engine speed. Electronic fuel injection allows better engine's efficiency, power and fuel economy, thus providing lower exhaust emissions and better pollution control.

Turbochargers have been around for nearly as long as the internal combustion engine itself. Although widely used in aircraft engines for decades, the sheer size of early turbochargers initially made them fairly impractical for use in automobiles.
Turbo engines can make the same power as a normally aspirated engine while using less fuel. Turbos are formed of two main parts – a **turbine** and a **compressor** that spin together. As fuel in the engine is burnt, exhaust gases are forced out of the engine at high pressure down a snail-shaped tube to spin the turbine. This turbine spins at incredibly high speeds – up to 250,000 rpm – and causes the compressor – effectively a reversed turbine – to spin. This sucks significantly more air into the engine than a normally aspirated unit, making more power.
Turbos run at immense speeds, which means they operate under huge pressures and temperatures, so, generally, an intercooler is paired with the turbocharger to cool the hot air coming out of it, and an oil cooling system ensures the turbo itself does not run too hot. Diesels, having tougher engine blocks and simpler intakes, are ideally suited to being turbocharged, so all modern diesels have them.

ONLINE RESOURCES
- **Parts of a car**



13 Find the English term for these definitions.

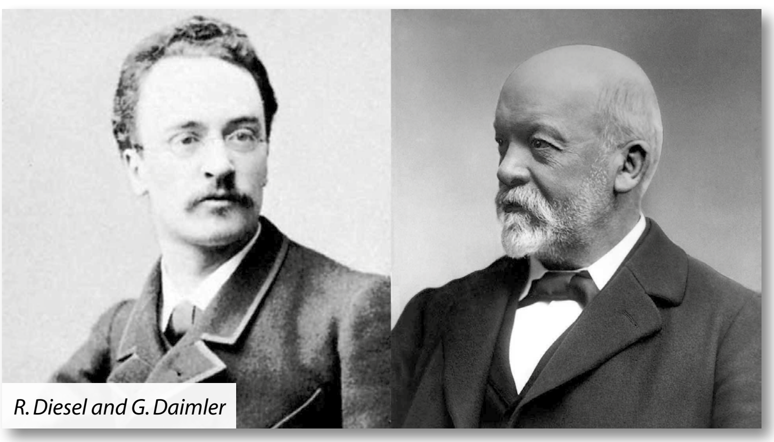
1. The part of an engine in which petrol is mixed with air: ....
2. Equipped: ....
3. Not done in direct way: ....
4. The part of an engine that connects different pipes for moving fuel and air into the engine: ....
5. Having a particular form: ....
6. Long and not wide: ....
7. Tiny, very small: ....
8. A pedal in a vehicle that is pressed down to make the vehicle go faster: ....
9. The action or process of making land, water, air, etc. dirty and not safe or suitable to use: ....
10. A machine that flies through the air: ....
11. A device that has a part with blades that are caused to spin by pressure from water, steam, or air: ....
12. A machine that compresses air or gas: ....

14 Use the words below to write sentences.

1. The automobile pioneer / first / Karl Benz / a carburettor / developed.
2. From the sensors / the ECU / the input signals / compares / already programmed into it / at the factory / with information.
3. Exactly / the Ecu / how much fuel / works out / to the engine / should be delivered.
4. Of fuel / is the introduction / fuel injection / combustion engine / into an internal / of an injector / by the means.
5. The exhaust flow / the turbocharger / from the engine / uses / a turbine / to spin.
6. Are / in the turbine / very high / the temperatures.
7. Work /so they operate / turbochargers / very high pressures / under / at immense speeds / and temperatures.
8. Is paired / an intercooler / usually / with the turbocharger.

15 (5.6) Listen to this text on the history of turbocharging and answer the questions.

1. When did Daimler and Diesel start research on how to improve the engine's power output?
2. What did they try to do?
3. What power increase did Alfred Büchi obtain?
4. What types of engines were first equipped with turbochargers?
5. When was the first turbocharged engine for trucks built?
6. When did the turbocharged passenger car engine become popular?
7. What types of cars did manufacturers produce with turbochargers?
8. Even though the turbocharged petrol engine was more powerful, why did the production of turbocharged cars decrease?
9. How are turbocharged engines considered today?



R. Diesel and G. Daimler

THE ELECTRIC CAR

coil: *avvolgimento*
drivetrain: *trasmissione*
like pole: *polo uguale*
opposite pole: *polo opposto*
stator: *statore*
tailpipe: *tubo di scappamento*

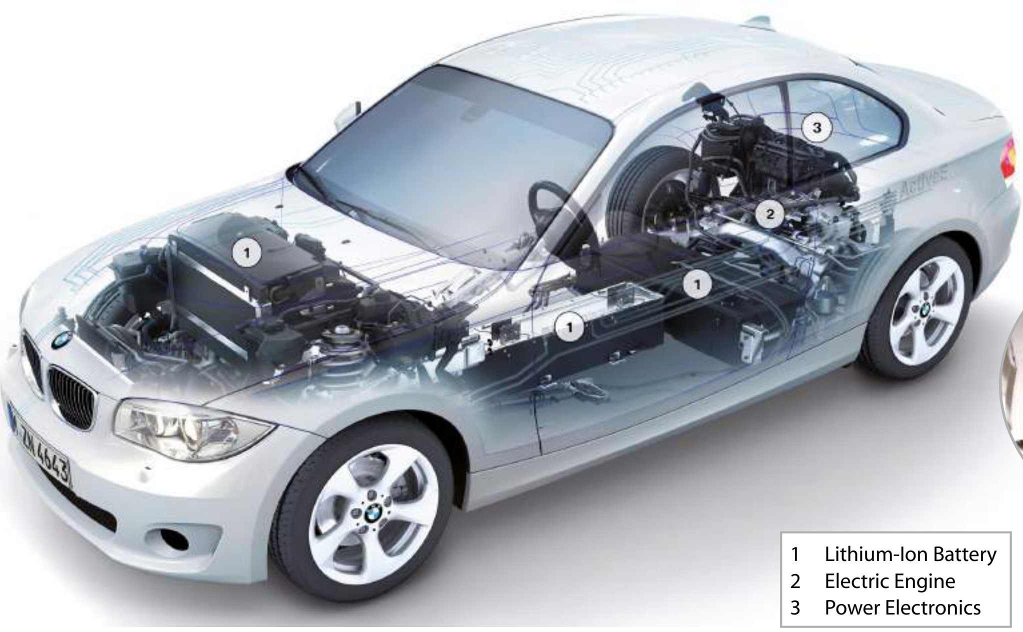
With the ever-increasing fuel problems, it has become necessary to use better forms of energy to drive cars. True electric cars are likely to be the transport solution of the future, according to manufacturers.
From the outside, most electric cars look exactly like fossil fuel-powered cars: they lack a tailpipe and gas tank, but the overall structure is basically the same. The electric vehicle power source is the battery which supplies the electric motor with the energy necessary to move the vehicle. The basic operation of a motor, i.e. the rotational movement, relies on the most basic laws of magnetism: like poles repel and opposite poles attract. This creates the force required to run the motor.
There are many kinds of electric motors, but in general they have some similar parts. Each motor has a **stator**, which may be either a permanent magnet or an electromagnet, and a **rotor**, which sits in the middle and is subject to the magnetic field created by the stator. The rotor rotates as its poles are attracted and repelled by the poles in the stator. The current is applied to an electromagnetic coil – the **armature** – that creates a temporary magnetic field with a particular direction of magnetism, creating a north and south pole at each end of the electromagnet, which can be reversed by reversing the direction of the current in the coil. This magnetic field interacts with the magnetic field produced by a series of permanent magnets aligned with alternating polarities. The interacting fields then either attract or repel each other to create a rotational movement on the output shaft, which is transmitted to the **drivetrain**. A **commutator** is used to switch the direction of the electric field so that the electromagnet and axle spin the opposite way. The heart of an electric car is the combination of:

- the **electric motor**;
- the motor's **controller**, which acts as a regulator and controls the amount of power received from the batteries and delivers it to the motor;
- the **batteries**, rechargeable storage cells situated in T-formation down the middle of the car, with the top of the "T" at the rear to provide better weight distribution and safety.

At present, EVs are mainly city technology because of the limited drive range before battery recharging, but expensive, top models can run up to 450 km, thanks to regenerative brakes which put the electric motor into reverse mode and act as an electric generator, producing electricity to feed into the vehicle's batteries.

Electric Car Weight

Weight in an electric car has been a recurring design difficulty. In electric cars, the battery and electric propulsion system are typically 40% of the weight of the car, whereas in an internal combustion-driven car, the engine, coolant system, and other specific powering devices only amount to 25% of the weight of the car.



1 Lithium-Ion Battery
2 Electric Engine
3 Power Electronics

16 Find the Italian words for these English terms.

1. To lack	....	**6.** Temporary	....
2. Tank	....	**7.** To reverse	....
3. Rotational	....	**8.** To switch	....
4. To repel	....	**9.** Axle	....
5. Permanent magnet	....	**10.** Regenerative	....

17 Read the text and choose the best word for each gap.

Electric Car Design

Today's electric cars are described as "modern era production electric vehicles" to (1) .... them from the series of false starts in trying to design an electric car (2) .... on existing production models of petrol-powered cars and from "kit" cars or privately engineered electric cars that may be fun and (3) .... but not production-worthy.

In the 1960s, interest in the electric car was profound, but (4) .... was slow. In the late 1980s, automotive engineers began designing an electric car from the ground up with heavy (5) .... to aerodynamics, weight, and other energy efficiencies.

The space frame, seat frames, wheels, and (6) .... were designed for high strength, for safety and the lightest (7) .... weight. This meant new configurations that provided support for the components and (8) .... with minimal mass and the use of high-tech materials including aluminum, magnesium, and advanced composite plastics. All extra details had to be (9) ...., for example the spare tyre. An added consideration was the pedestrian warning system; tests of prototypes showed that electric cars run so (10) .... that pedestrians don't hear them approach. Driver-activated flashing lights and beeps warn pedestrians that the car is approaching and work automatically when the car is in reverse.

Adapted from: //www.madehow.com/Volume-5/Electric-Automobile.html

1.	**a.** categorise	**b.** distinguish	**c.** determine	**d.** estimate
2.	**a.** established	**b.** placed	**c.** situated	**d.** based
3.	**a.** functional	**b.** occupational	**c.** worthless	**d.** idle
4.	**a.** addition	**b.** augmentation	**c.** development	**d.** maturation
5.	**a.** consideration	**b.** review	**c.** disregard	**d.** ignorance
6.	**a.** figure	**b.** concept	**c.** abstract	**d.** body
7.	**a.** probable	**b.** possible	**c.** hopeful	**d.** credible
8.	**a.** dwellers	**b.** holders	**c.** occupants	**d.** possessors
9.	**a.** eliminated	**b.** defeated	**c.** ignored	**d.** rejected
10.	**a.** audibly	**b.** quietly	**c.** freely	**d.** easily

18 PAIR WORK. Watch the video "Battery-electric Vehicles", then, in pairs, answer the questions.

https://www.youtube.com/watch?v=1TiaiCUuRME

1. Why are electric vehicles becoming more and more popular in Canada?
2. What are the three main components of an electric vehicle mentioned in the video?
3. Why are internal combustion engines relatively inefficient?
4. Why are transmissions in electric cars simpler compared to an internal combustion engine?
5. How can you recharge the batteries?
6. Are fuel costs more expensive for an electric car than for a traditional combustion engine?
7. How many kilometres can you drive before recharging?
8. Can you name some of the advantages of an electric vehicle?

ALTERNATIVE ENGINES

byproduct: *effetto secondario, sottoprodotto*
fuel cell: *pila a combustibile*
idle-off: *inattività del motore*
plug-in: *con possibilità di rifornimento*
stack: *pila*
to supplement: *integrare*
widespread: *diffuso*

Fuel cell vehicles (FCV) use hydrogen gas to power an electric motor. Fuel cell engines combine hydrogen and oxygen to produce electricity: the heart of the FCV is the fuel cell stack, which converts hydrogen gas stored onboard with oxygen from the air into electricity, which powers the vehicle's electric motor. FCVs are considered as electric vehicles, but unlike other EVs, their range and refuelling processes are comparable to conventional cars. Like other EVs, fuel cell cars can employ idle-off, which shuts down the fuel cell at stop signs or in traffic, and regenerative braking; moreover, while conventional cars rely entirely on friction brakes to slow down, here, the vehicle's kinetic energy is dissipated as heat is captured and turned into electricity. This stored electricity can later be used to run the motor and accelerate the vehicle. Converting hydrogen gas into electricity produces only water and heat as a byproduct, meaning fuel cell vehicles do not cause pollution when they are driven. Unfortunately, at present, fuel cell vehicles are still very expensive because their technology is quite new and unique and moreover, fuelling stations are very rare as hydrogen is highly flammable and difficult to store.

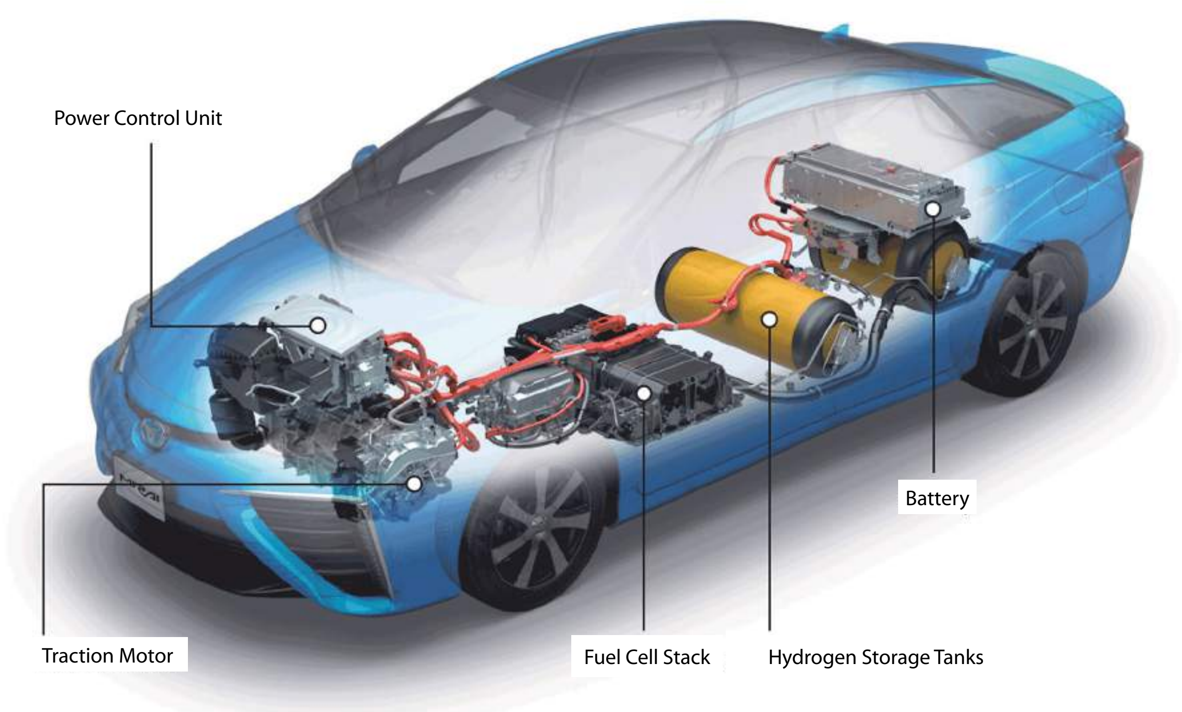
Plug-in hybrid electric vehicles (PHEV) are similar to battery electric vehicles, but combine a petrol or diesel engine with the electric motor. This allows them to be driven short distances on electricity only, switching to liquid fuel for longer trips. Although not as clean as EVs and FCVs, PHEVs cause significantly less pollution than their conventional counterparts. Idle-off and regenerative braking are present, too. Since the electric motor supplements the engine's power, smaller engines can be used, increasing the car's fuel efficiency without compromising performance.

Conventional hybrids also have conventional engines and an electric motor and battery, but can't be plugged-in. Though cleaner than conventional cars, non-plug-in hybrids derive all their power from petrol and diesel and are not considered electric vehicles. In hybrids that can't be plugged-in, electric-only drive is normally only utilised at low speeds and startup, enabling the gas or diesel-powered engine to operate at higher speeds, where it is most efficient.

Compressed natural gas (CNG) vehicles work much like petrol-powered vehicles, with spark-ignited internal combustion engines. The natural gas is stored in a fuel tank, or cylinder, usually at the back of the vehicle. For vehicles used for long-distance travel, **liquefied natural gas (LNG)** is a good choice. The advantages of natural gas as a transportation fuel include its availability, widespread distribution infrastructure and reduced greenhouse gas emissions compared to conventional petrol and diesel fuels.

The Drivetrain

A drivetrain is the collection of components that delivers power from a vehicle's engine to the vehicle's wheels. Hybrids that use a series drivetrain only receive mechanical power from the electric motor, which is run by either a battery or a petrol-powered generator. In hybrids with parallel drivetrain, the electric motor and internal combustion engine can provide mechanical power simultaneously. Series/parallel drivetrains enable the engine and electric motor to provide power independently or in conjunction with one another.



Fuel cell vehicle

19 Match the words with their definition.

1.	Hydrogen	☐	**a.**	Usable power that comes from heat, electricity, fuel and so on.
2.	To convert	☐	**b.**	A chemical that is found in the air, that has no colour, taste, or smell, and that is necessary for life.
3.	Idle	☐	**c.**	Present or ready for use.
4.	Shutdown	☐	**d.**	To change something into a different form.
5.	Energy	☐	**e.**	The act of stopping the operation or activity of a machine for a period of time.
6.	To switch	☐	**f.**	Chemical element that has no colour or smell and that is the simplest, lightest, and most common element.
7.	Power	☐	**g.**	To make a change from one thing to another.
8.	Oxygen	☐	**h.**	A container for holding liquid or gas fuel.
9.	Tank	☐	**i.**	Not working, active, or being used.
10.	Availability	☐	**j.**	The energy or force that someone or something can produce for movement, work, etc.

20 Complete the sentences.

1. Conventional hybrids have an electric motor, a battery and…
2. To power their electric motor, FCVs use…
3. Fuel cell vehicles convert hydrogen and oxygen into…
4. PHEVs combine the electric motor with…
5. Regenerative braking is used to capture…
6. FCVs range and refuelling processes are comparable…
7. In CNGs, the natural gas is stored in…
8. Natural gas engines emit fewer…

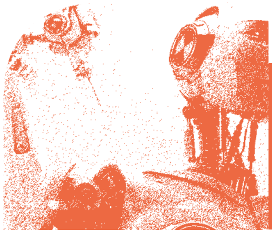
21 Complete the text with the given words.

amount • causes • conscious • drilling • effort • extraction • renewable • technique • vehicle

Well-to-Wheel

The Life-Cycle Assessment (LCA) is a (1) .... to assess environmental impact associated with all the stages of a product's life, from raw material (2) .... through materials processing, manufacture, distribution, use, repair, maintenance and disposal or recycling. "Well-to-Wheel" is the specific LCA used for transport fuels and vehicles. It takes a finite (3) .... of energy to extract oil from the ground, refine it and transport it to the pump. While this energy is not considered into the fuel economy of a (4) ...., its environmental influence is very real and should be considered to make a (5) .... decision whenever you are going to buy a car based on its fuel economy. In the early days of pumping oil from the ground, oil was called "easy" because it took so little (6) .... to extract it. For every unit of energy spent in the extraction process, you got 100 units of fuel energy out. After (7) .... a well, the oil would literally shoot out of the earth, but this "easy oil" has almost run out now. Getting oil from under the sea floor is far more difficult, expensive and often (8) .... environmental damage. While electric cars are much cleaner, if you are not using (9) .... energy to charge it up, you need to consider the environmental impact of the electricity used to power your car.

Adapted from: //en.wikipedia.org/wiki/Life-cycle_assessment
//www.johnsavesenergy.com/WellToWheels.html#.WoQb9q7ibcc



VOCABULARY

ACTIVITIES

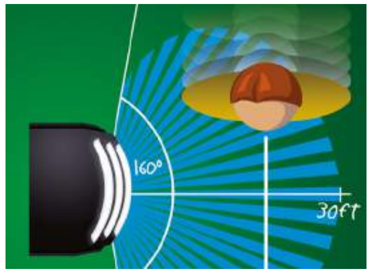
1 Write the correct caption under each picture.

movement sensor • bomb-defusing robot • robotic arm • mechatronics technician • turbocharger
spark plug • connecting rod • home automation • crankshaft • valve • piston • cobot

a. What do these pictures show?

1. ....

2. ....



3. ....

b. What types of robots are these?

4. ....

5. ....

6. ....

c. What parts of the engine are these?

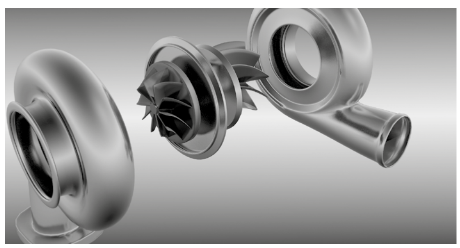
7. ....

8. ....

9. ....

10. ....

11. ....



12. ....

2 Use the given words to complete the sentences.

automate • cobot • controller • drive • handheld • move • non-autonomous • painting
safety • self-improve • sensors • slipping • spraying • tracks

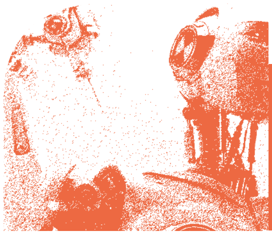
1. The .... is the “brain” of the robotic arm and allows the parts of the robot to operate together.
2. A teach pendant is a wired or wireless .... device.
3. The robot’s capacity to move its parts is provided by the ....
4. In a robot, the .... allow the robotic arm to receive feedback about its environment.
5. Material handling robots can .... some of the most tedious, unpleasant and unsafe tasks in a production line.
6. Assembly robots put parts together and .... faster and with greater precision than a human.
7. Dispensing robots are used for ...., gluing, applying adhesive, and ....
8. Robots increase workplace ....
9. The term .... is the contracted term for “collaborative robot”.
10. .... robots have a remote control which can communicate with the robot through an attached wire, or using radio or infrared signals.
11. Artificial Intelligence is the technology designed to learn and ....
12. In mobile robots, ... offer constant contact with the ground preventing ....

3 In the puzzle there are 14 hidden words about the engine. Find them.

V	E	G	I	T	E	S	M	N	Z	C	R	V	C	C
U	G	K	W	P	T	L	O	G	O	I	E	E	O	F
S	C	U	A	R	N	T	G	M	H	L	D	C	M	P
F	D	R	O	T	S	S	P	Q	E	Q	N	Q	B	E
S	P	K	A	I	N	R	N	S	Q	S	I	J	U	O
N	E	S	P	N	E	I	E	O	P	U	L	R	S	S
Z	O	R	X	S	K	I	O	W	I	V	Y	Y	T	Y
N	L	I	S	H	D	S	T	V	A	T	C	F	I	K
G	I	I	T	N	E	S	H	L	J	G	I	E	O	E
P	O	A	Z	C	U	Z	V	A	A	O	A	N	N	Z
N	W	P	I	A	E	E	X	R	F	W	T	D	G	S
W	X	Q	H	R	R	J	N	W	T	T	D	E	D	I
T	G	X	X	Y	L	U	N	K	R	A	P	S	L	A
N	E	G	M	A	H	V	H	I	C	A	C	L	E	J
E	N	I	L	O	S	A	G	I	Z	X	D	P	W	N


Mc Laren F1 Engine Bay

ACTIVITIES



GRAMMAR

COMPARATIVES AND SUPERLATIVES

	COMPARATIVE	RELATIVE SUPERLATIVE
	MAJORITY	
One-syllable adjectives or adverbs	• **adjective/adverb + er + than** → *This engine supports a* ***higher*** *pressure* ***than*** *that one.* → *This lathe works* ***faster than*** *that one.*	• **the + adjective/adverb + est + of/in*** → *This engine can bear* ***the highest*** *temperature of all.* → *With this assembly line this factory works* ***the fastest****.*
One-syllable adjectives ending in -e	• **adjective + r + than** → *This procedure is* ***safer than*** *that one.*	• **the + adjective + st + of/in*** → *This is* ***the safest*** *procedure of all.*
One-syllable adjectives/ adverbs ending in one vowel + one consonant	• **adjective/adverb + double consonant + er + than** → *Tom's car is* ***bigger than*** *mine.* BUT clean → cleaner (2 vowels) strong → stronger (2 consonants)	• **the + adjective + double consonant + est + of/in*** → *Tom's car is* ***the biggest*** *in this village.* BUT clean → the cleanest (2 vowels) strong → the strongest (2 consonants)
Two-syllables adjectives/ adverbs ending in -y	• **adjective/adverb without -y + ier + than** → *These instructions seem* ***easier*** *to understand* ***than*** *those ones.* → *Diesel engines are* ***noisier than*** *petrol ones.*	• **the + adjective without -y + iest +of/in*** → *This engine is* ***the heaviest of*** *the ones we produce.* → *This automation process is* ***the simplest*** *to use but also* ***the noisiest****.*
Adjectives/ adverbs with two or more syllables	• **more + adjectives/adverb + than** → *This robotic arm is* ***more useful than*** *the one we used before.* → *They work* ***more efficiently than*** *their competitors.*	• **the most + adjective + of/in*** → *This car is* ***the most expensive in*** *the exhibition.* → *The four-stroke gasoline engine is* ***the most widely*** *employed engine in the world.*
Irregular forms	• good → better • bad → worse • far → farther/further • old → older/elder	• good → the best • bad → the worst • far → the farthest/ furthest • old → the oldest/eldest
	EQUALITY	
Adjectives/ adverbs with one or more syllables	• **as + adjective/adverb + as** → *Visual sensors are* ***as efficient as*** *tactile ones.* With negative verb: **+ as/so + adjective + as** → *The technicians are not checking the engines* ***as/so quickly as*** *they should.*	
	MINORITY	
Adjectives/ adverbs with one or more syllables	• **less + adjective/adverb + than** → *Italian car factories are* ***less competitive than*** *German ones.* → *Workers have worked* ***less efficiently*** *recently.*	• **the least + adjective/adverb + of/in*** → *That car factory is* ***the least competitive*** *of all.* → *The workers who received the warning letter are the ones who work* ***the least carefully****.*

* In general, **in** is used with places, **of** with groups of people/things.

N.B. Certain adjectives form their comparative and superlative in both ways, either by adding -er/-est to the adjectives or by taking more/most. Some of these are: clever, common, cruel, friendly, gentle, narrow, pleasant, polite, shallow, simple, stupid, quiet.

⇨ *simple – simpler – the simplest* or *simple – more simple – the most simple*

4 Complete the table with the comparative and superlative forms of the adjectives/adverbs.

ADJECTIVE/ ADVERB	COMPARATIVE	SUPERLATIVE
0. *high*	*higher*	*the highest*
1. loud		
2. large		
3. thin		
4. heavy		
5. cheap		
6. quietly		
7. carefully		
8. dependent		
9. good/well		
10. bad		

5 Write sentences with comparatives using the clues given (+ majority; = equality; – minority).

1. Robotic arms are .... conventional machine tools. (+ versatile)
2. Sensors are car components .... mechanical devices. (= important)
3. Robots are .... human beings. (+ efficient and precise)
4. Diesel engine is .... gasoline engine. (+ bulky)
5. Diesel engine is not .... gasoline engine. (= reactive)
6. Sensors are becoming .... in the past. (+ accurate, cheap)
7. Petrol engines use fuel .... diesel engines. (– efficiently)
8. Petrol engines don't support a pressure .... diesel engines do. (= high)

6 Choose the correct option for each sentence.

1. He worked *efficiently, more efficiently, the most efficiently* than I did.
2. Prevention is *good, better, the best* than cure.
3. This car may be *as expensive as, the most expensive, more expensive* car in the shop.
4. These sensors are not *as sensitive, more sensitive, so sensitive as* those ones.
5. The piston moves *less smoothly, the least smoothly, more smoothly than* before.
6. This factory produces *the most powerful, more powerful, the less powerful* engines in Italy.
7. This car's engine works in a *more eco-friendly, eco-friendlier, the eco-friendliest* way *than/of/in* the previous ones.
8. The exhaust fumes of petrol engines are *more polluting, less polluting, as polluting* than the ones emitted by diesel engines.

7 Rewrite the sentences using the words given, without changing the meaning.

⇨ Diesel engines pollute more than petrol ones (as) → *Petrol engines do not pollute as much as diesel ones.*

1. I've never seen such a fast car. (this)
2. Tom's bike is heavier than mine. (not)
3. In this race Ferrari is the fastest car of all. (than)
4. He is a terrible driver. I don't know anyone worse than him. (the)
5. Human beings get more tired and over-stressed than robots. (so)
6. Pollution rate has never been so high. (this)

LISTENING

ARTIFICIAL INTELLIGENCE

Once it was material for science fiction novels and futuristic movies, but Artificial Intelligence (AI) is now very real to us. From business applications to everyday life, we are almost unaware that many of us interact with AI every day. Almost 60% of organisations with Big Data solutions are using AI in some way. It is predicted that AI and machine learning will impact all segments of our daily lives by 2025, with huge implications for industries, ranging from transport and logistics to healthcare, home maintenance, and customer service.

You will hear an interview with a university professor about AI. He will answer questions about the following main topics:

1. What are intelligent agents and how are they used in AI?
2. What is TensorFlow and what is it used for?
3. What is machine learning and how does it relate to AI?
4. What are neural networks and how do they relate to AI?
5. What is deep learning and how does it relate to AI?
6. Why is image recognition a key function of AI?

1 (5.7) **PET** **Read the sentences, then listen to the professor and decide if each sentence is correct or incorrect: if it is correct, choose "YES", if it is not correct, choose "NO".**

	YES	NO
1. Intelligent agents are autonomous entities that use sensors and then use motivation to perform their tasks.	☐	☐
2. TensorFlow is an open-source software library originally developed by the Google Genius Team for use in machine learning and neural networks research.	☐	☐
3. TensorFlow makes it much easier to build certain AI features into applications, including natural language processing and speech recognition.	☐	☐
4. Machine learning is a subspace of AI.	☐	☐
5. So far machine learning is a theoretical application of AI.	☐	☐
6. Neural networks are a class of machine learning algorithms.	☐	☐
7. Neural networks pass data among themselves, gathering more and more meaning as the data move along.	☐	☐
8. Deep learning refers to using multi-layered neutral networks to process data in increasingly complex ways.	☐	☐
9. Deep learning enables the software to train itself to perform tasks like speech and image recognition through exposure to these vast amounts of data.	☐	☐
10. Teaching machines to recognise and categorise images is a trivial part of AI.	☐	☐

SPEAKING

EDUCATIONAL ROBOTS

2 PET **Practise a conversation using the following indications.**

One of your classmates, David Phillis, is going back to England at the end of the year. He is very keen on robotics: you want to give him a present. In couples, discuss the different options and then decide which present would be best. Use the information given for each object to help your discussion.

Remember it is a conversation between you and you partner: describe the pictures in detail, then discuss, explain, share opinions, agree and disagree. Always motivate your decisions and ask for suggestions.

Use phrases such as:

Making suggestions: What do you think of…? How about…? Why don't we…? Maybe we could…; It would be a good idea to (+base form) because…;

Agreeing: I think you're right because…; I agree with you because…; That's true because…; That's a good idea…; I totally agree with you…; I couldn't agree more…

Disagreeing: I'm afraid I don't agree with you because…; I'm not sure I agree with you because…; I'm sorry but I don't agree with you…; Maybe, but on the other hand…; I don't think so because…

Expressing your opinion: I think…/I believe…; From my point of view…; I think we should…;

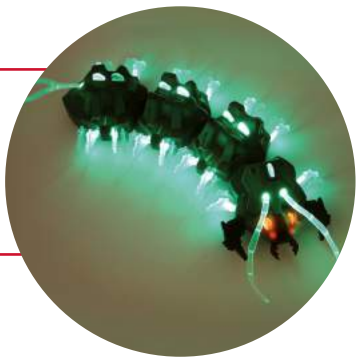
Asking your partner: How about you? Do you agree? What do you think?

A **Price 90,00 € -** Medium size Standard flying delta wing / Partially assembled (PNP) / Black moulded EPP foam structure / Multiple camera compatibility / Removable wings for easy transportation.

B **Price 85,00 €**
- Records video and takes photos / Displays footage right on your smartphone / Install the free app, available for Apple and Android devices, and start snapping still images and streaming video in real-time straight to your smartphone via the drone's built-in WiFi / Equipped with eight built-in LED lights, can fly safely even at night.

C **Price 60,00 € -** Meant to impart coding and robotics knowledge /The ant-like bot can navigate mazes and even fight with other units / Can be programmed using Scratch, Arduino IDE, and DFRobot's visual programming app WhenDo / Its thirty "neurons" make it capable of learning, similar to real living things.

D **Price 80,00 € -** Bright LED Eyes / Radio Controlled, Works up to 100 Feet / 4 Independent Body Segments, 28 independent animated legs for real insect movement.



E **Price 110,00 € -** With 5 different points of articulation and the ability to spin 360° in place, it can grasp, lift and carry nearly anything / Remotely control it from anywhere / With 6 all-terrain wheels it goes anywhere you want / Connected to your phone or tablet, it takes pictures or records videos to post and share online.

WRITING

DIESEL EMISSIONS

3 Read the text and analyse the two graphs showing the emissions of diesel engines. Write a passage about the main pollutants released by diesel engines using about 150 words.

What are diesel emissions?

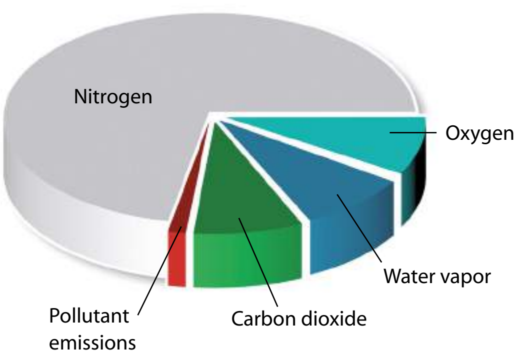
A diesel engine, like other internal combustion engines, converts chemical energy contained in the fuel into mechanical power. Diesel fuel is a mixture of hydrocarbons which – during an ideal combustion process – would produce only carbon dioxide (CO_2) and water vapour (H_2O). Actually, diesel exhaust gases are primarily composed of CO_2, H_2O and the unused portion of engine charge air (O_2).

Concentrations of these gases in diesel exhaust are usually in the following ranges:

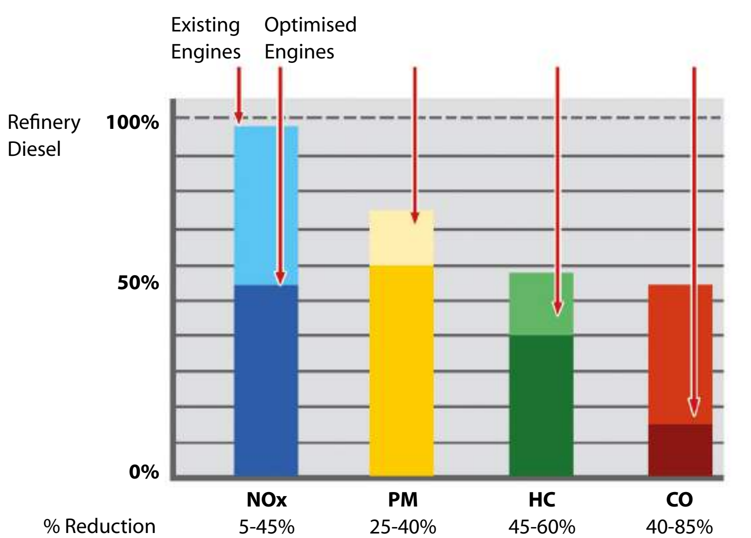
- CO_2 - 2 ⇨ 12%
- H_2O - 2 ⇨ 12%
- O_2 - 3 ⇨ 17%
- N_2 - balance

Diesel emissions also include pollutants that can have adverse health and/or environmental effects. Most of these pollutants originate from various non-ideal processes during combustion, such as incomplete combustion of fuel, reactions between mixture components under high temperature and pressure, combustion of engine lubricating oil and oil additives as well as combustion of non-hydrocarbon components of diesel fuel, such as sulfur compounds and fuel additives. Common pollutants include unburned hydrocarbons (HC), carbon monoxide (CO), nitrogen oxides (NO_x) or particulate matter (PM). "Near-zero" levels of pollutants are emitted from modern diesel engines equipped with emission after treatment devices such as NO_x reduction catalysts and particulate filters.

Relative Concentration of Pollutant Emissions in Diesel Exhaust Gas



Emissions benefits vary depending on vehicle type and technology level



There are other sources that can contribute to pollutant emissions from an internal combustion engine, usually in small concentrations, but in some cases containing material of high toxicity. These additional emissions can include metals and other compounds from engine wear or compounds emitted from emission control. Some fuel additives used to support the regeneration of diesel particulate filters, have been linked to emissions of highly toxic dioxins. The possibility of new emissions must be considered whenever additives, catalytic or not, are introduced into the fuel or lube oil and when fluids are introduced into the exhaust gas. Low quality fuels can be yet another source of emissions, for instance, residual fuels contain heavy metals and other compounds known for their adverse health and environmental effects.

ACTIVITIES

MECHATRONICS

Multidisciplinary field of science that includes a combination of mechanical engineering, electronics, computer engineering, telecommunications, systems and control engineering

AUTOMATION:
- Open loop control system
- Closed loop control system (feedback)

SENSORS: Analogue and digital sensors, visual sensors, tactile sensors, mechanical, electrical, magnetic and thermal, acoustic, ultrasonic, chemical, optical and radiation sensors

ROBOTICS

MAIN PARTS:
- Controller: computer program
- Drive: motor, electric, hydraulic, pneumatic
- Arm: segments, degrees of freedom
- End effector: tools, manipulates objects
- Sensors: information about environment and performed tasks

TYPES OF ROBOTS:
- Industrial robots: material handling, welding, assembly, dispensing, material removal, cobot
- Medicine/Labs: surgeries, handle hazardous materials
- Computer industry: assemble microchips
- Mobile robots (remote controlled non-autonomous / autonomous): insect-like robots, perform dangerous activities, military field, exploration rovers

ENGINES

RECIPROCATING INTERNAL COMBUSTION ENGINE - FUEL: PETROL/DIESEL

MAIN PARTS: Engine block, cylinder, piston, ring, connecting rod, crankshaft, camshaft, valve, manifold, fuel injector, turbocharger

4-STROKE CYCLE: Intake, compression, combustion, exhaust 4 cylinder movement = 2 crankshaft rotations.

2-STROKE Petrol Engine: Power cycle: two strokes. 2 cylinder movement. 1 crankshaft rotation. No intake/exhaust valve but intake/ exhaust ports, plus a transfer port

Petrol engine	vs	**Diesel engine**
Air/fuel mixture ignited by spark plug Compression ratio: from 8:1 to 12:1		Spontaneous combustion via injection pump. Compression ratio: from 14:1 to 25:1

ALTERNATIVE ENGINES

ELECTRIC VEHICLE (EV)
Electric motor ➛ fixed stator and turning rotor: electromagnets with reversed polarities + battery pack and controller

FUEL CELL VEHICLE (FCV)
Fuel cell stack: hydrogen reacts with oxygen and produces electricity to run the electric motor

PLUG-IN HYBRID VEHICLE (PHEV)
petrol/diesel + electric motor
Short distances on electricity, long distances on liquid fuel ➛ less pollution

CONVENTIONAL HYBRID VEHICLE
Like PHEV but cannot be plugged in

COMPRESSED NATURAL GAS VEHICLE (CNG)
spark ignited combustion engine fuel: either compressed or liquefied natural gas, reduced greenhouse gas emissions

FILM

THE BLUES BROTHERS

- PRODUCERS: Robert K. Weiss – Universal Pictures,1980
- DIRECTOR: John Landis
- WRITERS: Dan Aykroyd, John Landis
- CAST: John Belushi ("Joliet" Jake Blues), Dan Aykroyd (Elwood Blues), James Brown (Rev. Cleophus James), Cab Calloway (Curtis), Ray Charles (Ray), Aretha Franklin (Mrs Murphy), Carrie Fisher (Mystery Woman)
- FILMING LOCATIONS: Chicago

battered: *malconcio, malandato*
to be into: *essere molto interessato*
to dandify: *vestire da damerino*
fearsome: *spaventoso*
jeopardy: *rischio*
junkyard: *discarica*
mildly: *in modo gentile*
overpass: *cavalcavia*
pileup: *tamponamento a catena*
run-in: *discussione, litigio*
wasteful: *dispendioso, che comporta sprechi*
weird: *strano*
yell: *urlo*

A SYNOPSYS

Jake Blues is released from prison after serving three years, and is picked up by his brother Elwood in his Bluesmobile, a battered former police car. The brothers visit the Roman Catholic orphanage where they were raised, and learn from Sister Mary Stigmata that it will be closed unless $5,000 in property taxes is collected. During a sermon at the Triple Rock Baptist church, Jake has an epiphany: they can re-form their band, the Blues Brothers, which disbanded while Jake was in prison, and raise the money to save the orphanage. Jake and Elwood begin tracking down members of the band who join the band again with the hope of raising the necessary money with a single big show. Before the show can take place, a series of incredible actions follow, involving Chicago Police, a group of Nazis, state troopers, SWAT teams, firefighters and Military Police.

BEFORE VIEWING

1 Choose the correct word.

A Cult Film

The Blues Brothers is a 1980 American musical comedy film (1) ***conducted/directed/guided*** by John Landis. It is a kind of counterculture rebel-yell (2) ***against/across/through*** the rising tide of late-70s conformity. The Brothers' (3) ***dress/uniform/gown*** of dark suits, hats and Ray-Ban Wayfarer sunglasses quickly came to symbolise a (4) ***question/challenge/protest*** against the dandified disco aesthetic. The film includes one of the best car chases in (5) ***period/history/time***. It was the first movie to actually destroy a shopping (6) ***cloister/gallery/mall***, and the first to film on location in the city of Chicago. And then, of course, there was the music, better music (7) ***than/then/that*** any film had had for many years. The Blues Brothers wasn't much liked (8) ***while/when/after*** first released. It was too long, too expensive, too wasteful. Besides, everyone was into disco and didn't want to hear from John Lee Hooker, James Brown, Aretha Franklin, Ray Charles or Cab Galloway. In spite of all (9) ***criticisms/reviews/estimations***, the film is recognised now as more than a cult classic. By 2013, it had taken more than £70 million in (10) ***carton/box/pack*** office and DVD receipts and stands as one of Landis's finest films.

2 **Read Elwood's introduction to The Blues Brothers' final show and complete with the given words.**

enjoy • join • lovely • matter • representatives • survive • them • time

Elwood: We're so glad to see so many of you (**1**) .... people here tonight and we would especially like to welcome all the (**2**) .... of Illinois law enforcement community who have chosen to (**3**) .... us here in the Palace Hotel ballroom at this (**4**) .... We do sincerely hope you'll all (**5**) .... the show and please remember people, that no (**6**) .... who you are and what you do to live, thrive and (**7**) ...., there're still some things that make us all the same. You, me, (**8**) ...., everybody, everybody.

WHILE VIEWING

3 **Watch the video clip and underline the words you hear.**

affair • auction • bargain • bore • Bluesmobile • Cadillac • converters • cop • engine • jail
microphone • motor • machine • police • practical • prison • radio • spring • suspensions • winter

4 **Watch the video again and answer the questions.**

1. What did Elwood trade the Cadillac for?
2. Where did Elwood buy the "new" Bluesmobile?
3. When did he buy it?
4. Did Jake like the car at first?
5. What are the car "cop" parts that Elwood mentions?

AFTER VIEWING

5 **Here is a review written by Rogert Ebert when the film was first released in the USA. Write a short summary of the film review. Use about 100 words.**

"This is some weird movie. There has never been anything that looked quite like it; was it dreamed up in a junkyard?
It stars John Belushi and Dan Aykroyd as the Blues Brothers, Jake and Elwood, characters who were created on "Saturday Night Live" (*NBC variety series*) and took on a fearsome life of their own.
The movie's plot is a simple one, to put it mildly. The brothers visit their old orphanage, learn that its future is in jeopardy because of five thousand dollars due in back taxes, and determine to raise the money by getting their old band together and putting on a show. Their odyssey to find their old friends takes them to unlikely places, like a restaurant run by Aretha Franklin, a music shop run by Ray Charles, and a gospel church run by James Brown.
Their adventures include run-ins with suburban cops, good ol' boys, and Nazis who are trying to stage a demonstration. One of the intriguing things about this movie is the way it borrows so freely and literally from news events. The plot develops into a sort of musical, with the Blues Brothers being pursued at the same time by avenging cops, Nazis, and an enraged country and western band. The chase is interrupted from time to time for musical numbers, which are mostly very good and filled with high-powered energy: Aretha Franklin occupies one of the movie's best scenes, in her South Side soul food restaurant.
The fact is, the whole movie is a chase, with Jake and Elwood piloting a used police car that seems to have a life of its own. There are incredible, sensational chase sequences under the elevated train tracks, on overpasses, in subway tunnels. One crash in particular, a pileup involving maybe a dozen police cars, has to be seen to be believed: I have never seen stunt coordination like this before. What's a little startling about this movie is that all of this works!"

Adapted from: //www.rogerebert.com/reviews/the-blues-brothers-1980

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MechPower è rivolto in particolare agli studenti dei corsi a indirizzo **Meccanica**, **Meccatronica**, **Energia** e, in generale, a coloro che hanno l'esigenza di utilizzare la lingua inglese come strumento di studio e/o di lavoro in questi settori.

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