INTEGRATED SCIENCE 1

# GOING BY CAR

## Teacher´s book

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MASARYK UNIVERSITY
FACULTY OF EDUCATION

INTEGRATED SCIENCE 1

# GOING BY CAR

## Teacher´s book

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# Introduction

Vážené kolegyně a vážení kolegové,

otevíráte knihu „Going by car“, která je anglickou variantu textu „Jezdíme autem“. Tento text jsme vydali jako první z řady integrovaně zpracovaných přírodovědných témat. Text **„Going by car“** byl přeložen českými překladatelkami a následně byl velmi detailně revidován rodilou mluvčí, paní Cynthií Miles z USA. I díky její pečlivé práci a mnoha konzultacím s překladatelkami si myslíme, že výsledek překladu je kvalitní a i rodilý anglicky mluvící učitel přírodních věd by textu rozuměl.

Anglickou verzí textu bychom chtěli posílit užívání cizího – anglického – jazyka učiteli přírodovědných oborů a jejich prostřednictvím tak působit i na žáky ve školách. Součástí tohoto textu je i slovníček méně obvyklých anglických termínů z oblasti přírodních věd. Na přiloženém CD najdete originální českou verzi tématu „Jezdíme autem“.

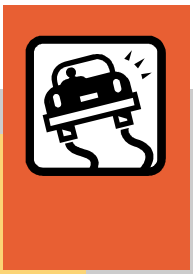
**„Going by car“** je již sedmým z integrovaně zpracovaných přírodovědných témat. Kromě zmiňovaného **„Jezdíme autem“** byly zpracování texty **„Domácnost - svět v malém“, „ Město a venkov“, „Počasí a podnebí“, Šaty dělají člověka“ a „Robinsonem dnes aneb jak si poradíme, když…“** .

V autorském týmu podílejícím se na zpracování výše uvedených témat jsou zastoupeni geografové, fyzici, chemici a biologové. Ti se pokusili o společný syntetizující pohled na každé z nich. Práce lidí, tisk, workshopy a další nutné aktivity byly financovány ESF projektem s názvem „Syntézou poznatků přírodních věd k rozvoji klíčových kompetencí učitelů s důrazem na realizaci kurikulární reformy“.

Jménem autorského i překladatelského týmu Vám přejeme, aby Vám text přinesl zajímavé informace, rozšířil Vaši anglickou slovní zásobu v oblasti přírodních věd a ukázal na možnosti užití anglického jazyka i v dalších předmětech na základní a střední škole.

Za autorský tým

Hana Svatoňová a Irena Plucková



# Content

# The Human World and Transport

*We travel by car. The car is our companion. Are you wondering why man constantly relocates? What his reasons are? What the meaning of the word barriers is, and if it is possible for us to overcome them? How everything relates? We are inviting you to consult this textbook to find the answers to the above questions, and, hopefully, to many others.*

Cars are everywhere. They have changed man and his behaviour, changed to a certain extent our landscape and have influenced the urban structure. Cars and everything which is connected with them are part of our everyday lives. How can we cope better with this broad issue? We need to get properly acquainted with the situation to be able to derive benefits from it later, and to minimize the adverse circumstances of its impact. An understanding of the context and the diverse aspects connected with it will enable us to predict these influences in future. This can contribute to a safe, healthy and happy life. Man is the only living being who consciously uses various means of transport. By using them he saves energy, which contributes to the immense growth of civilization. He can devote his time to other sophisticated activities and their development, as well as to getting to know his surroundings.

With the development of a post-modern society the importance of transport is steadily growing. Transport is one of the basic needs of humanity, especially due to potential variations in the terrain of the different countries of the world. People usually don't find all the things they need for life where they live, and, therefore, they are forced to move their material possessions and themselves.

*Example of appropriately located parking place in the centre of Brno*

The pace of life is speeding up, and that is why transport is speeding up as well. This is the main characteristic of contemporary development in the world. People continue to have a greater need for moving from one place to another, carrying loads and transferring information, while the distances are still getting longer and longer.

Further text deals particularly with **personal road transport.**

At present transport is also included among the core sectors of the economy. The current trend is to overcome the barriers of space in the shortest possible time. Barriers of space can be understood as physical obstacles (for example, distance and topography) or social obstacles (employment, trade, services). The word barrier in the context of road transport represents a new solution (see, for example, the development of the motorway network in the Czech Republic). Transport development is linked to important aspects of human society. These aspects are primarily social in nature, and are caused by the needs and desires of people to meet their everyday needs. For this reason, transport may have many meanings, of which the most important are the transportation of people and goods and the transfer of information.

Transport activity determines the spatial distribution of other human activities, while allowing their concentration in a small area (for example, on the roof of the Vaňkovka Mall). It unites sectors of the national economy, in particular, and ensures they are complementary by providing raw materials, products, food and labour. Transport also connects regions with different requirements for people's lives and their activities. In addition, it helps to develop cross-border cooperation within Euro regions, whose existence is dependent on the accessibility and penetrability of national borders.

## LEARNING ACTIVITIES

1 “DRIVING A CAR” brainstorming – methodological sheet

2 “DRIVING A CAR” mind map – methodological sheet

3a Distinguishing signs – Are you well acquainted with them?

3b Distinguishing signs – Are you well acquainted with them? – worksheet

4a License plates – Are you well acquainted with them?

4b License plates – Are you well acquainted with them? – worksheet

## THINK ABOUT

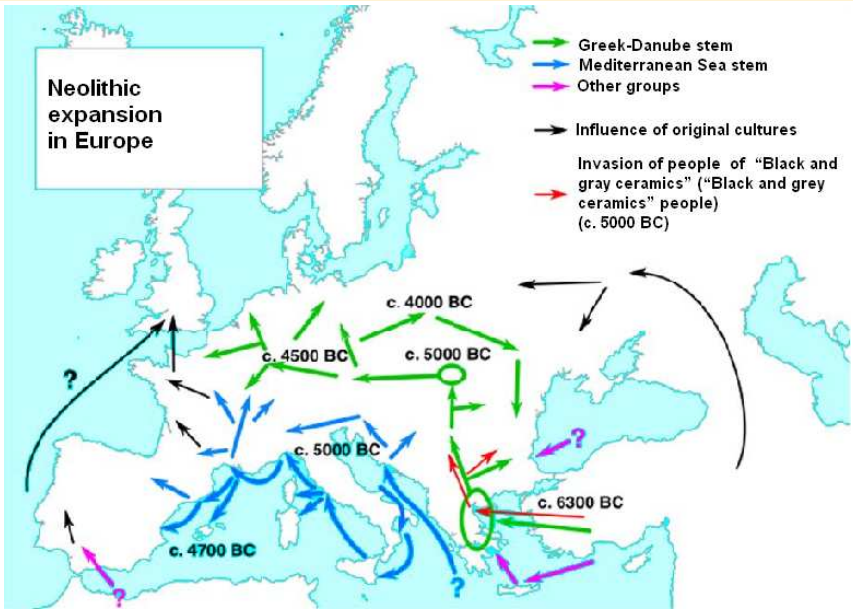
Try to think about the economic impacts of transportation. Illustrate both the positive and negative impacts of transportation on a countries economy.

# History of Transportation

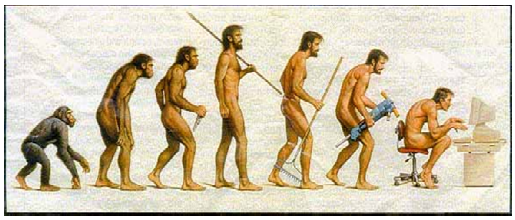
*Wondering which type of transportation is the oldest one? How many kilometers we cover in the course of our lives? What was the greatest discovery in transport? Did a gunpowder car ever exist? From what word is the Czech word for petrol "benzin" derived? The following text, among others, answers these questions.*

## FIRST ON FOOT … LATER BY CARRIAGE

People have been living on the earth for many, many years and throughout this long period, they have been forced to move from one place to another and to transport different belongings. From transport requiring only their muscles, people gradually moved towards transport based on an external source of energy – horse power. During the modern period, horse power has gradually been replaced by steam engines and engines powered by electricity – motor vehicles. From simple carrying of loads, through skid traction, people reached an epoch-making discovery – the discovery of the wheel. The wheel is still the fundamental element of transport. One hundred years ago, at the beginning of the 20th century, the classic car structure became set: motor, gear lever, car chassis, electronic ignition system, steering wheel and bodywork. This structure persists, with some minor modifications, to the present.




*Neolithic expansion in Europe (source: www.wikipedia.cz)*



*Human development*

## ON FOOT

"On foot" is the oldest type of transport of all. It has lasted more than 3 million years. Our ancestor – Homo sapiens sapiens, who originated in Africa, set off on long and significant journeys. He migrated first to Europe, then to Asia and at last to America. Neanderthal man migrated in winter to warmer areas of Southern Europe where he could more easily survive those ice age winters. On the other hand, in summers he hunted in the northern areas of Europe and in the shelf areas of the North Sea, which were dry lands during those times. Even today a human covers a distance of approximately 40 thousand kilometers during his life time – it is equal to a walk around the earth's equator.

## SKID

It is not difficult to imagine this way of transport in old the days (the same system was used by the American Indians prior to the arrival of the first Europeans): loads were carried on the back or head and heavier ones were carried with the help of a simple mechanism called the skid.

# History of Transportation

## THE WHEEL

The first, and if not downright epochal, contribution to the improvement of transport was invented around 3500 BC. It was the wheel (believed to have been invented by the Sumerians and Assyrians). It is necessary to realize that an inventor often "imitates" nature, i.e. improves on what he sees around him. But the case of the wheel is different. No living being is born using the wheel for movement. Therefore, we are talking about the most original, significant invention of all time, which was not known throughout the world until the modern period (neither American Indians, nor the Aborigines were not aware of its existence). Wheels were primarily carved out of tree trunks. However, the primitive carriages with these massive wooden wheels were too heavy for a drive on soft roads. Later, around 1500 BC, two-wheeled carriages appeared. They were much lighter and were made chiefly for warfare purposes, and were equipped with wheel rims and iron tyres (these were put on in a molten condition, so that after cooling, they firmly grasped the wheel). Carriages at that time were used for transferring goods and for warfare (battering rams, etc.).

*Wheel from the National Museum of Iran, around 2000 BC*

*One of the oldest paintings illustrating the use of wheels by the Assyrians around 4000 BC*

It is known from our history that during the Hussite Wars war wagons were used to protect moderately armoured foot soldiers, so they were equal adversaries to armoured knights on horseback.

*The Hussite Corral*

Throughout the centuries, horses, donkeys, their crossbreeds (mules), camels (domesticated about 1000 years later) and oxen were the only "motors", powering carriages, wagons and simple agricultural machines. During modern times, their power has gradually been replaced by steam and internal- combustion engines, and engines powered by electricity – motor vehicles.

## ON HORSE

At roughly the same time that the wheel was invented, people reached another important step in the development of transport – the domestication of horses. Thanks to natural selection and patient breeding work, a number of saddle and draught horses were bred from the Tarpan horse. The young generation today can hardly realize how important this beautiful, steady and intelligent animal was to man. Horse-drawn carriages conveyed newborn babies to baptisms, as well as the dead to cemeteries (in some cultures horses were buried with their masters). Horses worked hard in the cultivation of the land, carried goods and even decided battles. The discoverers of new lands couldn't get along without them –consider the role horses played during the colonization of North and South America. The local inhabitants (the Indians) didn't know about horses until then because due to unexplained circumstances their ancestors had died out long ago. For that reason, the Indians considered a man sitting on a horse as a divine being, and they were afraid of him. But when they had a chance to get to know the nature and character of a horse, they became its biggest admirers. Luckily, in these times horses returned to the Czech countryside – isn't the most beautiful view of the world from a horse's back?

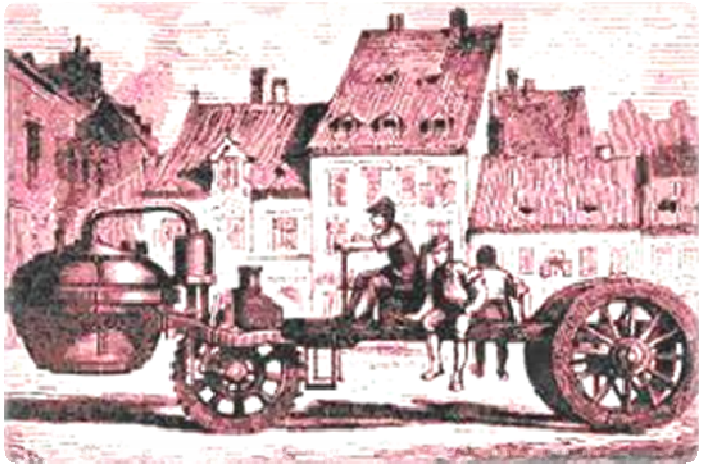
The importance of horses is reflected in how a unit of power is measured: 1 h. p. - horse power = 735, 8 W.

# History of Transportation

## WITH AN ENGINE

The propulsion of a motor vehicle is provided by an engine which is located in the vehicle. The development of motor vehicles began at the end of the 19th century in a period called the Industrial Revolution. We can divide them into single-track vehicles, two-track vehicles and three-track vehicles (three-wheelers), or into road vehicles, track vehicles and off-road vehicles. The most widespread motor vehicle nowadays is the automobile (Latin = self-propelled vehicle).

*Daimler vehicle - wheeled vehicle powered by gas or oil engine which was located under the seat and between the back axles.*



*In 1769 Nicholas Joseph Cugnot (France) constructed a steam powered three-wheeler whose speed was approximately 3 km/hr. A former Minister of War decided to provide financial support for its further development. The new, more powerful steam vehicle went out of control during the demonstration run and that was the moment of the first recorded transport accident.*

The 19th century is also called the Century of Steam. This period was significant due to the construction of more and more capable and high-efficiency steam engines. The steam engine certainly has its advantages, but there is also one big disadvantage: if the fire is extinguished you can't restart the engine right away. First the boiler, which is filled with water, must be fired up, and then the water must be kept at the boiling-point all day long, even though the automobile is parked. This handicap was solved with the invention of other engines which were not powered by steam.

In 1800 Medhurst from Britain took out a patent for a compressed-air vehicle, and in 1802 Isaac de Rivaz from Switzerland took out a patent for a rocket propulsion vehicle (gunpowder was used). In 1835 Stratingh from The Netherlands invented the first electromobile. In 1860 Jean Lenoir from Belgium invented the two-stroke internal-combustion engine with coal-gas as a fuel. But he didn't reach a speed higher than 6 km/hr. In 1864 Marcus from Austria constructed a water-cooled engine powered by oil steam which already had an electromagnetic ignition and a manual gear. In 1885 Gottlieb Daimler and Carl Benz, independent of each other, took out patents for internal-combustion engine vehicles. Read more about this in the chapter “How the car operates”.

*Benz's three-wheeled carriage powered by petrol.*

## WEB LINKS:

www.rsd.cz
www.silnice-dalnice.cz
www.ceskedalnice.cz

# History of Transportation

## HISTORY OF THE TRANSPORT IN THE CZECH REPUBLIC

With a certain sense of national pride we might declare that the Czech Republic plays and has played an important role in the field of automobile manufacturing (especially with regard to our country's size ). At the turn of the 19th and the 20th centuries, three motor car companies were in existence in the Czech Republic when automobile manufacturing began: Laurin and Klement (later Škoda), Praga and Kopřivnická Tatra. Tatraplan became a renowned car because Hanzelka and Zikmund set off on several successful journeys around the world using it.

*The car nearly becomes a member of a family. An annual contest is held to bring the most beautiful car of the year to light. The winner proclaimed the most beautiful car in the history was the Citroen DC.*

German inventors, Daimler and Benz, were at first competitors in the automobile industry, but in 1926 they joined forces and established a new motor car company: Daimler-Benz. The Czech word for petrol "benzín" is derived from the surname of one of these two inventors- Benz.

And what about the name of the high quality car "Mercedes-Benz"? This is another reminder of this famous car maker. The beginning of the 20th century was distinguished by substantial progress in the automobile industry. Many car companies were established at that time. Among these, for instance, we can name Benz, Peugeot, Renault and Fiat. In the Czech lands, which were at that time integrated into Austria-Hungary, a new outstanding motor car company was established: Laurin and Klement (later Škoda), Praga and Tatra Kopřivnice. The turning point in the automobile industry was the introduction of the mass production system at Ford's factories (USA). One of the best known cars was the Ford Model T (1908). It was at that time when the classic car structure became set: motor, gear lever, car chassis, electronic ignition system, steering wheel and bodywork. This structure persists, with some minor modifications, to the present.


*Ford Model T*

*President*




*Jiří Hanzelka and Miroslav Zikmund with their Tatra in South Africa*

In the interwar period and particularly after the Second World War, the personal motor car became one of the most important factors that have ever influenced mankind.

## LEARNING ACTIVITIES:

5 Time line – worksheet

6 Crossword - worksheet

## THINK ABOUT :

During the last decades, significant automobile manufacturers (especially the Asians) joined the traditional companies in the automobile market. Think of these causes of this change.

Analyze the significant events from the text which occurred in the development of cars.

Draw up their time sequence.

# Roads and Bridges

*Wondering how roads are built? Which roads were built first, and why? What the parts of the technical infrastructure of road construction are? Which is the longest road tunnel in the world? What is the oldest motorway in the Czech Republic and how these roads develop over time?*

A lot of the trodden paths of our ancestors have vanished, but a few of them have survived. Roads have always connected man with his places of interest, and over the centuries they have been adapted to his needs. People have always looked for the least difficult routes, secure and rapid, often along streams, or over mountain passes and saddles. With the increasing need to save energy and time, people have developed more modern means of transport. This has led to the building of more necessary technical facilities (terminals, security and information facilities). Bridges and tunnels have been built to overcome natural obstacles. Roads and other areas with their necessary technical facilities occupy large spaces in densely populated and developed parts of the world.

## ROADS

When a car goes through the factory doors and starts operating, it finds itself on a road; although off-road vehicles actually don't need roads. The construction of quality and safe roads is another contribution toward saving time and energy, not to mention safety. The saving of time, energy and safety are under the control of planning, construction, reconstruction and the maintenance of roads. The present standard of roads is paved roads. Paved roads have been built from the earliest times, but it was the Romans who started to build them to a greater extend outside the city. We are talking about roads paved with stone, sometimes covered with concrete. In the mid-19$^{th}$ century, asphalt roads began to appear (first in Paris, the asphalt was imported from Albania). The big boom in the construction of asphalt roads was connected with the development of the chemical industry built on petroleum production (petrochemical industry - petros = rock) in the first half of the 20$^{th}$ century, and especially with the rise of the car culture after World War II. Social and economic changes contributed to the situation in the world: a rise in living standards (people earned enough money not only to eat and live well, but to be able to buy a car - mass production of cheap cars gradually expanded worldwide); more free time (road trips); an increase in mobility (people became more interested in exploring their surroundings outside their local area - books, newspapers, magazines, TV and radio were no longer enough, and they wanted to see things with their own eyes) - and all of that along, with a considerable savings of their own time and energy (this was not possible when using public transport because it was sometimes unreliable - humans had just acquired an increased sense of individuality and autonomy). Thus cars and roads provided access for ordinary people to many parts of the world with all the attendant positive and negative consequences.

Massive development of the car industry called for the need for regulation of transportation and availability. Traffic rules and other necessary regulations were enacted to reduce traffic problems. The need for safer traffic touched not only the cars and roads, but also the creation of rules and constraints, such as speed limits, no entry areas or the use of certain car equipment (e.g. horn). Ensuring the safety and the flow of traffic necessitated the reconstruction of existing roads, and the construction of new ones which could carry more vehicles and which had a quality surface, so that the vehicles could move faster, and many other aspects which improved the situation on roads. Motorway construction began – roads were designed for fast vehicles – cars, motorbikes and buses.

# Roads and Bridges

The first motorways were built in Italy in the '20s of the 20th century. The U.S.A. Germany and Czechoslovakia began construction projects in the '30s. After World War II, people started building motorway networks in most countries of the world. Both old and new network of roads, which were accessible to other road vehicles (bicycles, carts, tractors) were linked to the motorway network. The road became an integral part of the landscape. Road transport infrastructure, facilities and other elements of transport networks occupy a substantial part of geographical areas (transport areas - motorways, high-speed roads and roads, but also all of the technical facilities - bridges, slip-roads, tunnels, viaducts, wildlife crossings *(ecoducts)*, etc.). Since the '80s, when building a new transport infrastructure, the emphasis has been placed on costs of construction, transport costs and fast shipment. Modern approaches to new construction also take into account environmental and technical requirements.

## HISTORY

The oldest news about the roads comes from Egypt (3000 BC) and from China (2000 BC). The Egyptians built their roads of flat, glazed stone blocks to be able to transport material needed for the construction of the pyramids. In Europe it was the Greeks, in particular, who paved paths. The first significant stage of the development of road transport dates back to Roman times. During this period the Romans managed to build 150,000km of roadways. The Romans constructed the roads in order to build, administer and maintain their empire. The road network of the Roman Empire was the highest quality not only in ancient times. Today a lot of places in the world still do not have as good a network of roads as did the former Roman Empire. The Romans were also particular about a well organized transport system - well-known, for example, is Julius Caesar's regulation on the prohibition of heavy vehicles on the roads in urban areas at night due to the loud noise. The most famous Roman road which has survived until the present time is the road called Via Appia. With the disintegration of large slave empires and the coming of the feudal society, business was on the brink of decline, and that was why road transport was lost its importance - stagnation in the construction of the road network. And the invention of the steam engine and railway construction were the causes of the further decline in road transport. With the birth of the car industry (Henry Ford, 1903) an important new stage in the development of road transport took place in the early 20th century, and this tendency still persists.

**Via Appia, Roman**

Via Appia was the most important road in the Roman Empire. Its construction began in 312 BC under censor Appius Claudius Caecus. The road bears his name. Via Appia began behind the city walls of Rome at the Porta San Sebastiano town gate and stretched 195km towards the city of Capua in Campania. It served as a supply artery for the army in the fight against the Samnites. Later it was extended to the port Bundisia, where the 15m columns stand to signal the end the road.

## ROADS IN THE CZECH LANDS

In the second half of the 18th century the construction of road networks were initiated in Bohemia. In mid 1746 Maria Theresa decided that the construction of roads should resume. The construction was interrupted by the death of Emperor Charles VI. and the subsequent wars. At the end of 1751, an inventory of main roads was drawn up and in 1752 the construction of other motorway sections was started. In the mid-19th century, a total of 23 state roads and 372 district roads were registered in Moravia and in Silesia . The massive development of road transport and the ensuing development of the road and motorway network necessitated the rehabilitation of the road infrastructure in Czechoslovakia in 1918. State financial support was required. Before the division of Czechoslovakia in 1992, the total length of motorways was 550 km and the length of Class I., II. and III. roads was 73,000 km - in the Czech Republic itself, there were 380 km of motorways and 55,500 km of roads. Towards the end of 1997 there was a total of 480 km of motorways and 55,080 km of roads in operation, and approximately the same number of local roads- 6,460 km of Class I. roads, 14,270 km of Class II. roads and 34,350 km of Class III. roads. The road and motorway network in 2009 amounts to 691 km of motorways, 360 km of high-speed roads, 5,850 km of Class I. roads, 14, 592 km of Class II. roads and 34,161 km of Class III. roads and other roads.

***1910***

***1962***

***2009***

*Videňská street in Brno - the main road to Wienna*

# Roads and Bridges

## MOTORWAYS

*What is the story regarding motorways?*

*Motorway pillar near the Brno Dam*

*Railway overpass of Hitler's motorway near Velké Opatovice*

### "HITLER'S MOTORWAY"

The directive for the construction of a motorway across the former Czechoslovakia first appeared in 1938 in Adolf Hitler's instructions addressed to Foreign Secretary Joachim von Ribbentrop. The reason was the to create a direct connection between the economically significant town of Breslau (now Wroclaw – Poland) situated in the German part of Silesia, and Vienna, which happened to be part of Germany after it had annexed Austria. Motorway construction continued until 1942. Many kilometres of Hitler's motorway have been overgrown with trees and numerous motorway segments were ploughed under. Some of the technical facilities and segments which were finished are well-preserved even today.

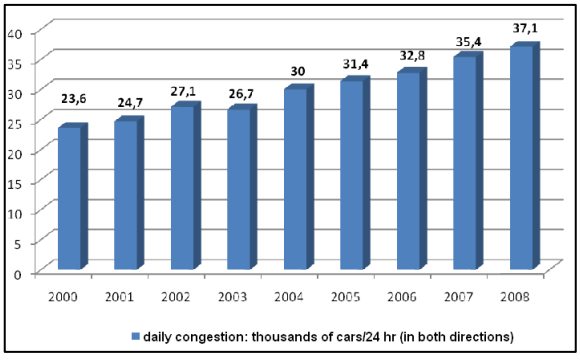
*Unfinished part of the motorway bank in Brno-Bystrc*

## FROM PRAGUE TO BRNO

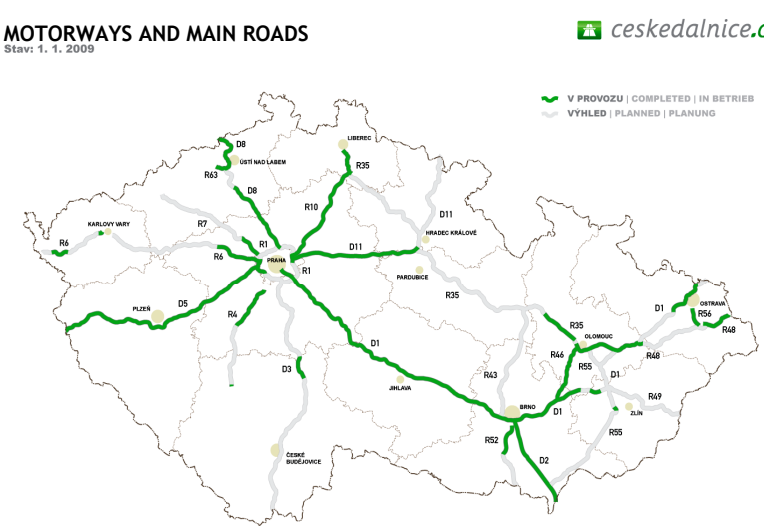
The oldest motorway in the Czech Republic, which is currently in operation, is the D1 motorway. The construction of the D1 motorway had been approved in 1938. The original intention was to connect Prague with Sub-Carpathian Russia. But it was not until 1963 that the government made the decision to begin building motorways in Czechoslovakia. The original project no longer matched the requirements, so that a new project was developed. The first segment of the motorway network, 21 km long, opened in the 12th of July 1971. But it took until 1980 before the whole D1 motorway, stretching from Prague to Brno, was finally finished. The D1 motorway was connected to the D2 motorway which ran from Brno to Bratislava in Slovakia. Nowadays the D1 (segment Prague – Brno) is a part of the Pan-European Corridor – Berlin/Nuremberg-Prague-Bratislava-Budapest-Constanta/Thesaloniki/ Istanbul. After its completion, a part of the motorway will also become part of a significant European route stretching from Poland to the south of Europe and from west to east. The current D1 motorway is 377 km long (298 km in operation, 79 km in preparation). Its maximum altitude is 655 m above sea level (at the 104km point) and minimum altitude is 198 m above sea level (at the 307km point).


*D1 motorway near Brno*

The Czech Republic in 2009 possesses 690,532 km of motorways and plans further extensions in the future.




*Transport congestion on the D1 motorway, segment Brno-Slatina as far as the Brno exits.*




*Motorways and main roads Czech Republic: 1st of January, 2009*

# Roads and Bridges

## WEB LINKS:

www.infoglobe.cz/zajimavosti/gotthardsky-tunel/

www.rsd.cz

www.ceskedalnice.cz

## BRIDGES *

Road infrastructure is consists not only of roads, but also of other significant structures: bridges, tunnels, overpasses, underpasses, water-conduit bridges, wildlife crossings etc. You can see some unusual transport constructions in the landscape which are also part of the road infrastructure. We are talking about types of bridges, for example water-conduit bridges, wildlife crossing, which meet the requirements for traffic safety.

***A Bridge*** - a structure built to span some natural or man-made obstacle – a body of water (river, stream, sea, lake etc.) or terrain obstacle (valley, gorges, gills etc.). There are even drawbridges that are used to span different levels. The first bridges were probably some primitive stone footbridges. Advances in technology enabled the construction of wooden bridges (eventually with stone pillars) or rope bridges (Inca civilization). The Romans knew about the arch, so that they could build stone bridges. But today we can build not only stone bridges, but also cable-supported steel bridges.

**Golden Gate Bridge**

The Golden Gate, located in San Francisco, is one of the longest suspension bridges in the world. Its overall length is 2737m and its span length is 1280m. After four years of work, the bridge-opening celebration was held on May 27, 1937. The project cost more than $35 million and was financed by bonds (in 2003 dollars its construction would cost approximately $1, 2 billion. The bridge is painted orange vermilion because it provides enhanced visibility for passing ships because of the frequent fog. More than 120,000 cars cross the bridge every day. It is the most photographed bridge in the world and, in addition, it is considered the most sought-after place to commit suicide. (According to statistics, more than 1200 people have jumped off the bridge and committed suicide.)

## TUNNELS *

***A tunnel*** - an underground passageway which stretches under a topographical elevation, sea, river or a city. It is used for road traffic, rail traffic or for pedestrians. The first tunnel was built in 1670 – this 158m long tunnel was excavated through a hill of solid rock near Beziers in France. Development of the railways hastened the construction on tunnels in the 19th century.

**Lærdal Tunnel**

Lærdal Tunnel, with its 24.5 km, is currently the longest road tunnel in the world, thus surpassing the St. Gotthard Road Tunnel in the Alps which is only 16.7 km long. Using this tunnel, unlike other mountain roads in Norway, is toll-free. (Norway, due to its oilfields, is among the wealthiest countries in the world.) Nowadays we can observe a cautious attitude in society regarding long tunnels, because everyone is aware of the recent catastrophe when 39 people died in the tunnel under Mont Blanc Mountain caused by a truck fire. The design of the tunnel takes into consideration mental strain on drivers, so that the tunnel is divided into four sections separated by three large mountain caves.


## THINK ABOUT:

Try to explain with your own words the types of roads in the Czech Republic and give an example on the map.

What are the main reasons to span natural obstacles?

Find out where the motorways and main roads in the Czech Republic are in located.

Explain why the transport congestion has increased on the D1 motorway.

# The Landscape* and Cars

*What is the relationship of road transport to landscape? What obstacles does man have to surmount to build the necessary road transport infrastructure? Does road transport only influence the environment in a negative way? Is it possible to build a sustainable road transport system?*

Since the earliest times, transport has had a strong impact on both coastal and mainland areas. Transport has called for the earmarking of suitable portions of the surface for the construction of transport arteries, transhipment stations, storages and other facilities which assist transport to overcome various obstacles (mountains, rivers, waterlogged areas, huge waves, steep and unstable slopes, avalanche areas, etc.).

Urban areas have had to be adapted to cars as well. Cars, if they aren't in motion, need large parking areas, traffic stoplights and petrol stations. Other cars need to be repaired, washed, or to be protected against climatic conditions. Garages, parking lots, emergency stopping lanes, petrol stations, service stations, car wash facilities, and car ports occupy space not only within the urban areas, but also the areas on their outskirts. Because of this large demand for space, some human activities have been removed from urban areas and have been relocated close to road and motorway junctions. We are talking about shopping centres *"parking lots" the locations where people* change means of public transport (*Czech abbreviation - MHD)*, petrol stations and car wash facilities. The need for economy of space has led to the construction of underground garages and multi-storey car parks. In combination with assuring greater safety, faster transport, overcoming obstacles more easily, but also with the need for economy of space, the road transportation system has led to the construction of tunnels, bridges and many scaffold bridges.

Road transport, as well as other kinds of industrial activities, negatively influences the environment during all stages of its existence (manufacturing, operation and recycling). That is why we are searching for comprehensive approaches whose effort is to minimize this negatively adduced evidence. Society oversees communication networks, passes laws regulating toxic substances and pollution levels and, with the help of road signs, regulates traffic. Manufacturing in car factories is strictly regulated so that no pollutants should escape into the environment. Waste sediments dumped from strainers and cleaners are reduced by means of environmentally-friendly technologies. In addition drivers attempt to use road transport rationally and to respect the rules for safe driving.

High energy consumption, significant adverse effects on the environment and small numbers of passengers per vehicle are among the frequently mentioned disadvantages of road transport.

*Tunnel construction in Troy, Prague.*

## ENVIRONMENTAL RELATIONSHIPS

Let's consider the positive and negative impacts of road transport. The positive ones particularly include the social benefits which are related to personal transport guaranteeing comfort, and, on the other hand goods transport guaranteeing the necessary functioning of economic activities. Construction of by-pass roads also has a positive influence on reducing pressure on transit areas.

**Social Benefits (internal and external)**

**Internal benefits**
(transport benefits for users)
- saving time
- quality improvement
- reducing transportation costs

**External benefits**
(benefits outside the transport system)
- saving time
- quality improvement
- reducing transportation costs

**Financial external benefits**
(benefits (*produce by the market*))
Lower costs in transportation lead to:
- development of employment market lives,
- development of product market
- flow of investments
- improvement of image and trust
- *free access to destinations*
- reduction in hospital costs

**Technological external benefits**
(benefits (*not produced by the market*))
For example:
- faster medical help can save reduce suffering, or can lead to less serious consequences

*Social benefits of transport (source: ECMT)*

# The Landscape and Cars

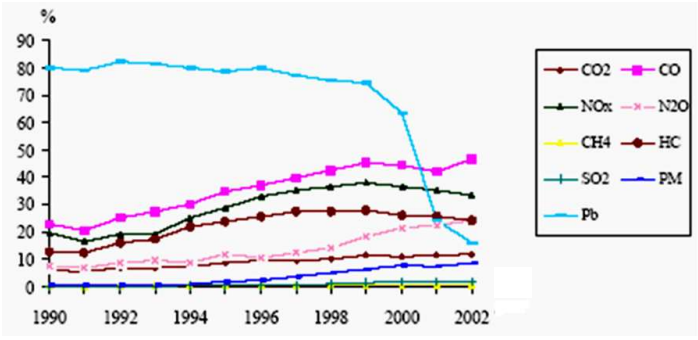
## ENERGY CONSUMPTION

The International Energy Agency (IEA) anticipates in its baseline scenario of further development of energy consumption that by 2030 the world demand for petroleum will grow annually by 1.4 %. This represents an increase of 79 million barrels/day in 2003 to 92 million barrels/day in 2010 and 115 million barrels/day in 2030. Two-thirds of total petroleum consumption will increase due to the transport sector. Petroleum still remains the dominant primary energy source. From the economic and political point of view, the alternatives, such as renewable energy sources, will be developed very slowly. Globally, transport consumes about 80 % of petroleum products, representing 98 % of the energy used in transport. In 2004 the world's daily petroleum consumption was approximately 80 million barrels (1 barrel = 159 litre). Transport's share in the total energy consumption in the Czech Republic, as well as in the world, has steadily increased. In 2003 it was possible to observe a steady increase in the energy consumption of transport. The largest share of energy consumption in transport is found in individual road transport and goods transport.

## ENVIRONMENTAL POLLUTION

The new report from the European Agency for the Environment (2008) states that in all the member states of the European Union the major source of air pollution is emissions from cars and trucks. For the most part, the following emissions are released into the atmosphere - CO, NO, $NO_2$, $SO_2$, hydrocarbons, particulates, ozone, and some lead. Also, the production of $CO_2$ has markedly increased. Overall, however, air pollutant emissions have been following a downward trend since 1990, primarily nitrogen oxides and sulfur dioxide.

THE SHARE OF TRANSPORT IN TOTAL POLLUTION




Large cities may be exposed to specific weather situations, such as poor air flow with a possibility of inversion and the buildup of a large amount of exhaust gases, which lead to the creation of smog that directly endangers people's lives. It is the chemical pollution of the atmosphere. The word "smog" is an amalgam of the words "smoke" and "fog." According to its origin, there are two types of smog:

### REDUCING SMOG

- mixture of urban and industrial smoke with a predominance of sulfur dioxide
- occurs mainly in winter conditions with distinct ground-based temperature inversions
- is also sometimes called London smog (first observed in London) or winter smog

### OXIDIZING SMOG

- first observed in the 1940's in Los Angeles
- is produced in urban areas, sunlight has an effect on certain components of transport emissions, particularly on ground-level ozone, hydrocarbon mixtures, nitrogen and carbon oxides
- reason for its creation is the increased concentration of $NO_2$, which due to UV radiation divides into particles, and at the end of the reaction ozone is formed (blue colouring of air), peroxyacetylnitrates, aldehydes and sulfuric acid
- is also called Los Angeles smog, photochemical or summer smog

## WATER POLLUTION

Water pollution is caused by the direct or indirect discharge of chemicals, dangerous biological substances and microorganisms. This contamination leads to a change in the quality or nature of the groundwater or surface water, affecting the health and status of the flora and fauna. Traffic accidents associated with the release of dangerous or harmful materials being transported are extremely hazardous. Leakage of large amounts of oil into the aquatic environment is accompanied by an oil film, limits the access of oxygen to the water surface, which ultimately reduces the self-purifying ability of the water.

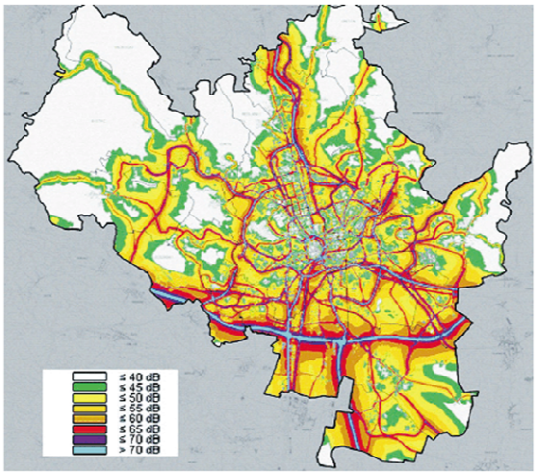
## SOIL POLLUTION

The oil from environmental accidents has the same effect as herbicides on most plant species. That is why only plants with a low susceptibility to petroleum hydrocarbons survive in affected areas. During physical, chemical and biological processes the contaminated soil gradually degrades and the contaminated soil gradually self-regenerates. Oil and naphtha take the longest time to break down (3 years); petrol and petroleum degrade quickly (usually within 1-3 years).

# The Landscape and Cars

## NOISE AND VIBRATION

The development of transport brings many negative impacts, including among others, excessive noise and vibration. The long-term effects of noise exposure may cause serious diseases of civilized society (hypertension, heart attacks, stress, neurosis, pathological changes in blood pressure, hearing loss, etc.). People don't respond as negatively to a permanent increase in noise as they do to those sound frequencies which are detrimental to them. However, such permanent exposure could have an adverse impact on the brain. It is the people in large cities and industrial areas who are exposed to this particular burden the most. The main source of noise and vibration in urban areas is primarily ground traffic, and also dramatically increasing car traffic. In the noisiest places noise levels reach up to 75 dB in the day time and 69 dB at night, and in the quiet places the noise levels drop to 50 dB in the day time and 40 dB at night. The highest noise readings were already traditionally found in noisy areas such as Plzeň, Praha 3 and 10 , in Ostrava, Olomouc and Liberec.




*Map of road transport noise readings in Brno - the day time (source: ENVIG, Ltd.)*

## LANDSCAPE DEGRADATION

Due to the expansion of road networks close to urban areas, agricultural and other types of land have been appropriated. This phenomenon has also contributed to the reduction of the retention capacity of the landscape, has led to a loss of high quality agricultural land, and to a loss of habitats of wild fauna and flora. Due to contact with acidic atmospheric deposits, emissions and solid or liquid waste products, soil degradation is also a cause of the reduction of the fertility of agricultural land, and the cause of contamination by undesirable elements and com-

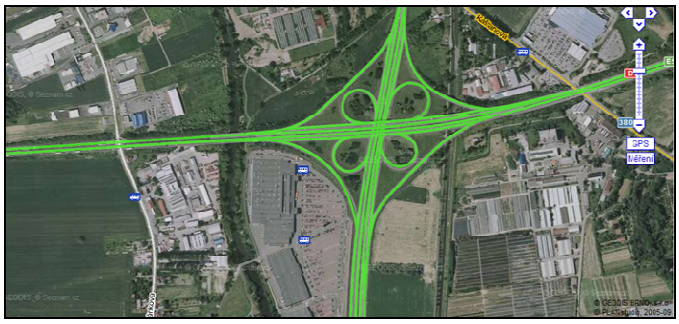


*Diagram of land appropriation due to construction of the Southern Shopping Centre in Brno. (Source: www.mapy.cz)*

Construction of road infrastructure results in the fragmentation of natural habitats, and the dispersal of specific species of plants and animals into smaller and more isolated units. This isolation, a result of fragmentation, threatens the survival of sensitive species. The process of habitat fragmentation affects ecological processes on multiple levels - the functionality of the habitat is limited by the reduction of its size, and the isolation disrupts sequential activities in the ecosystem. Another of the main causes of the fragmentation of habitats is, in addition to agriculture and urbanization, the construction and use of linear transportation infrastructure: not only roads, but also railways and waterways. Fragmentation affects not only the part of the habitat which is bounded by the linear structure, but according to the size of the construction, also the adjoining strip, which can be several tens of meters wide.

Basically, fragmentation reduces the possibility of species migration. It also directly contributes to a higher mortality rate of fauna, particularly at night during the summer months, when the species are attracted by the heat radiating from road surfaces. Transport networks in developed countries divide natural locations into smaller, isolated segments and create barriers between those segments. The segments are often not large enough for sensitive species to be able to survive there. Road transport has also become a factor that directly threatens the survival of many species in our landscape. Bridges which span traffic routes are generally considered places where animals can cross roads safely. This ecological function of bridges is dependent upon the size of the bridges, but also on the details of technical design modifications to the space under the bridge. The construction of underpasses for animals, with fences and ecoducts,(green bridges) is among the most important current *precautions* which has been undertaken.

*Ecoduct in Lipník nad Bečvou*

*Subway for amphibians*

# The Landscape and Cars

**WEB LINKS:**

www.euactiv.cz

http://epp.eurostat.ec.europa.eu

www.zubrno.cz/studie/00_obsah.htm

Policie ČR: Přehled o nehodovosti. http://www.policie.cz/

www.csopvlasim.cz/stanice/rady/jezci.php

Of the anthropogenic (man-made) shapes that are currently most controversial because of their large-scale interventions into the landscape, we can name overpasses, arched bridges and towers. The current trend, however, is the partial revitalization of the landscape, so that these improvements would be in harmony with the landscape.

*Anthropogenic shapes sprang into being after the construction of the D47 motorway near Lipník nad Bečvou.*

## TRANSPORTATION AND SUSTAINABLE DEVELOPMENT

Externalities are social costs, which don't pass through the market, their builder doesn't pay for them, and thus they are usually a financial burden for the whole society. It is the transportation, which is associated with a number of effects that don't pass through the market (that is why they are called external) but they cost the society money. As the traffic increases, the negative impacts on the environment and health increase as well. These impacts are not only local (health impacts on people living close to busy roads caused particularly by diesel particulate emissions and noise), but also regional, national and international (especially emissions of greenhouse gases). Therefore, there is growing attention paid to how to reduce the negative effects of transportation at all levels of its operation. State and local governments measure to influence the volume and structure of transport are generally referred to as traffic control.

A common definition of sustainable transport is "meeting the mobility needs of present generations without limiting the needs of future generations". Generally, there is a consensus that sustainable transport should permanently contribute to the growing socio-economic welfare without exhausting natural resources and damaging the environment. The European Ministers of Transport in their proclamation of 2004 states that the sustainability criteria in urban areas vary among countries, as well as among individual cities. We can distinguish three pillars of sustainability (economic, environmental and social justice), whose goal are monitored by the sustainable mobility. The economic and environmental pillars are connected. Their approach is to take the unacceptable costs and pass them on to the transporters, and to reduce the environmentally unfavourable impacts of transportation on social welfare. The pillars of social justice and economic security are linked through mobility needs and the redistribution of wealth within society. And the emphasis on ethical values and principles and the pursuit of intergenerational equity are the main goals of the social justice and environmental pillars.

## ANIMALS BEING KILLED ON ROADS

Vehicle-animal collisions are an issue on roads and motorways. When vehicles collide with small animals, such as invertebrates, amphibians and reptiles, the result is usually the death of these animals. But the collisions with big animals, such as mammals or birds, definitely endanger road safety (damage to the vehicle and accidents).

Police statistics indicate that annually around 8,500 accidents are caused by wildlife. Overall, most of the accidents occur on Class I. roads – 0.5/1 km accidents, while on the roads of Class III. – 0.04/1 km. The most accidents occur in the spring with a fewer number taking place in autumn, and the fewest in the winter. We are talking about collisions with deer and wild boars. Collisions with medium size animals, such as foxes, badgers, hare, etc., usually don't cause any extensive damage to vehicles, and, therefore, they are not reported and recorded.

# The Landscape and Cars

The death statistics for invertebrate animals are not very precise, because these animals are very difficult to find in nature. This applies, to a lesser extent, to small vertebrate animals: some of them are thrown off the road, or die after some time, and some of them are picked up by drivers and driven away. A mortality survey of animals (Hlavac, Anděl, 2008) on our roads and motorways in lowland and upland terrain is defined by the critically threatened species (see table).

| | No. of critically threatened species | |
|---|---|---|
| **MAMMALS** | **24** | common rat, domestic cat, hedgehog (both species), field mouse (all species) |
| **BIRDS** | **61** | whitewing, yellow-hammer, common pheasant, common blackbird robin redbreast, thrush |
| **REPTILES** | **5** | ringsnake slow-worm |
| **AMPHIBIANS** | **4** | European toad |

*Tab.: Critically threatened species of vertebrates from the point of view of the mortality rate on the roads in the Czech Republic*

*Badger killed on the road*

Although the relative mortality rate of animals (per 1 km of road/ unit of time) is the highest on the motorways (except the blackbird), most of the animals perish on lower category roads. This is evident mainly when we are talking about brown hares and deer. When we take the entire road network into account, the number of dead animals is so high that, for example, the number of hares killed on the roads is almost twice the number oh hares born in spring. And the number of hares shot by hunters is only one-tenth of the deaths of the hares killed on the roads. These statistics confirm the significant impact of road mortality on the population dynamics of many species. Measures to prevent the killing of animals on the roads (and railways) depend upon driver vigilance, mainly in the evening and night hours, and periods when the younger animals become independent.

Among other measures we can mention the introduction of the most endangered animals back into the wild. The specific example is the rescue program of young hedgehogs which are not able to survive winter. Both types of our hedgehogs (the eastern and western) are representatives of hibernating mammals. This means that they lie dormant, a state of unconsciousness associated with the lowering of their body temperature (winter sleep). To do this they need to have accumulated energy reserves in the form of fat. Hedgehogs need to weigh at least 700 g to be able to wake up from their hibernation in the spring. Therefore, young and weak hedgehogs have no chance of awakening. These hedgehogs are sought out during autumn, and kept in suitable breeding conditions. In the spring they are released into the wild again. Thus this program reduces the mortality rate on the roads. Hedgehogs look for invertebrates as food on the roads (mainly nocturnal butterflies) and are lured by the higher temperature of the road's heated surface.

*European hedgehog*

*Feeding of a young hedgehog*

## LEARNING ACTIVITIES:

7 Landscape fragmentation - methodological sheet
7b Landscape fragmentation - worksheet
8 Landscape and cars - methodological sheet
8b Landscape and cars - worksheet
9a Perishing animals on the roads (and railways) - methodological sheet
9b Perishing animals on the roads (and railways) - worksheet
22 Transportation and sustainable development - methodological sheet
22b Transportation and sustainable development - worksheet

## THINK ABOUT:

Considering where you live, document the impacts mentioned in the text. What solutions would you propose to improve the situation? What legislative tools are used in this case? Think of the changes which would occur in the landscape, if your municipality decided to build a new road to your neighboring village by constructing a road through a nearby forest (Scenario).

# Crude Oil Extraction

*Where does oil come from? What about its origin? Are its reserves endless? How are oil production and environmental protection connected? The following text will try to provide answers to these questions.*

Crude oil extraction is usually tied to the flat areas that once were or still are on the bottom of the sea. It is at the bottom of the sea where oil has formed from ancient remnants of dead organisms (plant and animal). In order to drill oil it is important to create a dense network of roads along which first the drilling equipments and then, after the successful opening of deposits, the drilling rigs can reach the appropriate places. The drilling sites need electricity to drive the pumps. It is also necessary to build a network of pipelines, which can divert the extracted oil into local reservoirs. From there, the oil is directed to collection stations where it is pre-cleaned and pumped into long-distance pipelines – the oil must often flow through thousands of kilometers of pipelines to reach the petrochemical industry processing plants. The oil passes through several pumping stations, where the pumps accelerate its movement. The oil drilling site is characterized by considerable fragmentation of the original landscape – island fragmentation (drilling sites), linear fragmentation (roads, power lines and pipelines).

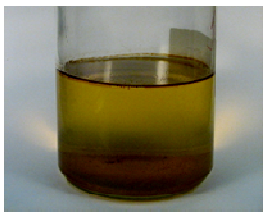
The equipment is highly vulnerable to natural incidents and accidents involving leakage of the crude oil which then pollutes soil, streams, lakes and seas as well as groundwater. Similar catastrophes can also occur along the transport routes of the pipelines or along tanker routes. These catasthropes can cause long term land and marine environmental poisoning. Since natural gas occures aling with the crude oil, it is, therefore, also collected, stored, and carried away in the pipelines. It is used as a fuel in businesses, homes, power stations, but increasingly also in cars. When the places of consumption are far away, or when the natural gas fields are not very abundant, the gas is often burnt as sidewaste.

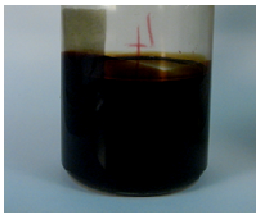
## PETROCHEMICAL INDUSTRY

The petrochemical industry is just the first stage of the multiple uses of oil. One portion of the oil is directed toward the production of fuels and lubricants used for cars and for machines in different sectors of industry. Another portion is directed toward the production of plastic materials, which are used for the construction of body panels, interior paneling, insulation and sub -components of the equipment in cars and engines. And the last portion is directed to ward the rubber industry and the manufacture of rubber tires and other components, in particular, hoses, flexible and soft casings and a number of other things.

## WHAT IS OIL?

Oil is one of the non-renewable sources of energy. Nowadays, together with natural gas and coal, it is one of the main primary energy sources. Oil deposits are located either in Paleozoic or Quaternary sediments, along with salt water and natural gas. Oil is the basic raw material in the petrochemical industry.





*Colour variation of oil: from yellow-green to brown*

**Oil** (sometimes also called crude oil or petroleum) is a flammable, oily liquid consisting of a mixture of hydrocarbons, in particular alkanes *, whose chain contains mainly 5 to 35 carbon atoms. Extracted oil sometimes contains gaseous alkanes with 1 to 4 carbon atoms in its chain. Oil has a characteristic odor. It is less dense than water (the density of oil is 0.73 to 0.98 g / cm3, the density of distilled water is 0.99 g/cm3 and the density of seawater is 1.025 g/cm3). Therefore, oil slicks float on the surface of the sea. Oil from different locations differs in its properties. Crude oil is divided into heavy, medium and light, according to its density. Depending on the type of hydrocarbons, they are divided into alkaline, cykcloakane and various aromatic hydrocarbons. The sulphur content in oil is also important. Westsiberian oil, which is produced in the Czech Republic, has a high sulphur content, is of medium density and belongs to the alkanes group. Oil also differs in its color - from yellow to green to brown or black.

# Crude Oil Extraction

## OIL

*Chemical elements contained in oil*

| *Element (name and symbol)* | *Percentage by weight [%]* |
|---|---|
| Carbon C | 83–87 |
| Hydrogen H | 11–15 |
| Sulphur S | 0,1–10 |
| Nitrogen N, Oxygen O, metals | trace amounts |

## THE ORIGIN OF OIL AND NATURAL GAS

Oil is located in the upper layers of the Earth's crust - often in areas of continental shelves *. Oil reservoirs lay beneath the impermeable layers, at depths up to 8 km below the surface. It is possible to detect oil in many types of rocks. Its accumulation is possible not only in porous rocks - sandstones, agglomerates *(pudding-stones)* and limestones, but also in igneous cracked or metamorphic rocks, in the layers beneath the seabed, beneath the frozen soil in Siberia, underneath salt deposits or buried in coral islands, in karst cavities or in sandy caves.

## THE ORIGIN OF OIL AND NATURAL

There are two scientific, yet conflicting theories about the origin of oil.

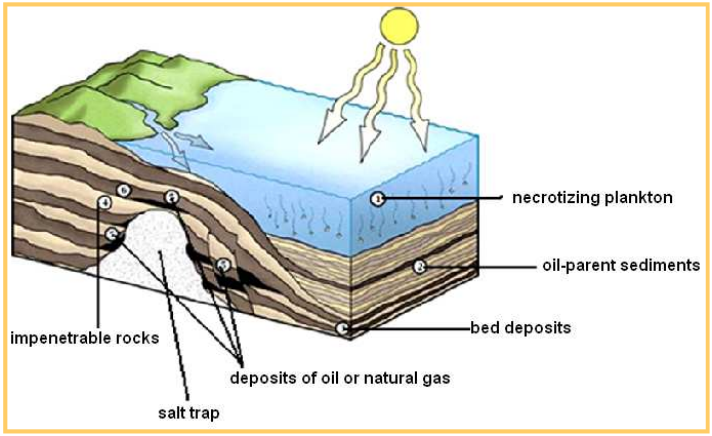
The inorganic theory origin of oil was proposed by Mendeleev when he stated that the origin lay in the effect of superheated steam on carbides * of heavy metals in the days when they occurred near the earth's surface. This theory can be supported by the laboratory preparation of certain solid, liquid and gaseous hydrocarbons (for example, uranium carbide), or by a continuous leakage of methane from the Earth's interior. A simulation of this leakage can be achieved under laboratory conditions (this reaction has actually been verified in the laboratory) according to the following equation.

$$4H2 + CaCO3 \rightarrow CaO + CH4 + 2H2O$$

The organic theory, accepted by most scientists, assumes that oil originated from the remnants of prehistoric animals and plants. Similar organisms (sea grass, algae, plant and animal plankton, micro-plankton, bacteria) live in salt or brackish waters even today. According to this theory, a large number of aquatic organisms, living on the seashore, process nutrients brought by big rivers and then reproduce and die. After descending to the bottom, it may happen that at a suitable moment (geologically speaking), the remains of these organisms are covered by sediment from the rivers. This produces parent or so-called source rocks, mostly grey clayey sandstones and black shale.

The first people who knew about oil were the ancient Syrians. They used it as a mortar. The Persians called it nephtoj, nephtaz or nephta. The Sumerians called it nepht and the Greeks naphtha. The Romans called it petroleum, and used it as a laxative or massage oil. The English also called it petroleum, but the Americans referred to it as rock oil, or seneca oil (after the Seneca Indian tribe from whose territory the oil was extracted). The word ropa (oil in Czech) is of Polish origin and means “pus”. Technological development in the use of oil occurred in the mid-19$^{th}$ century, when Pennsylvania began drilling oil the using distillation and oil refining processess. The production of motor fuels from crude oil did not begin until the late 19$^{th}$ century.

## OIL DEPOSIT DEVELOPMENT




Their layers are several meters thick. If there is a relatively rapid decline in the seabed (again in the geological sense), these rocks will be heated to a suitable temperature in the range of 60° C to 150° C. A so-called oil window is then created at depths of 2200m to 5500m beneath the Earth's surface. If the temperature exceeds 150° C, then we are talking about “burnt deposit”, in which only gas + graphite occurs. If, on the other hand, the temperature is below 60° C, there is only methane. Under optimal conditions for the emergence of the oil window, i.e., under high pressure and without the presence of oxygen (in the presence of specific bacteria and minerals as catalytic converters), small droplets of oil, which are dissolved in the form of an emulsion in the underground water, begin to arise. Subsequently, the underground water transports these droplets of oil through fissures into so-called “oil-traps”, where they accumulate in the porous rock. In about two thirds of all the deposits these are sandstones and limestones or dolomites. In order for the oil trap to be functional, the presence of a so-called “hat” or “umbrella” is essential. The hat consists of impermeable rock which does not allow the oil to leak to the surface (shale, permafrost, etc.). Oil traps can be of different shapes. All this happens as a result of the high pressure created by the surrounding rocks. The quality of the oil depends upon the amount of time it takes the oil to form - for every 5.5° C (depth of 150-180 m), the speed of the chemical reaction doubles. The older the oil, the more hydrocarbons it contains and the less asphalt it contains.

# Crude Oil Extraction

## CONDITIONS FOR THE ORGANIC ORIGIN OF OIL

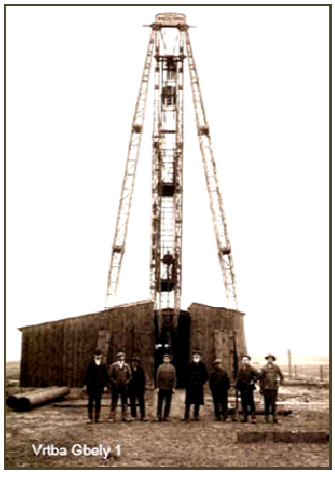
1. Migration paths of oil lead to geological traps.
2. The traps must be surrounded by thick layers (several hundred meters) of porous rock - an oil reservoir.
3. This porous rock must be covered with impermeable rock called “a hat”, to prevent the further migration of the oil.
4. Correct “geological” timing is very important. First the trap must be created and then the oil can migrate.

## CANADIAN OIL BOOM

Mining the oil sand in Alberta, which was once considered too expensive and too harmful to exploit, is a business worth billions of dollars nowadays. Deposits of a mixture of sticky bitumen, sand, clay and water are hidden under several tens of meters of soil. After clearing off the top soil, giant excavators fill trucks 24 hours a day and then carry the bitumen mixture to refining plants. The bitumen is separated from the sand and tree leaves in hot water, it then rises to the surface, and in the end it is sent to the refinery. The rest of the sand, water and bitumen is discharged into a sludge bed. It is necessary to displace four tons of soil in order to produce a single barrel of oil.

*According to National Geographic, March 2009*

## BEGINNINGS OF OIL PRODUCTION IN OUR AREA




*Oil drilling in Gbely*

In former Austria-Hungary in 1910, a resident of Gbely, John Medlen, was digging a drainage ditch on his land and he ran into natural gas. In 1914 Medlen started drilling for the gas. He died about three years after his discovery because he started using the flammable gas to heat his house, and due to ignorance as to how to treat this substance, there was an explosion and his house burned down.

## MATTER OF INTEREST

An interesting peace of information is so-called unconventional oil, which is obtained by other than traditional drilling methods. The sources of this type of oil are oil sands (tar sands, bitumens), oil shale, biofuels, thermal depolymerization of organic matter and conversion of coal or natural gas to liquid hydrocarbons. Tar sands contain bitumen, which is split by the cracking method. This process is energy intensive. Currently there are relatively large deposits of tar sands (Canada, Venezuela), and probably very soon oil will be extracted from this source as well (this type of mining is highly uneconomical and non-organic, leaving behind waste tanks full of sludge). The extraction of oil from bitumen deposits is expensive and, in addition, the tar sands lie in northern areas of virgin nature. To satisfy the demand for oil will be difficult and the price of the oil obtained from these remote locations will be higher. Oil shale is sedimentary rock containing hydrocarbon carboid. Carboid is converted to oil without oxygen through pyrolysis (heating at 450-500° C).

## OIL PRODUCTION

*Drilling rigs*

Currently, oil is extracted via oil wells. The drill bit is usually fitted with diamonds, or steel pins, and rotates in a curcular motion. The drilling speed varies according to the hardness of the rock from 30 cm/hr. to 60 m/hr. Additional drill rods are gradually attached to the first driving rod, and the so-called “*well mash* “ is injected under the tunnelling tip, which cools the head during drilling. At the top of the borehole, there is a special pressure valve which protects the oil from squirting uncontrollably. Along the sides of the boreholes, there are steel drill frames, which are cast in a concrete mixture, and which gradually narrow towards the surface (e.g., 76cm on the top and 18cm at the bottom of the borehole). After the successful discovery of an oil deposit, the oil is usually drilled in three progressive stages, known as primary, secondary and tertiary.

# Crude Oil Extraction

## TYPES OF OIL PRODUCTION

**Primary method** - natural gas, which occurs under pressure above the crude oil, pushes the oil out of the borehole. A maximum of 20 % of the oil is extracted in this way. The gas pressure gradually decreases, so it's necessary to use additional method to extract oil.

**Secondary method** - drilling pumps. Water, gas, air or CO2 are blown into the borehole. It is possible to extract another 5 - 15 % of the total amount of the oil. Then the final method comes.

**Tertiary methods** - using steam injection, hot oil viscosity is reduced, so another 5-15 % of the total amount of the oil can be extracted.

An oil deposit is never exploited 100 %. For light oil the extraction rate is around 80 %, while for heavy oil it's only 5 %. During the second half of the 20th century, oil was increasingly extracted from the bottom of shallow seas (previously it was Caspian Sea, and later the Gulf of Mexico and the North Sea). Oil platforms or rigs, wonders of modern technology, were built for this purpose.

*Oil Rig Hotel*

*Drilling pumps (Texas, USA)*

Even the dysfunctional oil rigs do not need to be a burden in the future. They could easily be converted into hotels on the sea, which would be completely self-sufficient in terms of energy. Sources of energy for their operation could be wind, which blows almost constantly there, solar panels and waves. Heating or cooling could be obtained from hydrothermal vents (holes in Earth's crust already in existence). Such hotels have been designed for the shallow parts of the Gulf of Mexico, where there are about 400 rigs - some of them have completed threir work in the terms of oil extraction. However, hotels in the North Sea could be interesting as well - fishing, transfer stations to polar regions, etc.

*Statfjord B oil platform*

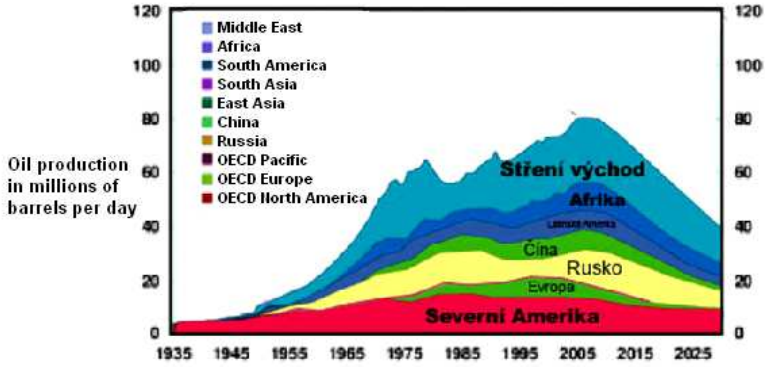
Currently, one of the options fro replacing dried up oil wells is to get the oil from the bottom of the deep oceans. Such exploitation is more expensive than drilling in the shallow seas and one oil company alone cannot afford either the research or construction of the facilities necessary for this extraction. Therefore, several oil companies have joined forces and are currently funding drilling and construction equipment. An example is the Jack 2 in the Gulf of Mexico. Studies indicate that this site is capable of producing around 15 trillion barrels. If that is true, the companies would realize a profit. Nevertheless, the possibility of failure is not out of the question.

The Statfjord B oil platform was built between 1978 –1981, and it is located 180km west of Songefjord and 185km north-east of the Shetland Islands. Its base consists of 24 concrete sections and above them are situated four hollow concrete towers. There is drilling equipment in two of the towers, and the other two contain the necessary technical equipment (pumps, piping, etc.). The upper part of the platform serves as a seven-floor hotel for 200 workers, offices, a refinery and a landing pad for helicopters. The distance from the bottom of the platform to the top is 271m, which is only about 30m less than the height of the Eiffel Tower. However, it exceeds its weight by almost 115 times. The construction of the platform took place on shore, where its parts were manufactured separately, and then it was assembled on site. The platform is so stable that even the biggest waves and strongest winds cause it to sway up to only 1cm. The Statfjord B drilling platform produces about 180,000 barrels of oil daily, which are then shipped by tankers. The entire construction cost was $1,840,000,000.

# Crude Oil Extraction

## OIL AND THE FUTURE

Currently, there are 85 million barrels of oil extracted every day. In the near future, this number will rise due to increased consumption of oil in China and India. So, we can expect that by 2020 oil consumption will be equal to twice the current level. It is natural that we are interested in the question concerning the future of oil. Oil has literally become the blood of global industry as well as the drug of humanity. Try to imagine a world without oil: no cars, the collapse of transport, agriculture and industry. The means of production would be similar to those used sometime in the mid-19th century, but at the same time there would be no similar infrastructure, so the society would have to rely on the power of horses - again - but would have to deal with countries with larger populations (who would be probably hungry). The country that possesses oil eould be wealthy. There would surely be wars for oil, food and water and the extinction of civilization would appear inevitable. What then is the future of oil and thus of humanity? In the 1950's, M. King Hubbert, an American geophysicist, published the theory of peak oil. According to this theory, every oil field is gradually being depleted, so that the time dependence of the quantity of oil follows a curve similar to the Gaussian curve (gradually increases, reaches the maximum and then declines). The shape of Hubbert's curve applies not only to one oil field, but to all oil fields on the Earth.

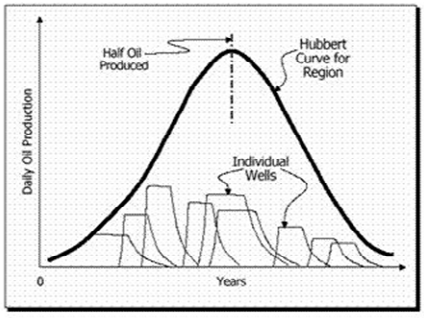



*Oil production and its prognosis*

## WHY IS OIL ECONOMICALLY SUCH A MIRACULOUS LIQUID?

This question is answered with the help of the so called ERoEI Index (Energy Return of Energy Invested), i.e. the price of energy obtained after deducting the price of energy invested. From the economic point of view, the sources with the ERoEI index of less than 5 are inefficient.

The table of the ERoEI Index shows us that oil (and, of course, the natural gas which accompanies it) is a very convenient source of energy, currently hardly replaceable. However, it is a finite resource, and sooner or later we will begin to feel its absence. If the extinction of our civilization is not going to happen, it is high time to begin an intensive search for replacements for oil. It seems that the most promising are nuclear energy, solar power and nuclear fusion, if ideveloped. Then there would be enough "clean" energy which would be inexhaustible and which would not destroy the environment.




*M. King Hubbert's curve*

M.K. Hubbert predicted this maximum, corresponding to global production, for the 1970. Fortunately, so far his prediction has not come true because there are new oil field still being discovered, and still improving methods for extracting the oil (reserves in the North Sea, Gulf of Mexico, etc.). Optimists say that mankind has oil reserves for about another 200 years (the coast of Brazil, Cuba, deep oceans' drilling, the oil sands in Canada and Venezuela, and other as yet undiscovered deposits). Pessimists argue the opposite - all the locations have already been discovered and the world is riding for a fall.

It is very difficult to decide where the truth lies for several reasons: 1) The unknown geographical distribution of oil reserves, actually new oil fields are still being discovered. 2) Perhaps in no area of human activity is there such a distorted situation, even lying, as it is in the oil production and consumption. The reason is the politicization of the issue. On the one hand, countries that produce oil and are economically dependent on oil production claim that there is enough oil left.On the other hand, oil cartels that want to raise the price of oil contradict these claims etc. Unfortunately, the cartels' claims may be proved by scientific expertise. It is also possible that part of the sky-high profits from oil is being used to deliberately slow-down the research of alternative energy sources.

| Energy | ERoEI |
|---|---|
| Middle East oil | 30 |
| Oil from oil | 4 |
| Nuclear energy | 4—5 |
| Solar energy | 2—5 |
| Hydropower plants | 5—10 |
| Wind energy | 5—10 |
| Coal | 4—20 |
| Biofuels | 0,9—4 |

*Index ERoEI*

## LEARNING ACTIVITIES:

11a Simple distillation - methodological sheet

11b Simple distillation - worksheet

21a Oil – Where it can be found and how much is left? - methodological sheet

21b Oil – Where it can be found and how much is left? - worksheet

## THINK ABOUT:

Map oil resources for the Czech Republic and draw their path to the site of oil processing in Kralupy nad Vltavou .

Oil is a non-renewable source of energy. Think of its alternatives and the advantages and disadvantages of their use.

# Oil Transportation

In the mid-19th century, when oil began to be extracted on a larger scale (Russia, USA) it was transported in wooden barrels with the help of horses. The capacity of such a barrel was set at a specific amount, and since that time oil has traditionally been measured in barrels*. Horse carriages were soon replaced by tanks and railway cars. Later, however, it became obvious that even this form of transportation was inadequate, so it was necessary to adopt a much more efficient way of transporting oil - pipelines and oil tankers.

## PIPELINES

The first pipeline was 9.6 km long, and was built in 1865 in Pennsylvania. Since then, many and much longer pipelines have been built, which daily carry huge amounts of crude oil. A pipeline consists of pipes with a diameter of 30 cm - 122 cm, which are often fastened onto medium-height poles. Sometimes, for different reasons, they are buried underground and at other times they run along the ocean floor. Pumping stations are located at regular intervals, and they ensure a constant flow of oil at 1-6 m/s. In order not to allow sediment to settle on the bottom of pipelines, steel “hedgehogs”, which clean the pipelines, were invented to be carried with the flow of the oil.

## OIL EXTRACTION, CONSUMPTION AND TRANSPORTATION

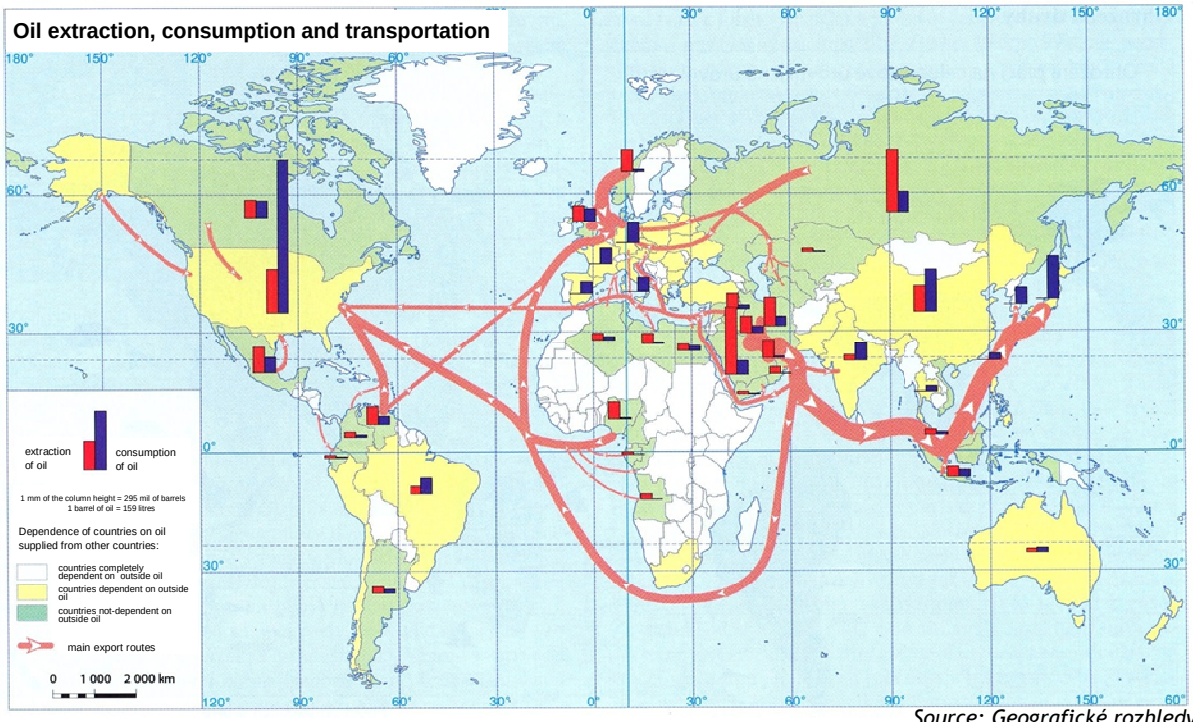
The main transport lines begin in the Arab states of the Persian Gulf (Saudi Arabia, Iraq, Iran, Kuwait) and lead mainly to East Asia (Japan, China) and also to Europe. In the USA a considerable amount of this material comes also from Venezuela. Significant oil fields are also located in Western Europe in the North Sea. The production of the countries of North Africa (Libya, Algeria, Egypt) and the Gulf of Guinea countries (Nigeria, Angola) is much less significant in terms of the world's total oil production.

## BARREL

Barrel (unit) - is the name of several units of capacity. The name comes from the English word barrel,,which also has other meanings than cask.

The following are the most frequent:

- bbl stands for a barrel of oil
  1 bbl = 159 dm3 = 42 U.S. gallons.
- Barrel of beer in Britain is equal to 36 UK gallons, ie. 163.65924 dm3.
- Barrel of beer in the U.S. is equal to 31.5 U.S. gallons, ie. 119.240471196 dm3




*Source: Geografické rozhledy*

# Oil Transportation


*Map of Druzhba pipeline*

## SIGNIFICANT PIPELINES

1. Alaska (Prudhoe Bay - Valdez), 1278 km long, hostile environment of Tundra.
2. Trans Arabia (Bahrain - Mediterranean), 1700 km long, leads mainly through large deserts.
3. Big Inch (Texas - Pennsylvania, USA), 2190 km long.
4. Canadian Oil Pipeline (Edmonton - Montreal), 3787 km long.
5. Druzhba (Kuibyshev in Russia - Záluží u Mostu, CR), 5502 km long.

**Other pipelines important for the Czech Republic:**

1. Adria Krk - Druzhba pipeline
2. Ingolstadt - Kralupy - Litvínov

## OIL TANKERS

In 1869 oil was brought to Europe from the USA by a specially adapted yacht named the Charles. The Charles can therefore be regarded as the first oil tanker – a ship constructed to transport oil. An important parameter of each ship is its capacity. It is indicated either in DWT (dead weight tons - that is the maximum load in tons), or GRT (gross registered tons - 2.83 cubic meters, indicating the total volume of the enclosed space of the ship). From the economic point of view, we conclude that the larger the ship is, the cheaper the cost of transportation, but, unfortunately, the worse the maneuverability of the ship and the greater the potential devastating consequences for the environment in case of a disaster. This is why oil tankers are not berthed in ports; the oil is unloaded far away from the port into undersea pipelines. Currently, the Japanese build the largest oil tankers. There are currently about 700 super oil tankers operating on the seas, (one of the biggest is the Happy Giant, which has a draft of 24 m, a width of 68 m and a length of 486 m. Its capacity is 200,000 DWT). All in all, there are more than 6,000 tankers of different sizes and quality in operation, sailing under flags of many different countries. Despite the ever-increasing requirements regarding the quality of oil tankers (each tanker must now have a double hull), shipwreaks occur from time to time and this is often followed by an ecological disaster.

All the machines and equipment which transport oil are highly vulnerable to natural events and accidents. Leaks of crude oil occur which pollute the land, water in streams, lakes and seas as well as groundwater. Similar events occur along the routes of pipelines or oil tankers.

*Exxon Valdez oil spill, March 1989*

| *Ship name* | *Place* | *Date* | *Amount of oil leaked* |
|---|---|---|---|
| **Torrey Canyon** | Cornwall | March 18, 1967 | 120,000 tons |
| **Olympic Bravery** | La Manche | January 23, 1976 | no exact data |
| **Amoco Cadíz** | La Manche | March 16, 1978 | 234,000 tons |
| **Aegean Captain** | Tobago | July 19, 1979 | 300,000 tons |
| **Exxon Valdez** | Alaska | March 23, 1989 | 206,000 tons |
| **Mobby Prince** | Italy | April 10, 1991 | 82,000 tons |
| **Braer** | Shetland Islands | January 5, 1993 | 85,000 tons |
| **Sea Empress** | Walles | February 15, 1993 | 128,000 tons |
| **Erika** | Brittany | December 12, 1999 | 12,000 tons |
| **Limburg** | Aden | Septemeber 6, 2002 | no exact data |
| **Selendang Ayu** | Aleutian Islands | December 8, 2004 | 2000 tons |

*The world's biggest oil tanker disasters*

Oil tanker accidents result in long-term poisoning of the continental and marine environment, and result in the direct consequences which affect the organisms that are dependent on the marine ecosystem. Disasters have long-term destructive effects on the environment, they severely affect water birds, fish and other sea creatures. This is the reason why an oil spill should be cleaned up as soon as possible; for example by using floating barges, which stop the leak and drain off the oil. Another option is to sprinkle the spill with wood shavings, which soak up the oil, and after drying-out, may serve as a fuel.

## LEARNING ACTIVITIES:

10a Simulation of oil accident and its consequences - methodological sheet

10b Simulation of oil accident and its consequences

21a Oil – Where can it be found and how much is left? - methodological sheet

21b Oil – Where can it be found and how much is left? - worksheet

## THINK ABOUT:

Conclude from the diagram on page 26 which countries have the highest production of oil and the highest consumption of oil.

What are the advantages and disadvantages of shipping oil by sea?

# Oil Processing

*One of the first methods of oil processing - distillation- was developed by the chemist and inventor Ignacy Lukasiewicz (1822 - 1882) in Polish Lvov. He was the first who managed to separate petroleum from oil using distillation. He also constructed the first petroleum lamp. Petroleum, as one of the distilling fractions of oil, was used not only for lighting but also as motor fuel. In earlier times, the oil rose to the Earth's surface. Later, the oil was drawn from wells by a normal bucket.*

The main skill needed for oil processing was to master the **process of repeated oil distillation** under atmospheric pressure - **rectification***. This process enables us to **separate individual parts of the oil such** as mixtures of different hydrocarbons with different lengths of chains.

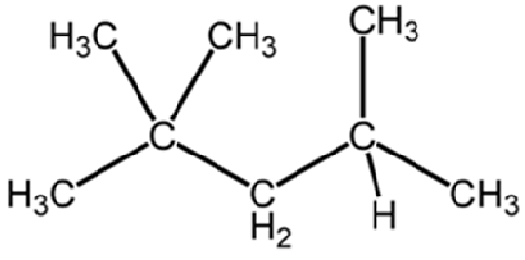
The first fraction obtained from oil is petrol fraction. Petrol, which is used as fuel for cars, is made from the fractions called medium and heavy petrol. These are modified in order to create an anti-knock immunity which is determined by octane number*. For example, if the petrol has an octane number of 80, it means that this fuel is composed of 20 percent n-heptan and 80 percent isooctane. The octane number shows the anti-knock quality of motor petrol. The standard fuel mixture consists of n-heptan (octane number 0) and isooctane /2,2,4 trimethylpentan/ (octane number 100). The octane number is equal to the percent of isooctane in the fuel. The higher the percentage of isooctane the higher the quality of the petrol and petrol combustion is better. It thereby avoids knock. Earlier, the antiknock agent tetraethyl was used to improve the quality of petrol. The main components of the anti-knock agent are derived from mixtures such as methylethercbuthyleter - MTBE, ethylcbuthyler - ETBE, tercamaylmethyleter - TAME.

## WHAT ARE INDIVIDUAL FRACTIONS OF OIL USED FOR?

| Fraction | Approximate boiling point (°C) | Approximate content of fraction in oil (%) | Approximate density (kg.m$^{-3}$) | Number of carbon in hydrocarbon chain |
|---|---|---|---|---|
| Petrol | 70—180 | 20—30 | 700 | 6—12 |
| Light petrol | do 90 | | | |
| Medium petrol - motor petrol | 90—150 | | | |
| Heavy petrol - motor petrol | 140—180 | | | |
| Petroleum | 170—250 | 5—15 | 800 | 9—12 |
| Diesel oil, fuel oil | 240—300 | 15—25 | 900 | 12—20 |
| Paraffin | >300 | | | >20 |
| Mazut (black oil) | Distillation residue | 40—50 | 950—1000 | 25—35 |

*Table of products derived from distillation of oil*

The second oil fraction is petroleum. The flashpoint* of petroleum which is used for producing light should be at least 25°C. The petroleum should have a low viscosity in order for it to rise up the wick. It is also used as fuel for low-turning internal combustion engines.




*Structural formula of isooctane*

# Oil Processing

## WEB LINKS:

http://vydavatelstvi.vscht.cz/knihy/uid_isbn-80-7080-619-2/pages-img/

www.poptavka.net/Poptavky-ESC332-stroje-pro-chemicky-prumysl-tezbu-ropy-zpracovani-plastu

www.total.cz/lub/lubczechrepublic.nsf/VS_OPM/6D15D5CB6E5E7884C125701C002CFD25?OpenDocument

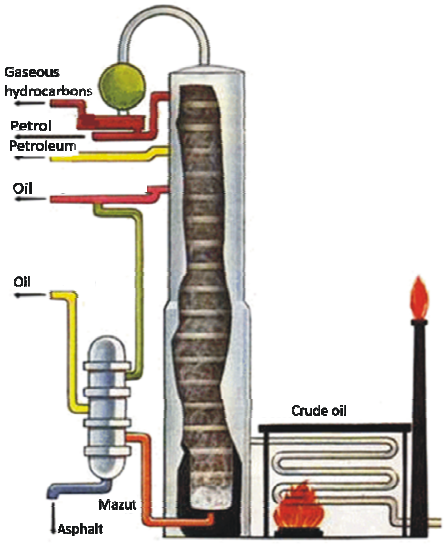
http://economics.webz.cz/kdy-dojde-ropa

www.petroleum.cz/svet-ropy.aspx

www.mnd.cz

**Diesel oil** is made from the mixture of the primary petroleum fraction and gas oil. It must be able to combust spontaneously at the temperature which is achieved by air compression in the engine cylinder. Summer diesel oil may contain a small quantity of paraffin. But this paraffin cannot be contained in winter diesel oil because it could solidify and block the fuel supply to the engine. The quality of the diesel is determined by the **cetane index***. Diesel oil is often made with a cetane index of 45 to 60.

Alterntives to motor diesel are **renewable engine fuels** derived completely from renewable resources. Very often such motor fuels are made from modified vegetable oils and ethanol which are created by the fermentation of glucose. Another possibility of renewable fuel is biodiesel oil which is made from vegetable oils - sunflower, rape and soybean.



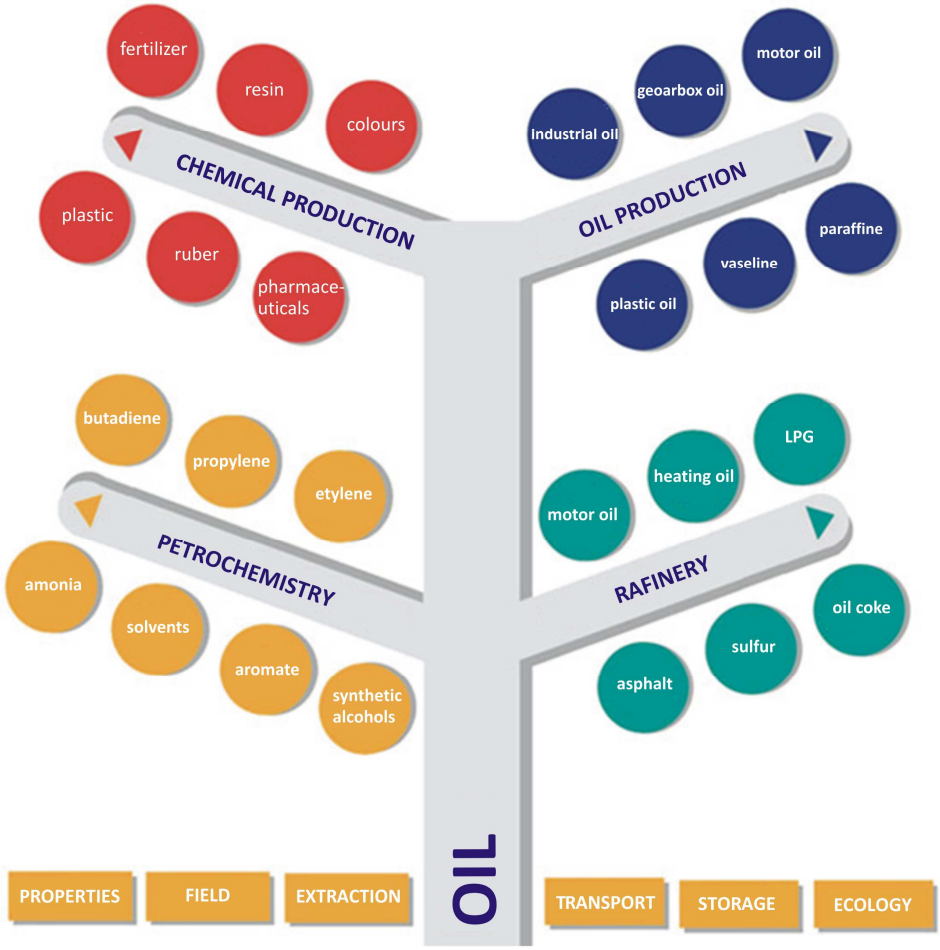

*The scheme of oil distillation*

## THE OIL PRODUCTS

**Mazut** (black oil) is a residue from the distillation column in which the oil is processed under standard pressure. Further distillation of mazut under low pressure results in asphalt.

**Paraffin** is originally a by product of the production of lubricating oils. It is used to manufacture candles and as a waterproofing material.

**Asphalt** is used in the building industry and especially for road building.




*Oil products, source: www.ceskarafinerska.cz*

## LEARNING ACTIVITIES:

12a Oil Is Not Only Petrol - methodological sheet

12b Oil Is Not Only Petrol - worksheet

20a The Price of Petrol - methodological sheet

20b The Price of Petrol - worksheet

## THINK ABOUT:

Think about the scheme titled Oil Products, which shows us most of the oil products. Which of them do people need in everyday life? Is oil important for people?

# Automobile Manufacturing

*Automobile manufacturing (and the production of other motor vehicles) needs not only qualified workers, but also various materials. As we shall see, the greater part of animate and inanimate nature is in some way engaged in the production of motor vehicles.*

## THE IMPORTANCE OF TRANSPORT

There are many human activities that are closely connected to **transport;** for example **economic** (extraction of raw materials, farming, animal husbandry, development and manufacturing of vehicles and its subsidiaries), **military** (the priority is speed and safety), **residential** (towns, as the centres of economic development were established near roads and crossroads) and, of course, **cultural**, because transport enables people to meet other people from distant places faster and easier and to have more time for their creative work. Road transport has experienced the greatest development. Motorised road transport started to be developed from the end of 19th century and nowadays cars are the most widely used means of transport. **The car industry and** everything related to it makes up **most of the world's economy**. An enormous amount of energy, materials, time and knowledge is directed toward car manufacturing, safety, driving, parking and also toward dealing with the adverse impact on the environment. And it is still the most effective means of transport because of time and human energy savings.

*When comparing the automobile manufacturing in earlier time and today, we see a number of differences , especially in the use of many more modern machines and assembly lines.*

## PEOPLE'S JOBS

**Many people** with many **different professions** are involved in the production of cars. It is necessary to build **towns and shops** for these people, **schools** for their children and to educate **teachers**, **shop assistants** and other workers connected with the various necessary services related to areas such as housing, **health care**, culture, entertainment, etc. From this point of view, **the car is an inseparable part of human society**.

## CAR DESIGNERS

The work of different people with different professions is necessary before people can use cars. As there are fashion designers who are interested in fashion trends and styles, so there are car designers and builders. These people decide what kind of materials are the most suitable for car manufacturing. Materials are chosen for the safety of the drivers and passengers and for their comfort. At the same time, materials enable the car to run well. In the picture, we can see winning design models of Ferrari with their designers.

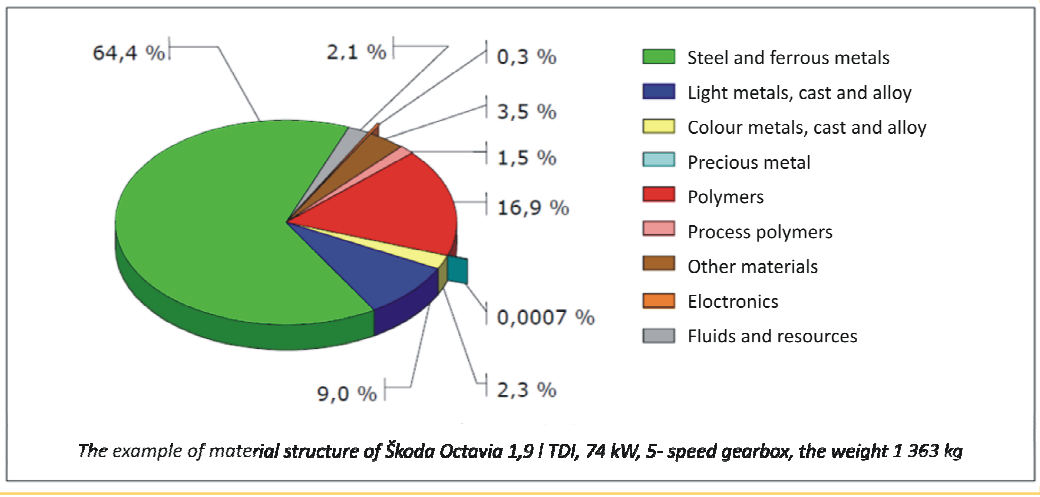
# Automobile Manufacturing

## MATERIALS – PARTS OF THE CAR

### METALS

Metals are irreplaceable materials in cars – steel is used for manufacturing the chassis (body), engine, axles and other mechanical parts. Zinc is used for the protection of the metal parts which are exposed to the environment. Copper is used for the production of electrical components, aluminium for the lighter parts of engines, transmissions and for the production of wheels and other components. Molybdenum and wolfram are necessary for the manufacturing of lighting equipment. **The mining of ores** strongly impacts the earth's surface due to the use of surface mining. It is necessary to build a dense network for the ore's transport to the smelting works where the metals are extracted.

**Animated and inanimated nature connected in car manufacturing**




*The example of material structure of Škoda Octavia 1,9 l TDI, 74 kW, 5- speed gearbox, the weight 1 363 kg*

**Surface mining seriously** affects the landscape and leaves **scares on the landscape** which are connected with deforestation and soil pollution. It is often necessary to drain large areas of land and to reroute original river systems in order to keep mines out of flood danger. Sometimes it is necessary to drain the water from mines. Surface mining causes dust, river pollution, and noise from mining and transport activities. Smelting works may be sources of toxic waste water, dust, gas emissions and noise. Ore extracts travel a long way before its final processing in smelting works. Metals are extracted from many ores by using a huge amount of electric energy, through a process called haemolysis. Aluminium, copper, nickel and other metals are obtained by using this process.

The processing of these metals **is concentrated in countries and areas with large amounts of cheap electrical energy which come from renewable resources** (the Scandinavian and equatorial countries). Lead, zinc, chrome and other metals are made by combining different chemical reactions with smelting. As we can see, the production of metals requires a vast amount of manpower, a huge amount of energy, transportation of materials and labour power. All these things together affect the final value of a car. In addition, the **production of metals pollutes the environment with vast** amounts of toxic emissions, wastewater and noise.

### TYRES

**Tyres** are an essential part of every car. They often influence the safety of a car's occupants. Tyres are made of natural **and synthetic rubber, soot and oil**. The rubber components (natural and synthetic) account for approximately 80 % of the tyre's weight. The remaining 20 % consists of strengthening materials. The wheel, upon which the tyre is mounted, is made of special lightweight alloys, especially aluminium.

Contrary to the normal car, whose chassis is made of steel, the body of a racing car is made of a special plastic, called **Kevral**. This plastic has very special features. It is very solid, inflexible and lightweight. It is used for the manufacturing other things like bulletproof vests for policemen and for the bodies of planes and ships.

# Automobile Manufacturing

## MATERIALS – PARTS OF THE CAR

### GLASS

The car industry is one of the biggest **consumers of glass**. Glass for windscreens and some other parts of the car is made from silicate and silicate sand. Glass works are usually located near the sources of the raw materials – **silicate and silicate sand**. The operation of a glass works is energy intensive. The melting of the materials for glass requires high temperatures. Previously wood, charcoal and coal were burned in glass furnaces. Nowadays the use of natural gas has many more advantages. This includes a reduction in the release of harmful atmospheric emissions.

### PLASTICS

Plastics are made from oil. They can replace some metal parts and make the car lighter. This leads to lower fuel consumption, greater speed and more safety.

Synthetic textiles resist wear and are easier to clean. Many parts of the car interior and electrical system are made of plastics.

### CLAYS

Ceramic parts such as insulators are made of clays. They contribute to the functioning of the electrical system.

### PLANTS AND ANIMALS

Not only synthetic materials, but also natural plant materials are used for the manufacturing of seat covers and interior facings. Animal fibres are used as well.

### THE BEST INVENTION – STEEL MANUFACTURING

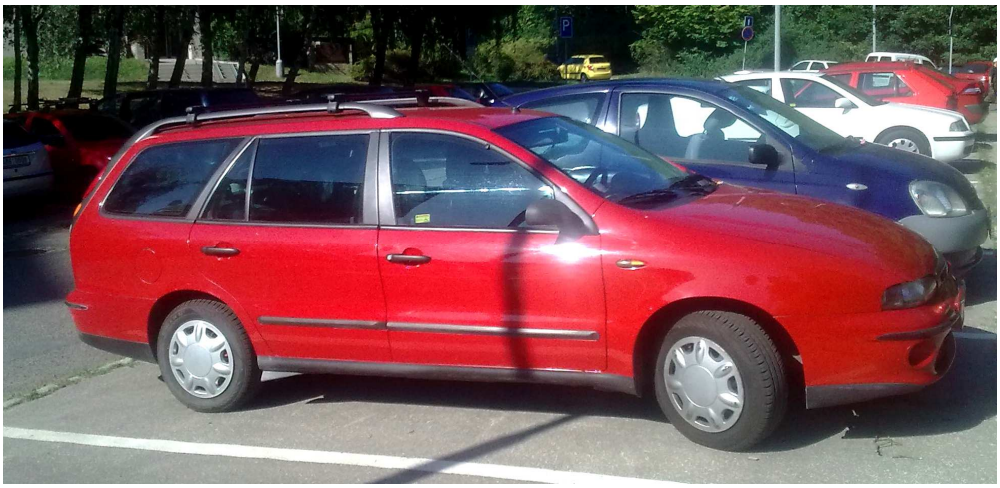
Steel is made by the process of refining raw iron, by reducing the volume of carbon and some other elements. The steel is processed into metal sheets at the steel works. The sheets are delivered to the car company where it is cut into a variety of shapes. These shapes are used to form the car body and are joined together by spot welding. The body is covered with a layer of zinc to prevent corrosion. The body is then attached to the chassis by a strong steel girder. The entire structure is placed on an assembly line and other components are attached.

**Car windows (windscreens), mirrors and lights** are made of safety glass. The glass is composed of layers and, therefore, the windows do not break into sharp pieces which can cut the occupants of the car.

**Seats and steering** wheels may be coated with various materials. Chamois, which is a type of soft leather, is used very often. This material allows for a very good grip on the steering wheel.

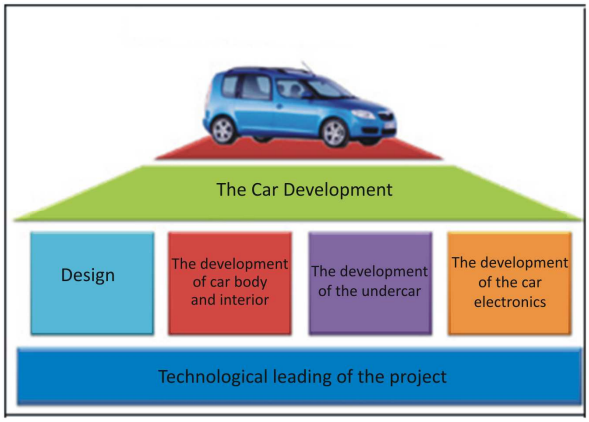
The car industry has taken advantage of the many advantageous properties of plastics.

Various types of **textiles** are also used in the car, especially in its interior. Carpets are made from recycled textiles. Seat covers are made from synthetic textiles.



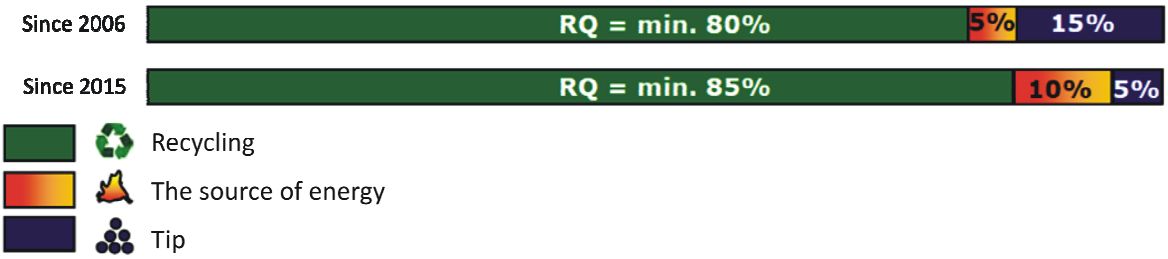
# Automobile Manufacturing

All the parts needed for the final assembly of the car are arranged in a row in the car factory. The car proceeds on a moving assembly line and all the parts, components and accessories are gradually added. Once the car is finished, it is tested for possible defects.




*The development of a new car includes several interconnected activities that are made by professional car designers*

Meeting the required quota (RQ) during the ecological liquidation
(Data in % of car weight)




## ECOLOGICAL DISPOSAL OF THE CAR

**What does recyclability mean?**

Recyclability means that we can treat car components that have already been used so that they can be used again. Recycled car components and materials can be used for the manufacture of pellets, furniture, glass products and many other goods. The recycling rate of a product is known as the fixed recycling quota. For instance, Škoda cars are at least 85 % recyclable, and another 10 % can be used for energy. So, it is possible to dispose of only 5 % of the car in the landfill.

A recycle quota for passenger cars of 85 % of the car's weight was established by an EU directive. Metals, liquids, and components which may be dismantled (which means larger plastic components) are considered recyclable parts when there are proven technologies which allow for further processing. New technologies such as those which allow for the separation of materials from wrecked cars have also significantly increased the recycling quota.

## LEARNING ACTIVITIES:

13a Where are you from Mini? The World of Components – methodological sheet

13b Where are you from Mini? The World of Components – worksheet

14 The Car Registration Book – worksheet

16 The World Car Producers – worksheet

17a Getting Familiar with Manufacturing Cars at ŠKODA AUTO a.s., Mladá Boleslav – methodological sheet

17b Getting Familiar with Manufacturing Cars at ŠKODA AUTO a.s., Mladá Boleslav - worksheet

# The Car Industry

*We have seen the largest increase in the production of cars occur during the second half of the 20th century. Are you interested in how many cars are made currently? Who the largest car producers are? Which car companies produce the most cars? Which company now manufactures Škoda? Which brands of cars are seen on our roads most often? The following text is going to answer these and other questions related to automobile manufacturing.*

When the car is finally completed, there will be the retailer and, ultimately, the final customer – the car owner or driver. The customer pays as much money for the car as was necessary to produce the car. This price included everything from the extraction and processing of the raw material, the production of components and car parts and their assembly, the costs for the construction and operation of the production plants which are involved in the process of car manufacturing, and the profit of the car dealer. Only then does the owner sit in the car and drive on the road.

The operation of the car requires power which is provided by fuel. At the car dealer, where car is sold, the petrol tank is filled with as much fuel as it needs to get to the nearest petrol station. Meanwhile, this fuel, which has been put into the car, has undergone a long journey from oil drilling all the way to the pump in the petrol station. Now, it is pumped into the tank and then passes into the engine, where the combustion releases energy and supplies the car with movement and speed. The fumes emitted through this process affect the surrounding environment. People have had to invest time, energy and materials in the construction of the roads.

*New Ferrari model - 458 Italia Model which was developed in cooperation with Michael Schumacher, the ex-Formula 1 driver.*

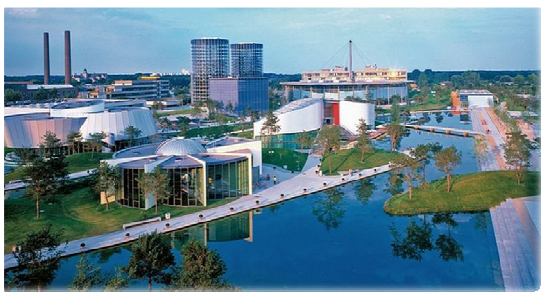
## AUTOMOBILE MANUFACTURING

The manufacturing of cars and other vehicles has become the symbol of economic development in the 20th century. Car production increased rapidly, especially, in the second half of 20th century. The number of countries producing cars is increasing, but also the proportion of each country's total output is changing. Gradually it is leading to the shift of production from traditional industrial powers to other developing countries.

Japan, with its output of 11.5 million cars per year is the world leader in car production. China produced 9.3 million cars in 2008 and the United States produced 8.7 million cars. In fourth place is Germany. We can see that for the first time in its history the market for cars has slightly declined (by about 3.7 % in comparison to the year 2007). Some countries (e.g. France, USA) have registered slight declines compared with previous years, on the other hand, we can see the car markets rapidly developing in other countries, e.g in Brazil, India or China. We can also expect a shift of car production into these countries within the next few years. Everyday, the number of customers in these countries is increasing and there is still very cheap labour whose price is incomparable with developed western countries (or with the developed Asian countries).

| Name of country | Number of cars |
|---|---|
| 1. Japan | 11 563 629 |
| 2. China | 9 345 101 |
| 3. USA | 8 705 239 |
| 4. Germany | 6 040 582 |
| 5. South Corea | 3 806 682 |
| 6. Brazil | 3 220 475 |
| 7. France | 2 568 978 |
| 8. Spain | 2 541 644 |
| 9. India | 2 314 662 |
| 10. Mexico | 2 191 230 |
| 11. Canada | 2 077 589 |
| 12. Russia | 1 790 301 |
| 13. Great Britain | 1 649 515 |
| 14. Thailand | 1 393 742 |
| 15. Turkey | 1 147 110 |
| 16. Iran | 1 051 430 |
| 17. Itály | 1 023 774 |
| 18. Poland | 950 908 |
| 19. Czech Republic | 945 822 |
| 20. Belgium | 724 498 |
| **World Total** | **70 526 531** |

*The number of cars produced in 2008*



*The industrial city Wolfsburg is the headquarters of Volkswagen. In 2000 a new exhibition was opened at the car museum Autostad. Every model made by Volkswagen has its own exhibition. The area reserved for Škoda is 650 square metres.*

# The Car Industry

**WEB LINKS:**

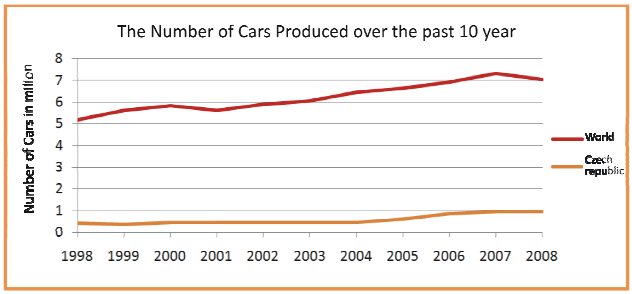
http://news.auto.cz/ekonomika/

http://www.oica.net

Due to the wide range of raw materials, components and parts needed from many specialized suppliers, the need for skilled workers and vast sales opportunites , the car industry is a **driving force in a country's prosperity**.

## THE AUTOMOBILE MANUFACTURING IN THE CZECH REPUBLIC

Because automobile manufacturing is one of the most important industries in the Czech Republic, it has a substantial effect upon the Czech economy. The car industry in the Czech Republic is characterised by technological improvements in vehicle quality (lower noise, fuel consumption, emissions), a growing number of motor vehicles and an increasing density of traffic. There are more than 5 million cars registered in the Czech Republic. Within the last 20 years this number has doubled. All this has created a negative impact on the environment.




The largest car manufacturers are: General Motors, Ford/Mazda, Volkswagen and Toyota. Altogether they produce almost half of all the world's cars.

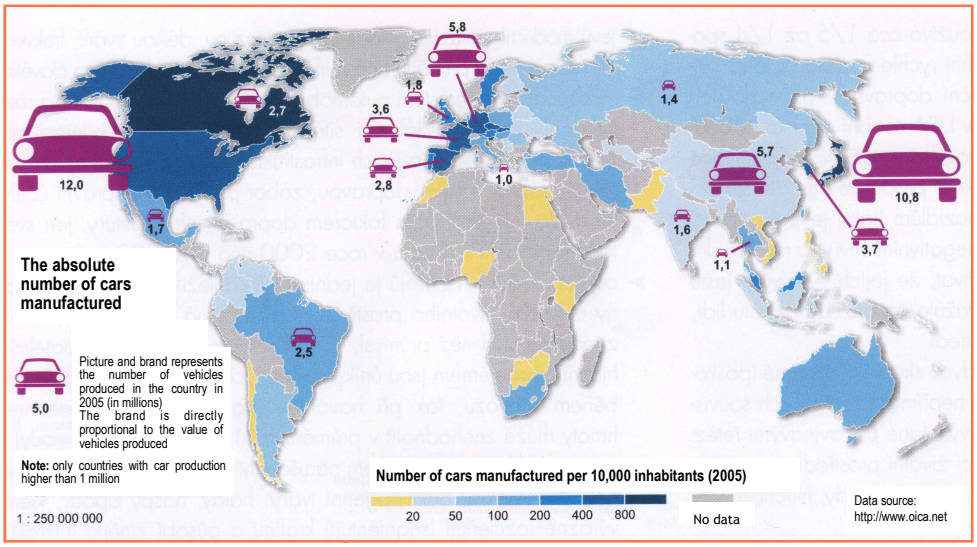
## ŠKODA AUTO

Automobile manufacturing has a long history in the Czech Republic, See the chapter on History of Transportation. Škoda Auto has been building cars since 1925. **Škoda Auto** is **one of the country's largest** and most important businesses with an exceptional position in the Czech economy. In 2007 Škoda Auto produced more than 620,000 cars and posted sales in excess of 220 billion Czech crowns. The company employed **23, 500** workers in the Czech Republic. With its almost **7.5 % share of exports it has defended its position as the top exporter in the Czech Republic** . It also has played a key role in supporting the 265 Czech subcontractors of components and services. In 1990, due to not being able to keep up with world markets, Škoda Auto became part of Volkswagen, the German car company which also produces the Audi and Seat brands.

| Car make | Number of Cars |
|---|---|
| 1. TOYOTA | 9,237,780 |
| 2. GENERAL MOTORS | 8,282,803 |
| 3. VOLKSWAGEN | 6,437,414 |
| 4. FORD | 5,407,000 |
| 5. HONDA | 3,912,700 |
| 6. NISSAN | 3,395,065 |
| 7. PSA | 3,325,407 |
| 8. HUNDAY | 2,777,137 |
| 9. SUZUKI | 2,623,567 |
| 10. FIAT | 2,524,325 |
| 11. RENAULT | 2,417,351 |
| 12. CHRYSTLER | 1,893,068 |
| 13. B.M.W. | 1,439,918 |
| 14. KIA | 1,395,324 |
| 15. MAZDA | 1,349,274 |

*Tha Car Production According to the Automobile Manufacturers*

### Number of cars manufactured in countries around the world




*Taken from Dnešní Svět : Auta na Zemi, n.1, vol. 2006/2007*

## THINK ABOUT:

Explain which countries automobile manufacturing has shifted to and why.

Using your own words, describe the history of automobile manufacturing at Škoda Auto.

http://www.novinky.cz, Wednesday August 5th 2009

The average age of a car in the Czech Republic is 13.6 year

On the last day of June 2009, a total of 4,409,508 cars were registered in the Czech Republic. Their average age of a car was 13.68 years old. More than half of the registered cars were more than 10 years old....

.....Škoda, Fiat, Ford, Peugeot and Renault are among the cars most often still in use when older than 15 years. On the other hand, the brands used the shortest period of time are Alfa Romeo, Subaru, Kia, Trabant and Toyota.

# Visions and Predictions

*Are the oilfields exhausted? Are there any new oilfields to be discovered? Will oil become more expensive? How many cars are there now in the world? Where to go to find cheaper and healthier means of transportation? Is there any way to get out of the labyrinth of dependence on oil and to find the cheaper and healthier sources of fuels for transportation?*

Oil is one of a limited number of sources of fuels. It's still considerable reserves will be used up and, therefore we are looking for new ways to replace it. The growing number of cars, even if they use less oil, will result in still higher oil consumption. New oilfields are being discovered in previously technically inaccessible places. This has begun with the expensive extraction from oil sands or on the bottom of oceans. The areas which contain the remaining oil reserves are of great concern to those countries, especially the USA, whose consumption of oil is the highest in the world. Thirst for oil can also create an explosive situation. Independence from oil will allow for a freedom from this dependence on oil.

Teams of experts continue to look for new, cleaner and less oil-dependent energy sources for cars. At the present time there are cars running on natural gas or ethonol. Currently, there are prototypes for cars which run on hydrogen or solar energy. There are also some cars which use two or more sources of energy.

Car transportation significantly contributes to environmental pollution. That is also a serious motivation for finding alternative sources of fuel.

## NEW SOURCES OF OIL

The modern world has enough oil for the next few years, and we do not expect the oil wells to dry up. But the demand for oil is still growing; today it is around 80 million barrels per day (1 barrel = 159 litters). Oil drilling has shifted from the continental shelves to the ocean bottoms, to the depths of thousands of meters. That is more technically demanding and less safe ecologically. Another possibility today is the mining of oil sands, see the Chapter on Mining.

## THE WORLD CAR PARK

The number of cars in the world is still growing. A **great boom** is expected in the two most populated countries, India and China. **The world car park** now consists of **800 million** cars (in the Czech Republic there are 4.5 million cars). Within the next 25 years this number will **double.** Even in the developed world it will not be possible to refuse individuals this means of transport, only to regulate it. It is necessary to **develop cars which have lower fuel consumption and are more environmentally-friendly**.

## THE SECRET OF LOW FUEL CONSUMPTION

More powerful engines have been designed since the construction of the first cars. Petrol consumption increased and nobody thought about how to use fuels economically. But, the oil crisis has forced car manufacturers to produce less thirsty cars. The quantity of pollutants, which are released into the air during combustion is connected with the high consumption of fuel. Due to technological progress, 100 cars emit less pollutants into the air today than one car did in 1975.

**Fuel consumption is influenced by:**

- engine efficiency
- driving resistance – friction, aerodynamics, ….
- driving style – driver
- terrain and weight of the car
- car status

The resulting combustion efficiency to power the car is only about 25 %. Most of the energy is transformed into heat, as we can see from this infrared picture which shows the temperature field of a moving car.

# Visions and Predictions

There are already types of cars which use **less than 3 litres of fuel per 100 km**. The main goal is a car which could get by with consuming only **1.5 litres of fuel per 100 km**. Extremely low consumption levels could be achieved if the car could meet other design requirements:


*Prototype of VW - petrol consumption is 1.5 litres per 100 km*

- **Minimal air resistance.** Air resistance can be reduced by using an aerodynamic body shape. The ideal shape would be that of a falling drop of water which would be the lowest coefficient of drag.
- **Low weight.** A lower the weight means less energy is required for car acceleration. The efficient car should be made of light materials, such as plastic and aluminium.
- **Chassis with the engine in the middle of the car.** An engine located in the middle divides the weight of car which is then more stable at the corners. It also leads to a more efficient driving style , which is encouraged by the low centre of gravity.
- **Limit the maximum speed.** Drivers who speed to get to their destination faster, sometimes do not arrive at all. In order to protect passengers, the ecological car will, therefore, have a limited maximum speed.

*This really interesting flat car is included in Guinness World Records as the lowest car in the world. It is 48 centimetres high. The car is very similar to Batman's Batmobile. But the car is also dangerous - its creator, Perry Watkins, forgot to think about high urban curbs. Although the car meets the conditions for operating in traffic, it is extremely dangerous to crash or roll over in this car.*


## DEVELOPMENT OF INNOVATIVE IDEAS

Nobody knows, what ideas will be developed for car manufacturing in the future. Maybe there are some alternative fuels which have not been thought of yet. That is the task for scientists, engineers and technicians, to test innovative and new ideas. We can only introduce some of possibilities.

The volume of emissions is a part of the technical documentation of the vehicle. Part of the regular state technical inspection of the vehicle (known as STK) is a measurement of the amount of fumes emitted. The certification of the technical inspection is marked on a sticker which is placed on the motor vehicle license plate.

## THE AIR CAR

Sometime in the future we might see cars which run on compressed air. These cars could be equipped with small compressors so that they could refill the air anywhere they have access to electricity. Actually, the use of compressed air would overcome the problems of hydrogen or electric cars. Energy storage requirements for compressed air itself are small, but total the storage space required is large and heavy. The air must be compressed by using an internal combustion or electric engine. This reduces efficiency and so the air car's consumption of conventional fuels increases.

## THE NATURAL GAS CAR

A fuel which is usable in an only slightly modified engine is natural gas. Its world reserves are large and it could be 150 years before they are used up. Application is possible in compressed form as CNG (Compressed Natural Gas) or as LNG (Liquefied Natural Gas). Even though natural gas is a fossil fuel, it releases only a small amount of emissions.

## THE LPG CAR

Currently the most popular alternative fuel is Liquefied Petroleum Gas (LPG). It is a mixture of hydrocarbons obtained as a by-product of refining oil. It is possible to convert this gas into a liquid state by compressing or cooling it. As a liquid it has a small volume. Converting a gasoline engine to LPG is simple. Propane and butane are currently being used in the transport of gas mixtures, but the question of fuel for future cars does not deal with LPG.

# Visions and Predictions

## THE ELECTRICCAR

The electric car still has not advanced very far. Heavy batteries need to be recharged for hours and a driving radius of a distance of only 100 km is clearly insufficient. Its advantage is that electricity can be generated from emission-free sources – from the earth's core, the sun, wind and water.

*Current electric car shapes and range per charge - from the left Venturi Fetish (2006, Monako, range per single charge - 250 km), Testa Roadstar (2007, England/USA, range - 230 km), Lighting GT (England, range - 400 km)*

## THE HYBRID CAR

Hybrid drive systems, which have found their way into production, could be useful during a transitional period. A car, which runs on the hybrid drive system uses more than one source of energy. The word hybrid most often means the combination of an internal combustion engine and electric traction. Hybrid drives take advantage of the different working condition of the vehicle.

A serial hybrid drive – a combination of internal combustion engine, electric motor and battery pack – has been tested. For short distances (driving around town) the car runs on a lectric motor. The motor is powered by a battery pack. For long distances or when greater acceleration is needed, the car runs on an internal combustion engine. When the car is running on its internal combustion engine the electric motor changes its function and starts to work as a generator. Also, when braking, it produces electricity for recharging the battery pack. The advantage of the serial hybrid drive system is the possibility of the combined use of each drive in the moment of its greatest efficiency. This ensures a reduction in consumption. On the other hand, the disadvantages are a high vehicle price and increased vehicle weight due to the weight of the battery pack.

## CAR USING BIO-FUELS

The use of ecological fuel generates many controversial discussions. Agricultural crops such as the following are used for its production: rapeseed oil, corn, and sugarcane. One possibility is to use bio-diesel which is made from rapeseed oil. Bio-diesel is biodegradable and does not threaten the land or water. Therefore, it is suitable for cars or chainsaws in protected areas.

The disadvantages of bio-fuels can be summarized as follows:

- The use of machines for planting, harvesting and transport is a decrease in CO2 emissions by about 35 %.
- Emissions of nitrogen oxides are slightly higher than for normal fuel.
- Intensive cultivation of rapeseed oil is not possible without the use of fertilizers and protective equipment for plants. By cultivation of monocultures is limited animal and vegetable world.
- Cultivation of plants required large quantities of water.
- At a time in which food shortages exist in many areas of the world it seems like a luxury to use agricultural land to produce fuel. However, this need to be looked at in relation to agricultural overproduction, e.g. in Europe.

**Green Volvo**

The carmaker Volvo has introduced a prototype car to experts which runs on various types of fuel. Volvo wants to present the efforts it is making to find different ways of transport in the future. The Volvo V70 Multi - Fuel is a prototype car which has been modified for the use of five different fuels: a mixture of hydrogen and gas or methane, bio-methane, gas or bio-ethanol E85 and petrol. The gaseous fuels (methane, bio-methane, and natural gas) can be placed into one larger and two smaller tanks for a total volume of 98 litres; for the liquid fuels (bio-ethanol E85 and petrol), a 29 litre tank is available.


# Visions and Predictions

## HYDROGEN CAR

### Hydrogen and its production

Hydrogen could propel environmentally clean cars in the future. Hydrogen production itself is very demanding in terms of electricity. Hydrogen is produced by means of other primary energy sources (fossil fuels, electricity from nuclear power, or electricity from alternative sources). The greening of the energy depends on the ecological purity of the hydrogen car.

Hydrogen is perhaps usable throughout the energy economy as a handy accumulator of surplus electricity from renewable resources. Hydrogen is not a classic fuel, but an energy vector or energy carrier. It is difficult to release hydrogen from water. To break this bond you need to use a lot of energy. At times each power station has a surplus of electricity which is stored and could be used to split water molecules into hydrogen and oxygen. By initiating a reverse reaction of hydrogen with oxygen, energy can be released and it is, therefore, usable.

*A Japanese automaker has started producing a car powered by hydrogen. It is the first commercially produced car running on hydrogen. This model, called FCX Clarity, uses hydrogen and its exhaust is pure water vapour.*

### Why not run on hydrogen?

The only practical way to transport and store hydrogen is in its liquid form. However, even that is tricky for re-fuelling. The handling of hydrogen is problematic, but the advantage is that the only by-product of burning hydrogen is water vapour.

Currently, ways are being explored as to how to store hydrogen:

1. liquefied and stored in insulated containers
2. high pressure compression and storage in pressurized containers
3. stored in a solid state – in the form of light metal hydride
4. absorbed into porous materials having a high specific surface

*Fiat presented the new concept of an ecologically clean car. It is the Fiat Phylla - a small car which runs on hydrogen and solar power. The Phylla does not emit any exhaust other than water vapour.*

The prototype hydrogen car has only used the first method (liquefied H2). This method is problematic, for liquefied hydrogen requires maintaining a temperature below -250 °C which is very demanding in terms of energy. It says that liquefaction needs more than 30 % of the energy which is gained by burning hydrogen. Moreover, it is subject to continuous loss due to evaporation, which can be more than 1 % per a day.

The main disadvantage of the second method of preserving hydrogen (storage in pressurized containers) is the relatively low density of hydrogen. The evaporation rate in pressurized containers is only about 1 – 3 %.

It would be better to store hydrogen in the form of metal hydrides. Almost 200 litres of hydrogen (under low pressure) can be stored in 1kg of these metals or their alloys and are safe for people. This method is currently being researched. Containers of light metal hydrides could be available at existing service stations. The main factor preventing the expansion of this system is the high price of these compounds. This price reflects the complicated path that leads from elementary metal production to hydrogen production, transport and to pressurization of the hydride. Significant reduction in the price of hydride, along with the development of electric cars is a prerequisite for their establishment.

## CAR USING ENERGY FROM FUEL CELLS

**Fuel cells*** are the source of energy for the car running on an electric engine. The main limitations of this kind of fuel are the size and price of fuel cells, which are now used only in submarines and the space programme. The Czech H2bus, a hybrid bus running on hydrogen fuel drawing power from fuel cells 48 kW PEM, has been put into trial operation this year. The first hydrogen filling station in the Czech Republic was built in Neratovice.

Normally, there are dozens of units of stationary fuel cells in use, which act as the backup power supply for banks, airports, and hotels. Every major automaker has its own prototype fuel cell vehicle. There are also prototype fuel cells for laptops, cameras, etc. The present in fuel cell technology could be characterized as a period of intense research and development, demonstration projects and preparation.

*Hydrogen powered bus, which was developed in 2006 by the Nuclear Research Institute in Řež near Prague.*

*Source: www.autobusovenoviny.cz*

# Visions and Predictions

## HUMAN MUSCLE STRENGTH AND THE ELECTRIC ENGINE

The human can move a reasonable distance by using his or her own muscle power. Leg muscles are used more efficiently when riding a bike rather than when walking. Bicycles are ineffective only on steep inclines or in strong headwinds. To offset these disadvantages, engineers have developed a special bicycle which is still primarily driven by human muscle power. Its auxiliary electric motor is activated by the pedals and assists the rider. For example, if there is a 300 watt electric motor, an active rider, by using the pedals, could contribute 200W, and, therefore, replace two thirds of the power. The more athletic the riders, the more efficiently they ride. Bicycles using these principles have been made especially for operation in urban areas. By utilizing an electric motor, a bicycle can haul cargo weighing more than 200 kg.

The various vehicles continue to be improved. Only the driver still remains the same. It can be said that most traffic accidents are caused by human carelessness, selfishness and ruthlessness. Only a small percentage of accidents are caused by the car itself. What the perfect car of the future might be missing is the perfect driver.

Already today, designers are trying to create the robot-driver. Volkswagen has presented an automatic driver with three legs and three hands called Klaus. The robot drives totally automatically, without human intervention and without special equipment. Information for navigation on the road is provided by a stereo-camera, a satellite navigation system and radar. These devices are connected to an onboard computer which gives driving commands. Although the robot is not yet ready for normal use, some components like the electronic breaking system and the collision avoidance technology could help people now. The problems connected with the robot-driver are not only with the technologies, but also with legislation. The laws of all the European countries state that the driver is responsible for the operation of the car. A robot cannot be held responsible. We see, therefore, that the issues are related not only to science and engineering, but also to moral and ethical questions.

## LEARNING ACTIVITIES:

15a The Dream Car – methodological sheet

15b The Dream Car – worksheet

18 CO2 Emission – methodological sheet

19a CO2 and its features – methodological sheet

19b CO2 and its features – worksheet

**Comparison of $CO_2$ emissions released by petrol and by diesel combustion**

| Type of fuel | Power | Engine | Consumption (v l/100km) | $CO_2$ emission (v g/km) | Price of the same model with different engine |
|---|---|---|---|---|---|
| petrol | 75 kW | 1.6 MPI. | 7,4 | 176 | 500 000,- |
| diesel | 77 kW | 1.9 TDI PD. | 4,9 | 130 | 550 000,- |

## THINK ABOUT:

1. Assess which driving style factors negatively affect fuel consumption
2. Compare and evaluate the pluses and minuses of using bio-fuels to power cars.
3. Consider the reasons for the slow increase in the use of propane butane for cars.
4. Work with the table. If you consider the life of an engine to be 100 000 km, calculate how much fuel a car uses if running on petrol and on diesel. According to the present prices of petrol and diesel, calculate the price of the fuel needed to operate a car for 100 000 km. According to your calculations and differences in the price in the table, evaluate whether it is more efficient to operate the car on petrol or on diesel? How will it change if the lifespan of the car is 200 000 km?

# Car Safety

*Can technique prevent the failure of a driver? How can we increase the safety of the occupants of the car?*

Designers ask these questions during the design process of every car. The safety of the car is also the most often asked question which the customer asks the salesman when choosing a new car.

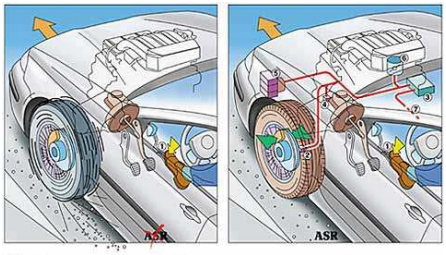
Cars are equipped with various safety features which can save people's lives in the case of an accident. But, the car's equipment isn't the only important aspect of safe driving. Compliance with safety regulations and recommended rates of speed also affect the number of accidents on the road. The ability of the driver also plays a big role. Some drivers overestimate their abilities and the possibilities of their car.

It is up to each of us as to what extent we take responsibility for people's lives and our willingness to respect our environment.

## ACTIVE SAFETY

In this group we can include technical components, equipment and features of the car which can prevent or avoid accidents. The most important of these is good brakes. Although the current electronic systems are a great help for coping with critical situations, cars equipped with an ABS brake system, brake assistant, slip systems (such as ARS) or stability control systems are better.

Even seemingly small things like a comfortable ride and a good view on all sides, easy access to all drivers, they all are very important or the active safety. The right temperature can prevent sleepiness and a reduction in driver's alertness.




*ARS-traction control system prevents wheels from spinning by reducing power*

### Driveability

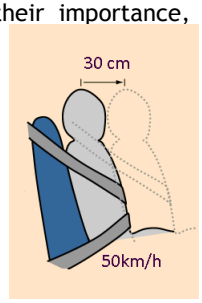
Every car must be stable enough for normal driving conditions. It should have effective brakes and sufficient dynamic characteristics – the ability to accelerate. Good and well-functioning brakes can prevent many accidents. The main goal of the car manufacturer is for the car to achieve the shortest stopping distance on the every type of surface and to be able to control the car while braking. In order to optimize the operation of the brakes it is necessary to use the appropriate tires and sometimes modern electronics.

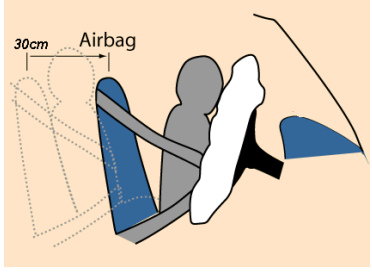
Driveability can be influenced by the technical condition of car, the quality of the tires and by the weight distribution which determines the position of its centre of gravity. Understeer or oversteer are given as mass per front and rear axle.

## PASSIVE SAFETY

In the case of an accident, passive safety plays the most important role. The kinetic energy of a car crash needs to be absorbed so that it minimizes risk to the occupants. That is why the car is divided into three parts: with the space for passengers in the middle, which acts as a safety cell, and crumple zones in the front and rear which are flexible. The car's safety design has a special structure; the critical parts of car body are composed of rigid and fixed longitudinal and transverse beams, profiles and also the columns are reinforced. Upon impact the car body is damaged and absorbs a large part of the energy to keep the passenger compartment from undergoing significant changes.

**The seat belt** plays one of the most important roles in a person's safety because it prevents the movement of the body during a crash. By fastening it we reduce dangerous body movement. The use of airbags moderates the crushing force at impact and prevents contact with parts inside the car. Air bags should reduce the effects of an accident. Seat belts have not lost their importance, even in the time of **air bags**. Air bags are just another support system and if the driver is not wearing his seat belt during an accidental release of an airbag, the airbag can cause injuries. In the case of adaptive air bags it is possible to activate two types of airbags. If the crash is not too serious and the passenger is sitting close to the dashboard, the amount of air in bag is reduced and his upper body is struck with less force. The length of time an air bag remains inflated does not depend upon the degree of the impact.



# Car Safety

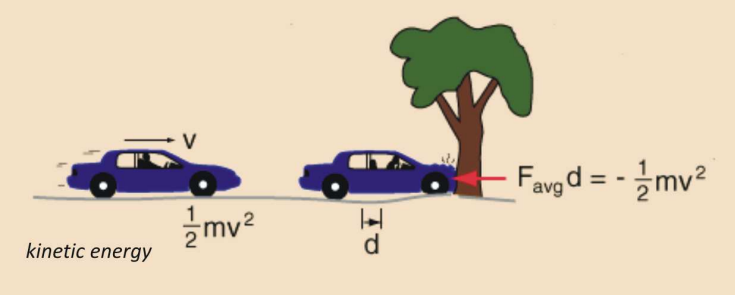
## CRASH TESTS

During the development of the car, manufacturers conduct crash tests from different directions and speeds and do tests for rollovers and for collisions with smaller barriers. Due to the physiological structure of the human body these internal tests are carried out at speeds of around 75 km/h. Over this speed the risk of an accident is significantly reduced. Tests take into account crashes which cause fatalities and serious injuries. Most tests are focused on frontal collisions, where the activity of airbags and deformation of body can be evaluated. The second group of tests are related to side crashes, where they look at airbag performance and the behaviour of the sides of the car and their influence on the safety of the passengers. Also included are rear-end collisions and roll-over tests, which evaluate the risk of injury to passengers. Lastly are a series of tests related to collisions with other objects, such as pedestrians or animals.

**Dangerous energy increases with the square of speed**

A car with a weight of 1 ton travelling at a speed of 90 km per hour. it has a kinetic energy of 312 500 J. If the car travels at double that speed, 180 km/h, its energy increases fourfold to 1 250 000 J.

The impact on obstacles (rails, other cars, trees) is then equal to four times the work, which not only damages the car.




**Stopping distance** has a quadratic dependence on initial speed. The calculation of the stopping distance for vehicle driver's reaction time= $t_1$, constant technical timeout brakes=$t_2$, initial velocity=$v_0$, the variable coefficient of friction=f and so on.

General solution is

$$s = v_0 (t_1 + t_2) + \frac{1}{2} \cdot \frac{v_0^2}{f \cdot g}$$

where g means gravity acceleration.

## THE DISTANCE BETWEEN CARS

A driver should maintain a reasonable distance behind the vehicle in front of him, 2 seconds is recommended.

Driver reaction time is about 0.7 seconds if the car's speed is 180 km/h (50m/s) the car is going 0,7 x 50 = 35 m. More time is required for the brakes to begin to work. It means that if the driver wants to come to a complete stop when travelling at 180km/h he needs around 60 meters. Whether a driver can come to a stop in time also depends on road conditions. The driver whose stopping distance is too short can do nothing.

Under bad conditions, e.g. rain, it is difficult to "estimate" the safe driving distance necessary between cars. This can cause a chain of highway accidents. So an "intelligent highways" system is being tested. A computer located on the dashboard communicates with sensors placed on the highway (analyzing weather, movement of cars, etc.) and in the surrounding cars. The system automatically adjusts the speed of the car and recommends the distance to be maintained between cars. What emerge is group of cars travelling at a constant speed. But the car is still operated by a person. It is still not possible for a car to be driven without human involvement, because of the current laws.

### LEARNING ACTIVITIES:

23a Safety Map - methodological sheet

23b Safety Map - worksheet

24a First Aid after an accident- methodological sheet

24b First Aid after an accident- worksheet

25 Reaction Time

### THINK ABOUT:

Indicate principles for controlling the car to increase traffic safety in the city.

Specify the safety features and equipment which can be classified as active and passive ones?

# How the Car Operates

*Does the steam engine give more to science than science gives to the steam engine? Is the internal combustion engine – the most important source of mechanical energy in the world?*

Most of today's cars are powered by the internal combustion engine. This engine occupies a leading place in the list of human inventions. Unlike the steam engine, the internal combustion engine is compact and fits easily into your car. Unlike the electric engine, the combustion engine is able to power a car over long distances thanks to the combustion of fuel. The internal combustion engine achieves an excellent balance between the use of fuel and its weight, has low maintenance requirements and is reliable.

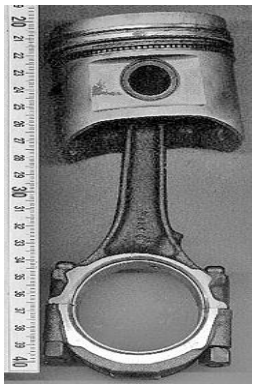
The key to the functioning of the internal combustion engine was to manage the work of gas in the so-called ring events. These engines gave rise to research into how to use petrol in as effective way as gas was used in steam engines.

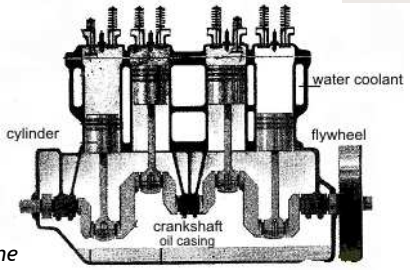
Mechanical energy can be easily changed in the Internal Energy; but reverse conversion is needed in the engine. This is what happens to fit the gas as the working substance because gases can quickly give off and receive heat. The work of gas which is done within the one event is small and if we need the gas to do more work and for a long time then it is necessary to convert the gas to its original state so the event can be repeated. This is **the ring event*** which is a sequence of changes. After this the working gas quickly returns to its initial state. The size of the work of gas per cycle is estimated from the content of areas located in the so-called pV diagram between the respective curves.

The gas in the engine usually works in an enclosed space (usually in the cylinder). The gas is formed after the ignition of a small quantity of fuel droplets in the inlet air. The fuel explodes and it produces large amounts of hot gas which pushes the floating piston in the cylinder. The piston is attached directly to a **connecting rod**, the other end of the connecting rod is attached to a handle, the so-called crankshaft. The piston pin and a connecting rod are two of the most demanding mechanical parts of the engine.

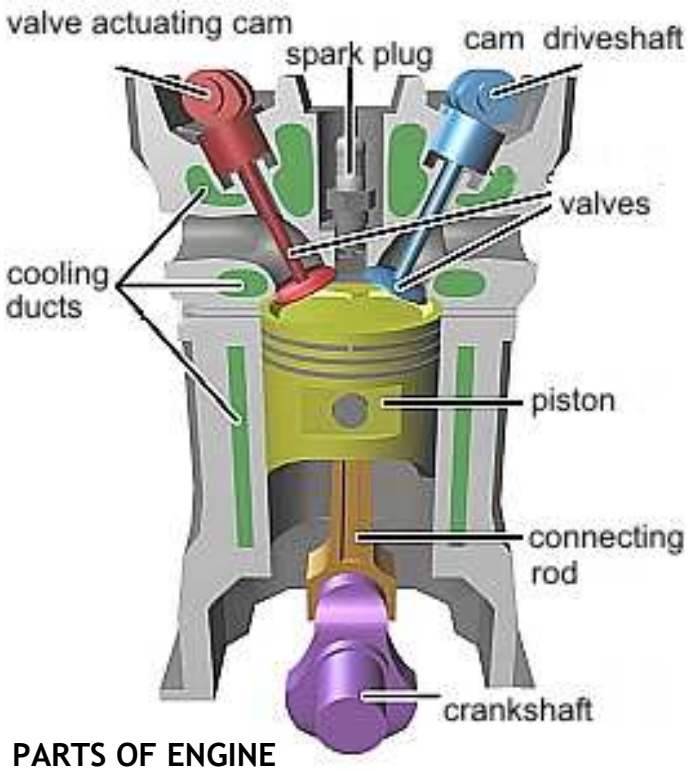
A sliding up and down movement of the piston turns the crankshaft which then turns the car's wheels. For most cars, which are front-wheel drive, the crankshaft turns only the front wheels. However, in a four-wheel drive car it turns all four wheels. Typical car engines have 4, 6 or 8 cylinders. The movements of the pistons in the cylinders are timed to move in line with the pistons in the other cylinders, all continuously rotating the crankshaft.

Engine performance can be enhanced in several ways – by increasing the volume of the cylinders or increasing engine speed. This method is taken to the extreme e.g. in Formula 1, where it is prohibited to use engines with a capacity greater than 3 litres. Therefore by increasing speed it increases performance. Modern cars use electronic devices for maintaining precise timing in ignition and for the metering of fuel into the cylinders. This improves performance and reduces fuel consumption.





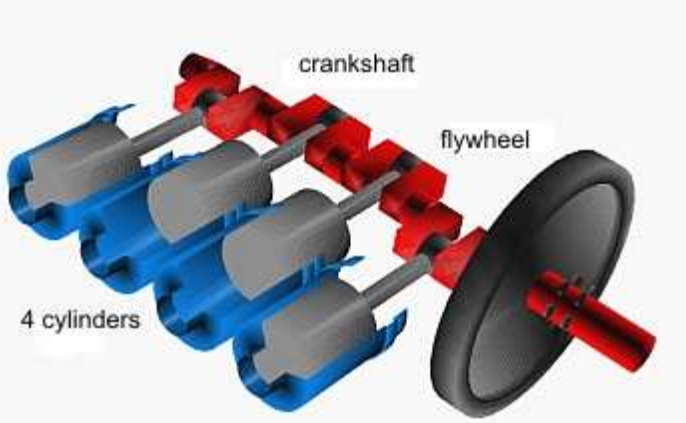

*Section of 4 cylinder engine*




**PARTS OF ENGINE**

# How the Car Operates

The type of fuel mixture used divides internal combustion engines into either **gasoline or diesel engines**. A diesel engine is more efficient than a gasoline engine because it is able to absorb and compress air at a ratio of 14:1 to 25:1. Diesel is injected into the compressed air, which spontaneously ignites. A gasoline engine compress air with gasoline and this mixture can be compressed only at a ratio of 8:1 to 12:1.




*Crankshaft*

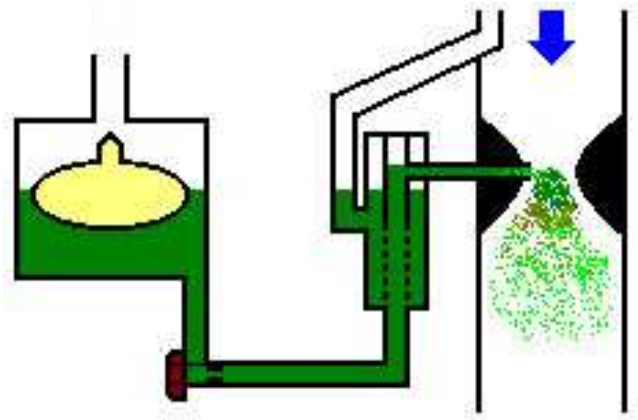
## OTTO'S GASOLINE FOUR-STROKE ENGINE

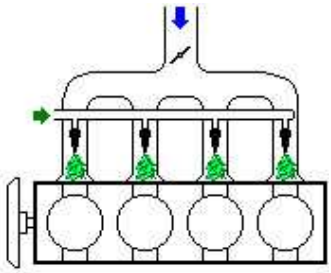
The gasoline engine is the most widely used thermal machine in the world. The cylinder head of a gasoline engine contains a spark plug and intake and exhaust valves. Both valves are automatically opened at the appropriate time by rotating cams. The gasoline engine is fed by an emulsion – a mixture of gasoline with air. This mixture is prepared in the carburettor or is controlled by the electronic dispensing of mixture to each cylinder according to the operating conditions.

**Otto's engine – gasoline**

The four-stroke engine has 4 phases, after which the whole process is repeated

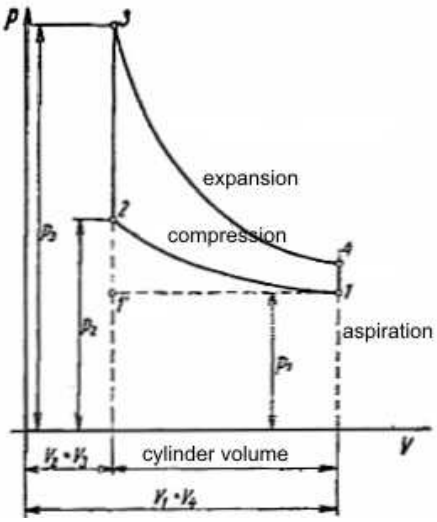
## CARBURETTOR AND FUEL INJECTION





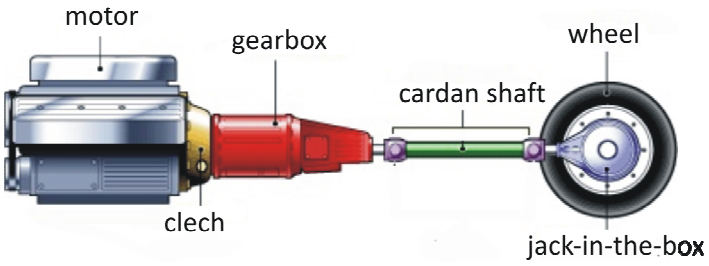
*The scheme of the carburettor and mechanism of fuel injection - supply air is shown in blue and fuel in green.*

The dispenser is the heart of the **carburettor**. The petrol is fed from the petrol tank into the float-chamber. The float is lying on the surface and is connected to a needle. The float chamber and fuel jet are communicating vessels. If the petrol in the float chamber is at the desired level, an additional supply of gasoline is stopped. The fuel jet leads to the mixing chamber through which air flows from the outside. In the air which flows around the jet, there is a vacuum. Due to this, petrol is soaked and sprayed. The amount of emulsion of this fuel mixture which is sucked into the cylinder engine is controlled by the butterfly valve.




*The scheme of four-strokes and estimation of pV diagram of ring- events of gas in the engine.*

# How the Car Operates




Engine work takes place in one cycle, so its operation is uneven. Smoothness is achieved by mounting a flywheel onto the crankshaft. To start the engine, the engine must perform four-strokes; the crankshaft turns two times - this means that the fuel is extracted and compressed. Therefore, when it is started, the engine shaft rotates the auxiliary electric motor. The efficiency of the four-stroke engine is around 30 %. The rest of the energy is unused. The main problem is in the back and forth movement of the piston. The piston accelerates constantly in one direction. Then it reverses its direction and accelerates in the second direction. Every up and down movement of the piston, at a thousand times per minute, consumes some energy which is supplied by the fuel.

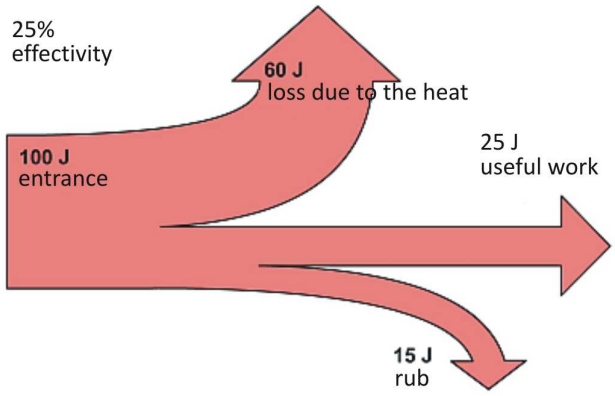
## DIESEL ENGINE

This engine is usually four-stroke. It is similar to the gasoline engine, but there is not any spark plug or any carburettor. There is a fuel injection pump. The construction of the diesel engine is massive because it must be able to withstand huge pressure and so the weight is heavier than a gasoline engine. This slightly limits its use. The fuel burns more freely and is combusted more completely and, therefore, the diesel engine is more efficient (40 %). Also, fuels can be of less quality and so diesel is used. As we said, the diesel compression engine has a more favourable ratio and less demand for cooling.

*Diesel engine*

## PHYSICAL NOTES:

The first law of thermodynamics precludes the existence of a device that would continuously work without consumption of any energy. But it does not exclude the existence of periodically operating machines, in which all the heat supplied is converted to work. The reversible cyclic process is called the **Carnot cycle***, after its discoverer. Carnot proved that the driving force - the work gained within this cycle is not dependent on the working substance; its size is established only by body temperature, among which heat transfer eventually takes place. The working substance must move the heat to the cooler, otherwise the machine cannot work. It is not possible to get they work cyclically, every time the heat is transferred. This means that the efficiency of machines is limited by nature. This fact reflects the second law of thermodynamics.




*The scheme of using energy of fuel for car*

Irreversible processes are all around us, e.g. friction caused by all work is converted into heat but the reverse (all heat is converted into work) is not possible. Heat spontaneously transfers from warmer objects to cooler ones, but not conversely. Therefore, this event is also irreversible.

In thermal machines it is necessary to dissipate heat to the cooler within isothermal compression; otherwise the device does not work at times. This heat is unusable for work in the machine, therefore we call it heat loss. It is possible to say that heat is a degradation of energy transformation; in thermal machines other forms of energy degrade the heat of the inner energy of surrounding objects.

## LEARNING ACTIVITIES:

26 The stopping distance of a car - methodological sheet

27 How to read charts of movement? - methodological sheet

28 The movement of the piston in an engine - methodological sheet

29 Heating and cooling, how they cooperate with each other? - methodological sheet

## THINK ABOUT:

What are the advantages and disadvantages of the internal combustion engine?

What kind of fuels can be burned in the internal combustion piston engine?

# Who Can Be a Driver?

*Who may obtain a driving licence in the Czech Republic? What to do in case of an accident? What effect does alcohol have on the concentration and awareness of a driver? What effects do drugs have on the concentration and awareness of a driver?*

**Who may obtain a driving licence?**

In the Czech Republic a driving licence may be obtained by people who are older than 18 and who are physically and mentally able to safely operate a vehicle on the road. Every person must take driving lessons and pass a driving test – even foreigners. One of the conditions for obtaining a driving licence is an assessment by a doctor of the applicant's medical fitness to drive motor vehicles. According to the law, a person must be medically fit to drive motor vehicles or medically fit with restrictions (includes minor medical restrictions).

Stricter criteria are applied to professional drivers – a part of their driving licence approval process includes repeated medical certificates which contain a traffic-psychological examination and an examination by electroencephalograph.

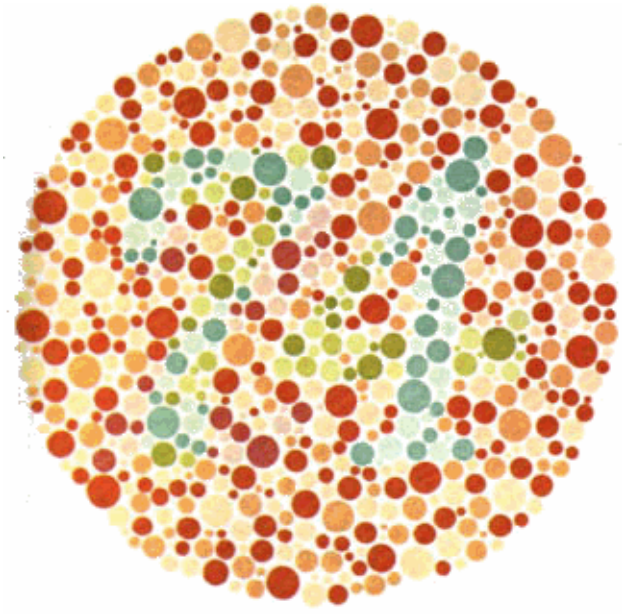
Other licence holders are obliged to have a medical examination during the six months before they become 60, 65 and 68 years old. After 68 they are obliged to have a medical examination every two years.

**Driving licence cannot be obtained by persons:**

- with a mental disorder
- who are taking long-term medication which affects awareness and concentration
- with some visual problems (colour blindness, severe short-sightedness ..)
- with some physical problems

**Driving licence with certain restrictions can be obtained by persons:**

- with visual problems – short-sightedness – which can be corrected with glasses or contact lens
- with hearing problems – this must be marked on the car
- with some physical problems for which the car can be specially equipped (e.g. by manual steering) and the car must be marked



*Correctly seen no. "74", some visual defect no. "21"*

One of the barriers in obtaining a driving licence is colour blindness. Around 10 % of the population in the Czech Republic suffer from colour blindness, or partial colour blindness. One of the disorders of colour blindness is Daltonism (the failure in perception of red and green). Men are most often affected because the gene which is responsible for the development of the cone and its work is situated on the X chromosome. In men the gene cannot be compensated for by the gene from the second chromosome X. It is women who very often transmit this defect.

**Decree No 277/2004 Coll.,** paragraph 1, provides that a doctor's report confirming the applicant's ability to drive is necessary in determining the ability to drive motor vehicles, medical confirmation of the ability to drive motor vehicles with the restrictions and pertinences of doctor's confirmation proving health problems for which the driver cannot wear a seat-belt (the confirmation cannot be replaced by the document on ability stated in the application form for a driving license, because this concerns the doctor's record for fulfilling the restrictions to be accepted on the course for obtaining a driving license).

# Who Can Be a Driver?

**INFORMATION RESOURCES**

**According to § 207 of decree No. 140/1961 Coll. (criminal law)**

(1) If you do not give first aid to a person who is in danger of dying or who is seriously injured in a stiuation where there is no danger to yourself, you can be punished by imprisonment for one year.

**According to § 208 of decree No. 140/1961 Coll. (criminal law)**

If the driver of a vehicle who after an accident in which he was involved does not give first aid to a person who is serously injured in a situation where there is no danger to himself can be punished by imprisonment for up to three years.

## FIRST AID IN TRAFFIC ACCIDENTS

The basic skills of the driver, besides driving and basic technical maintenance of the car, include the skill to give first aid.

**PRINCIPLES OF GOOD FIRST AID**

**After arrival at the location of a traffic accident first aid guidelines should be followed:**

**Ensure the safety of yourself and the injured** - use a triangular safety reflector, use a safety vest, with help of another person stop approaching cars, move people behind a guard-rail- if it is possible...

**Examine the injured** - identify the number of injured people, find out whether they are able to communicate or are unconscious, try to determine their injury.

**Call emergency number 155, we use 112 only in the case of a large number of injured people** - the dispatcher can help with other tasks. The more exact and the more detailed information we give, the better the help the dispatcher can provide.

**Give first aid** - according to your abilities and skills and with the help of the dispatcher give first aid.

**Check the injured until the arrival of emergency rescue** - inform medics about the operations you have done and about any changes in the health condition of the injured from your arrival up to the time of emergency rescue's arrival.

**In order to not make the health condition of the injured worse, we should not:**

- Undress the injured - do not take the helmet off, except in the case of an inability to breathe
- Return intestines back into the abdomial cavity
- Test the depth of a wound or put bone fragments back into a wound
- Remove protruding objects from wounds
- Put powder or ointments or disinfect liquids into a wound
- Give fluids or food

## FIRST AID KIT

**The compulsory content of first-aid kit is set by the Ministry of Transport of Czech Republic No. 341/2002 Coll.**



| | |
|---|---|
| Sterile dressing No. 2 | 2 pcs |
| Sterile dressing No. 3 | 2 pcs |
| Sterile dressing No. 4 | 2 pcs |
| Triangular bandage | 2 pcs |
| Sticking-plaster (tape) 2.5cm x 5m | 1 pcs |
| Plaster 8cm x 4cm | 6 pcs |
| Bandage roll 70cm long | 1 pcs |
| Sterile dressing 5 cm x 7.5cm | 1 pcs |
| Mask | 1 pcs |
| PVC sheet 20cm x 20cm | 1 pcs |
| Wrapped surgical gloves | 1 pcs |
| Safety pin in anticorrosive treatment | 2 pcs |
| Scissors | 1 pcs |
| From 2010 there will be a change in the compulsory items - the safety pin will be excluded and thermo-insulating foil will be included. | |

# Who Can Be a Driver?

## THE INFLUENCE OF ALCOHOL, DRUGS AND SOME PRESCRIPTION MEDICINE ON CONCENTRATION AND AWARENESS WHEN DRIVING

Drivers must not drive after taking alcohol, drugs or prescription medicine. Although the ban on the use of these substances while driving is generally well known (like the statistics on road accidents due to their influence), the law is still broken.

### STATISTICAL DATA ON ACCIDENTS CAUSED BY ALCOHOL AND SOME DRUGS IN THE YEAR 2008

- In 2008 there were 160,376 traffic accidents in the Czech Republic. From this total 992 people died, 3,908 people were seriously injured and 24,776 suffered slight injuries.
- 6,602 accidents were caused by drivers who were intoxicated. Within these accidents, 79 persons died. This is around 4.8 % of the total number of accidents for the year and 8 % of the total number of people killed. (This number is the highest in the Czech Republic since the year 2000.)
- In one month (June, 2008) intoxicated drivers caused 700 accidents and 37 people were seriously injured. 348 of these accidents took place between 6 p.m. and 6 a.m. 173 of the accidents were caused by drivers younger than 25.
- The number of cases in which drivers were under the influence of drugs increased from 45 in 2000 to 109 cases in 2008. This reflects the number recorded by the police in 2008, which increased 2.5 times from the year 2000. This significant increase began in 2004 and more than half of these drivers were younger than 30.
- The proportion of the number of drivers affected by drugs (except for alcohol) during an accident has increased from 3.5 % in 2000 to 9.3 % in 2008.

Current statistical data on accidents on regions in the Czech Republic are on web pages of the Czech Republic police: *http://aplikace.policie.cz/statistiky-dopravnich-nehod/* .

Alcohol and various drugs have different effects on the awareness and concentration of drivers.

- **can cause fatigue and sleepiness**: cannabis, opiates, hypnotics
- **can cause aggression and irritability**: methamphetamine, cocaine, alcohol
- **can cause feelings of persecution**: cocaine, hallucinogens
- **can cause increased reaction time:** cannabis
- **can cause inadequate response to stimuli:** cannabis, opiates, alcohol
- **can cause reduction of fear:** hypnotics, cocaine, methamphetamine
- **can cause mistakes at traffic lights:** alcohol, cannabis


*Sokolnice (3 June 2008) Motorcyclist and her passenger were struck down by a car turning into a car park. The driver of the car was under the influence of alcohol and did not see them.*

The effects of drugs are extremely serious, especially on young drivers. These drivers have had very little practice in driving a car and with traffic. Young drivers also have little experience with the effects of alcohol and other drugs and they are less resistant to them. They process the drugs more slowly and they have a lower body weight. Therefore, even relatively small amounts of alcohol can cause a high level of alcohol in the blood and have a greater effect than in adults. During adolescence there is also a greater tendency to take risks and to go beyond normal limits.

# Who Can Be a Driver?

**WEB LINKS:**

www.onlinedata.cz/zakony/247_2000.asp

http://aplikace.policie.cz/statistiky-dopravnich-nehod/

www.volny.cz/ lk77/barvy/slep/uko.htm

www.lekari-online.cz/ocnilekarstvi/novinky/zrak-a-rizeni-motorovych-vozidel

www.driverspraha.cz/download/alkohol-pusobeni.doc

www.nemyslis-zaplatis.cz

www.autolekarnicka.cz/obsah-autolekarnicky.html

www.chcizit.cz/1-598-alkohol-za-volantem

www.zentiva.cz

www.diagnoza.cz

www.adiktologie.cz/articles/cz/70/1353/Drogy-a-rizeni-myty-a-polopravdy.html?acc=enb

Some drugs can have an effect on the awareness and concentration of a driver. Especially with over-the-counter drugs, users do not read the leaflet carefully and are not aware of the potential impact the drug could have on his driving. In general, if a driver feels sick and is aware of signs of a minor illness, such as the flu, he or she should consider the reasons for the trip and should think about postponing it.

All information about the possible effects and possible risks connected with taking the drug must be written in a leaflet. It is also possible to find this information on the web pages of the drug producer (e.g. www.zentiva.cz) or on web pages dealing with health topics (www.anamneza.cz).

WE CAN DIVIDE DRUGS INTO THREE CATEGORIES IN CONNECTION WITH DRIVING

1. Their influence on the driver and his or her ability to drive is unknown – Endiaron, Paralen, Ibalgin and all nutritional supplements
2. May have an impact on driver tiredness and he or she should consult a doctor about driving a car while using them – e.g. Imodium Plus, Coxtral, Modafen, Paralen Plus,…
3. They affect awareness and concentration and they can affect the ability to drive a car – Codein, Diazepan, Hypnogen, Medrin, …


**LEARNING ACTIVITIES:**

24a First Aid After an Accident – methodological sheet

24b First Aid After an Accident – worksheet

30a Who Can Drive a Car? - methodological sheet

30b Who Can Drive a Car? - worksheet

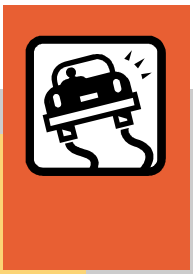
**THINK ABOUT:**

How is the subject matter of the human body related to the topic of driving?

Suggest an approach to teaching the topic „Who can be a driver?“ to pupils who would need to know more about this topic so they can understand the timeliness of this issue for their lives.

# Key Concepts

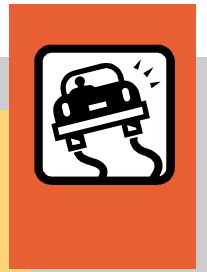
| | |
|---|---|
| ***ABS*** | An anti-lock braking system (ABS, from German: Antiblockiersystem) is a safety system that allows the wheels on a motor vehicle to continue interacting tractively with the road surface as directed by driver steering inputs while braking, preventing the wheels from locking up (that is, ceasing rotation) and therefore avoiding skidding. |
| ***Alkane*** | are chemical compounds that consist only of hydrogen and carbon atoms and are bonded exclusively by single bonds (i.e., they are saturated compounds) without any cycles (or loops; i.e., cyclic structure). Alkanes belong to a homologous series of organic compounds in which the members differ by a constant relative molecular mass of 14. |
| ***ASR*** | A traction control system (TCS), also known as anti-slip regulation (ASR), is typically (but not necessarily) a secondary function of the anti-lock braking system (ABS) on production motor vehicles, designed to prevent loss of traction of driven road wheels. When invoked it therefore enhances driver control as throttle input applied is mis-matched to road surface conditions (due to varying factors) being unable to manage applied torque. |
| ***Barrel*** | A barrel is one of several units of volume, with dry barrels, fluid barrels (UK beer barrel, U.S. beer barrel), oil barrel, etc. The volume of some barrel units is double others, with various volumes in the range of about 100–200 litres (22–44 imp gal |
| ***Barrier*** | A barrier or barricade is a physical structure which blocks or impedes something. |
| ***Bridge*** | A bridge is a structure built to span physical obstacles such as a body of water, valley, or road, for the purpose of providing passage over the obstacle. Designs of bridges vary depending on the function of the bridge, the nature of the terrain where the bridge is constructed, the material used to make it and the funds available to build it. |
| ***Carbide*** | In chemistry, a carbide is a compound composed of carbon and a less electronegative element. Carbides can be generally classified by chemical bonding type as follows: (i) salt-like, (ii) covalent compounds, (iii) interstitial compounds, and (iv) "intermediate" transition metal carbides. Examples include calcium carbide, silicon carbide, tungsten carbide (often called simply carbide), and cementite, each used in key industrial applications. |
| ***Carnot cycle*** | The **Carnot cycle** is a theoretical thermodynamic cycle proposed by Nicolas Léonard Sadi Carnot in 1824 and expanded by Benoit Paul Émile Clapeyron in the 1830s and 40s. It can be shown that it is the most efficient cycle for converting a given amount of thermal energy into work, or conversely, creating a temperature difference (e.g. refrigeration) by doing a given amount of work. |
| ***Cetane number*** | **Cetane number** or CN is a measurement of the combustion quality of diesel fuel during compression ignition. It is a significant expression of diesel fuel quality among a number of other measurements that determine overall diesel fuel quality. |
| ***Continental shelf*** | The **continental shelf** is the extended perimeter of each continent and associated coastal plain. Much of the shelf was exposed during glacial periods, but is now submerged under relatively shallow seas (known as **shelf seas**) and gulfs, and was similarly submerged during other interglacial periods. |
| ***Distillation*** | **Distillation** is a method of separating mixtures based on differences in their boiling points. Distillation is a unit operation, or a physical separation process, and not a chemical reaction. |
| ***Electrolysis*** | In chemistry and manufacturing, **electrolysis** is a method of using a direct electric current (DC) to drive an otherwise non-spontaneous chemical reaction. Electrolysis is commercially highly important as a stage in the separation of elements from naturally occurring sources such as ores using an electrolytic cell. |
| ***Environment*** | An "environment" is the whole of surrounding things.Surroundings are defined by a central entity. In ecology, environment refers to the surroundings of humankind. Generally, environment refers to the biological, physical and social things on the earth or in inhabitable space outside the earth's atmosphere. |



# Key Concepts

| | |
|---|---|
| ***Euroregion*** | In European politics, the term Euroregion usually refers to a transnational co-operation structure between two (or more) contiguous territories located in different European countries. Euroregions represent a specific type of cross-border region. |
| ***Flash point*** | The flash point of a liquid is the lowest temperature at which it will ignite. |
| ***Fuel cell*** | A fuel cell is a device that converts the chemical energy from a fuel into electricity through a chemical reaction with oxygen or another oxidizing agent. Hydrogen is the most common fuel, but hydrocarbons such as natural gas and alcohols like methanol are sometimes used. Fuel cells are different from batteries in that they require a constant source of fuel and oxygen to run, but they can produce electricity continually for as long as these inputs are supplied. |
| ***Highway*** | A highway is any public road. In American English, the term is common and almost always designates major roads. In British English, the term (which is not particularly common) designates any road open to the public. Any interconnected set of highways can be variously referred to as a "highway system", a "highway network", or a "highway transportation system". Each country has its own national highway system. |
| ***Landscape*** | Landscape comprises the visible features of an area of land, including the physical elements of landforms such as (ice-capped) mountains, hills, water bodies such as rivers, lakes, ponds and the sea, living elements of land cover including indigenous vegetation, human elements including different forms of land use, buildings and structures, and transitory elements such as lighting and weather conditions. |
| ***Octane number*** | Octane rating or octane number is a standard measure of the anti-knock properties (i.e. the performance) of a motor or aviation fuel. The higher the octane number, the more compression the fuel can withstand before detonating. In broad terms, fuels with a higher octane rating are used in high- |
| ***Rectification*** | the process of repeated distillation |
| ***Roads*** | A road is a thoroughfare, route, or way on land between two places, which typically has been paved or otherwise improved to allow travel by some conveyance, including a horse, cart, or motor vehicle. Roads consist of one, or sometimes two, roadways (British English: carriageways) each with one or more lanes and also any associated sidewalks (British English: pavement) and tree lawns (British English: verge). Roads that are available for use by the public may be referred to as public roads or highways. |
| ***TCS*** | A **traction control system** (**TCS**), also known as **anti-slip regulation** (**ASR**), is typically (but not necessarily) a secondary function of the anti-lock braking system (ABS) on production motor vehicles, designed to prevent loss of traction of driven road wheels. When invoked it therefore enhances driver control as throttle input applied is mis-matched to road surface conditions (due to varying factors) being unable to manage applied torque. |
| ***Transport*** | **Transport** or **transportation** is the movement of people, cattle, animals and goods from one location to another. Modes of transport include air, rail, road, water, cable, pipeline, and space. The field can be divided into infrastructure, vehicles, and operations. Transport is important since it enables |
| ***Tunnel*** | A **tunnel** is an underground passageway, completely enclosed except for openings for egress, commonly at each end. |
| ***Vehicle*** | A **vehicle is** a device that is designed or used to transport people or cargo. Most often vehicles are manufactured, such as bicycles, cars, motorcycles, trains, ships etc. |
| ***Wildlife crossing*** | **Wildlife crossings** are structures that allow animals to cross human-made barriers safely. Wildlife crossings may include: underpass tunnels, viaducts, and overpasses (mainly for large or herd-type animals); amphibian tunnels; fish ladders; tunnels and culverts (for small mammals such as otters, |

# Table of Cross-Curricular Subjects



| Cross-curricular subjects | Personal and social education | | | Democratic citizenship | | | | Education towards thinking in European and global context | | | Multicultural education | | | | | Environmental education | | | | Media education | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Personal development | Social development | Moral development | Civil society and school | The citizen, civil society and the state | Forms of citizen participation in political life | Democratic principles as forms of government | We are interested in Europe and the world | We explore Europe and the world | We are Europeans | Cultural differences | Human relations | Ethnic origins | Multiculturalism | Principles of social reconciliation and solidarity | Ecosystems | Fundamental conditions for life | Human activities and environmental problems | Humankind's relation to the environment | Critical reading and perception of media messag | Interpretation of the relationship between media | The structure of media messages | Perception of the author of media messages | Functioning and influence of the media in society | Creation of the media message | Working on a production team |
| The Human World and Transport | • | | | • | | | | • | • | | | • | | • | | • | • | • | • | • | | | | | • |
| History of Transportation | • | • | • | | • | | | • | • | • | | | | | | | | • | • | • | | | | | • |
| Roads and Bridges | • | | | | • | • | | | • | | | | | | | • | • | • | • | • | | | | | • |
| The Landscape and Cars | • | • | | • | | | | • | • | • | | | | | | • | • | • | • | • | • | | | • | • |
| Crude Oil Extraction | • | | | • | | | | • | • | | | | | | | • | • | • | • | • | | | | | • |
| Oil Transportation | • | | • | | | | | • | • | • | | | | | | • | • | • | • | • | | | | | • |
| Oil Processing | • | | | • | | | | • | • | | | | | | | • | • | • | • | • | | | | | • |
| Automobile Manufacturing | • | | | • | | | | • | • | | | | | • | | • | • | • | • | • | | | | | • |
| The Car Industry | • | | | | | | | | • | | | | | • | | • | • | • | • | • | | | | | • |
| Visions and Predictions | • | | • | | | | | | • | | | | | | | • | • | • | • | • | • | • | • | | • |
| Car Safety | • | | • | | | | • | | • | | | | | | | | | • | • | • | • | • | | | • |
| How the Car Operates | • | | | | | | | | • | | | | | | | | | • | • | • | | | | | • |
| Who Can Be a Driver? | • | • | • | | | • | | | | | | • | | | | | | • | • | • | | • | | | • |

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# GOING BY CAR

## — LEARNING ACTIVITIES—

Summary of methodological sheets and worksheets

17a Getting Familiar with Manufacturing Cars at ŠKODA AUTO a.s., Mladá Boleslav – methodo logical sheet

17b Getting Familiar with Manufacturing Cars at ŠKODA AUTO a.s., Mladá Boleslav - worksheet

18 CO2 Emission – methodological sheet

19a CO2 and its features – methodological sheet

19b CO2 and its features – worksheet

20a The Price of Petrol – methodological sheet

20b The Price of Petrol - worksheet

21a Oil – Where it can be found and how much is left? - methodological sheet

21b Oil – Where it can be found and how much is left? - worksheet

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22b Transportation and sustainable development - worksheet

23a Safety Map – methodological sheet

23b Safety Map - worksheet

24a First Aid after an accident– methodological sheet

24b First Aid after an accident– worksheet

25 Reaction Time

26 The stopping distance of a car – methodological sheet

27 How to read charts of movement? - methodological sheet

28 The movement of the piston in an engine – methodological sheet

29 Heating and cooling, how they cooperate with each other? – methodological sheet

30a Who Can Drive a Car? - methodological sheet

30b Who Can Drive a Car? - worksheet

# INTEGRATED SCIENCE 1

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PhDr. Hana SVATOŇOVÁ, Ph.D., et al.

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