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РЕСПУБЛИКИ БЕЛАРУСЬ

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Тексты для чтения для студентов механических специальностей

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С О Д Е Р Ж А Н И Е

ENGINEERING LANDMARKS

The Auto: From Coal to Hydrogen

The automobile is one of the most fascinating devices that a person can own. It contains dozens of different technologies – everything from the engine to the tires is its own special universe of design and engineering.

The first working steam-powered vehicle was probably designed by Ferdinand Verbiest, in China around 1672. It was a 65 cm-long scale-model toy for the Chinese Emperor, that was unable to carry a driver or a passenger.

Nicolas-Joseph Cugnot is often credited with building the first self-propelled mechanical vehicle or automobile in about 1769. However, this claim is disputed by some who doubt Cugnot's three-wheeler ever ran or was stable.

In the 1780s, a Russian inventor, Ivan Kulibin, developed a human-pedalled, three-wheeled carriage with modern features such as a flywheel, brake, transmission, and bearings; however, it was not developed further.

The modern automobile got its start in Germany. The first working car, made by German engineer Gottlieb Daimler and named after his daughter, Mercedes, appeared in 1884. At nearly the same time, another German, Karl Benz, designed his own, similar version of the car. It was an integral design, and included several new technological elements to create a new concept. He began to sell his production vehicles in 1888. However by the 1930s, the Germans were looking at American road systems to develop the famous Autobahn superhighway.

The large-scale, production-line manufacturing of affordable automobiles was started by Ransom Olds at his Oldsmobile factory in 1902. This concept was greatly expanded by Henry Ford, beginning in 1914. As a result, Ford's cars came off the line in fifteen minute intervals, much faster than previous methods, increasing productivity eightfold. However, paint became a bottleneck. Only Japan black would dry fast enough, forcing the company to cut on the variety of colors available before 1914. This became the source of Ford's famous remark, "any color as long as it's black".

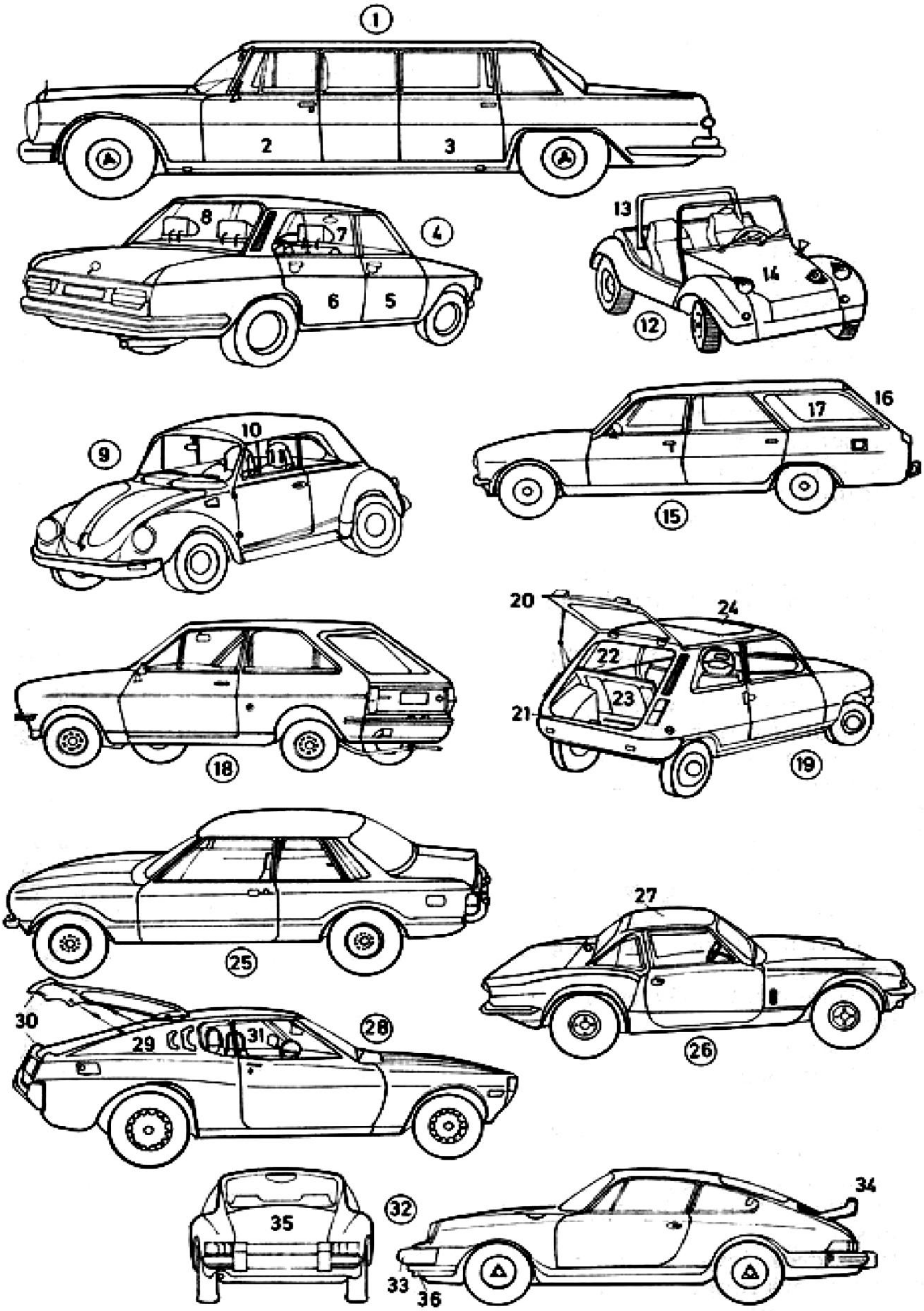
First automobiles were generally powered by a steam engine, which was fed by burning gasoline. Most automobiles in use today however are propelled by an internal combustion engine, fueled by gasoline (also known as petrol) or diesel. Both fuels are known to cause air pollution and are also blamed for contributing to climate change and global warming. Efforts to improve or replace existing technologies include the development of hybrid vehicles, electric and hydrogen vehicles that do not release pollution into the air.

Body styles have changed as well in the modern era. Three types, the hatchback, sedan, and sport utility vehicle, are relatively recent concepts. All originally emphasised practicality, but have transformed into today's high-powered luxury crossover SUV and sports wagon. The rise of pickup trucks in the United States, and SUVs worldwide has changed the face of motoring, with these "trucks" coming to command more than half of the world automobile market.

Vocabulary Notes

fascinating – захватывающий
tire – шина
steam-powered vehicle – паровая машина
scale-model toy – масштабная игрушечная модель
self-propelled mechanical vehicle – самодвижущееся механическое ТС
claim – заявление
feature – характеристика
flywheel – маховик
bearing – подшипник
large-scale – крупномасштабный
production-line – производственная линия, конвейер
affordable – доступный
become a bottleneck – стать препятствием (букв. бутылочным горлышком)
eightfold – в восемь раз
Japan black paint – чёрный лак
internal combustion engine – двигатель внутреннего сгорания
hydrogen – водород
SUV – внедорожник (сокр. от Sport Utility Vehicle)

1–36 car models (*Am.* automobile models)
1 eight-cylinder limousine with three rows of three-abreast seating
2 driver's door
3 rear door
4 four-door saloon car (*Am.* four-door sedan)
5 front door
6 rear door
7 front seat headrest (front seat head restraint)
8 rear seat headrest (rear seat head restraint)
9 convertible
10 convertible (collapsible) hood (top)
11 bucket seat
12 buggy (dune buggy)
13 roll bar
14 fibre glass body
15 estate car (shooting brake, estate, *Am.* station wagon)
16 tailgate
17 boot space (luggage compartment)
18 three-door hatchback
19 small three-door car
20 rear door (tailgate)
21 sill
22 folding back seat
23 boot (luggage compartment, *Am.* trunk)
24 sliding roof (sunroof, steel sunroof)
25 two-door saloon car (*Am.* two-door sedan)
26 roadster (hard-top), a two-seater
27 hard top
28 sporting coupé, a two-plus-two coupé (two-seater with removable back seats)
29 fastback (liftback)
30 spoiler rim
31 integral headrest (integral head restraint)
32 GT car (gran turismo car)
33 integral bumper (*Am.* integral fender)
34 rear spoiler
35 back
36 front spoiler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Radio

"Radio waves" transmit music, conversations, pictures and data invisibly through the air, often over millions of miles – it happens every day in thousands of different ways. Even though radio waves are invisible and completely undetectable to humans, they have totally changed society. Whether we are talking about a cell phone, a baby monitor, a cordless phone or any one of the thousands of other wireless technologies, all of them use radio waves to communicate.

Even things like radar and microwave ovens depend on radio waves. Things like communication and navigation satellites would be impossible without radio waves, as would modern aviation – an airplane depends on a dozen different radio systems. The current trend toward wireless Internet access uses radio as well, and that means a lot more convenience in the future!

The meaning and usage of the word "radio" has developed in parallel with developments within the field and can be seen to have three distinct phases: electromagnetic waves and experimentation; wireless communication and technical development; and radio broadcasting and commercialization. Many inventors, engineers, developers, businessmen contributed to produce the modern idea of radio and thus the origins and 'invention' are multiple and controversial. Early radio could not transmit sound or speech and was called the "wireless telegraph".

In 1878, David E. Hughes noticed that sparks could be heard in a telephone receiver when experimenting with his carbon microphone. He developed this carbon-based detector further and eventually could detect signals over a few hundred meters. He demonstrated his discovery to the Royal Society in 1880, but was told it was merely induction, and therefore abandoned further research.

Experiments, later patented, were undertaken by Thomas Edison. Edison applied in 1885 to the U.S. Patent Office for his patent on an electrostatic coupling system between elevated terminals. In 1893, Nikola Tesla made devices for his experiments with electricity. He described and demonstrated the principles of his wireless work. The descriptions contained all the elements that were later incorporated into radio systems before the development of the vacuum tube.

In 1895 Alexander Stepanovich Popov built his first radio receiver, which contained a coherer. Further improved as a lightning detector, it was presented to the Russian Physical and Chemical Society on May 7, 1895. A description of Popov's lightning detector was printed in the Journal of the Russian Physical and Chemical Society the same year.

In 1895, Marconi built a wireless system capable of transmitting signals at long distances (2.4 km). In radio transmission technology, early public experimenters had made short distance broadcasts. Marconi achieved long range signalling due to a wireless transmitting apparatus and a radio receiver claimed by him. From Marconi's experiments, the phenomenon that transmission range is proportional to the square of antenna height is known as "Marconi's law".

The next advancement was the vacuum tube detector, invented by Westinghouse engineers. On Christmas Eve, 1906, ships at sea heard a broadcast that included Fessenden playing the violin and reading a passage from the Bible. This was the first transmission of what is now known as amplitude modulation or AM radio.

Early uses of radio were maritime, for sending telegraphic messages using Morse code between ships and land. One of the most memorable uses of marine telegraphy was during the sinking of the Titanic in 1912, including communications between operators on the sinking ship and nearby vessels, and communications to shore stations listing the survivors. Today, radio waves are used in many forms, including wireless networks and mobile communications of all types, as well as radio and TV broadcasting.

Vocabulary Notes

to transmit – передавать
invisibly – невидимо
undetectable – необнаруживаемый
baby monitor – радионяня
cordless – беспроводной
radio broadcasting – радиовещание
to contributed to – содействовать
controversial – спорный
spark – вспышка
telephone receiver – телефонная трубка
to abandon – оставлять
to undertake – предпринимать
electrostatic coupling system – электростатическая система связи
vacuum tube – электронная лампа
radio receiver – радиоприёмник
coherer – когерер
lightning detector – молниерегистратор
to claim – заявлять о правах
transmission range – диапазон передачи
advancement – улучшение
vacuum tube detector – ламповый детектор
amplitude modulation – амплитудная модуляция
maritime – морской
vessel – корабль
survivor – оставшийся в живых

Television

Television is certainly one of the most influential forces of our time. Try to imagine life without television... It is nearly impossible. The modern world and TV are deeply intertwined. Through the device called a television set or TV, you are able to receive news, sports, entertainment, information and commercials. An average person spends between two and five hours a day glued to “the tube”!

In its early stages of development, television employed a combination of optical, mechanical and electronic technologies to capture, transmit and display a visual image. By the late 1920s, however, those employing only optical and electronic technologies were being explored. All modern television systems rely on the latter, although the knowledge gained from the work on electromechanical systems was crucial in the development of fully electronic television.

The first images transmitted electrically were sent by early mechanical fax machines, developed in the late nineteenth century. The concept of electrically powered transmission of television images in motion was first sketched in 1878 as the telephonoscope, shortly after the invention of the telephone. At the time, it was imagined by early science fiction authors, that someday that light could be transmitted over wires, as sounds were.

In 1884 Paul Gottlieb Nipkow, a 23-year-old university student in Germany, patented the first electromechanical television system which employed a scanning disk, a spinning disk with a series of holes spiraling toward the center, for rasterization. The holes were spaced at equal angular intervals such that in a single rotation the disk would allow light to pass through each hole and onto a light-sensitive selenium sensor which produced the electrical pulses. As an image was focused on the rotating disk, each hole captured a horizontal “slice” of the whole image.

Later designs would use a rotating mirror-drum scanner to capture the image and a cathode ray tube (CRT) as a display device, but moving images were still not possible, due to the poor sensitivity of the selenium sensors. In 1907 Russian scientist Boris Rosing became the first inventor to use a CRT in the receiver of an experimental television system. He used mirror-drum scanning to transmit simple geometric shapes to the CRT.

Scottish inventor John Logie Baird demonstrated the transmission of moving silhouette images in London in 1925, and of moving, monochromatic images in 1926. Baird’s scanning disk produced an image of 30 lines resolution, just enough to discern a human face, from a double spiral of lenses. This demonstration by Baird is generally agreed to be the world’s first true demonstration of television.

By 1927, Russian inventor Léon Theremin developed a mirror-drum-based television system which used interlacing to achieve an image resolution of 100 lines. Also in 1927, Philo Farnsworth made the world’s first working television system with electronic scanning of both the pickup and display devices, which he first demonstrated to the press on 1 September 1928.

The first practical use of television was in Germany. Regular television broadcasts began in Germany in 1929 and in 1936 the Olympic Games in Berlin were broadcast to television stations in Berlin and Leipzig where the public could view the games live. On 2 November 1936 the BBC began transmitting the world's first regular high definition service.

Since the 1970s the availability of video cassettes, laserdiscs, DVDs and now Blu-ray Discs, have resulted in the television set frequently being used for viewing recorded as well as broadcast material. Televisions today use various display technologies such as CRT, LCD, Plasma, and more recently OLED. In recent years Internet television has seen the rise of television available via the Internet.

Vocabulary Notes

influential – влиятельный
intertwined – переплетённый
commercial – реклама
to glue – приклеивать
to capture – захватывать
to rely on – зависеть
to gain – получать
to sketch – описывать в общих чертах
rasterization – растрирование
angular – угловой
to space – располагать с промежутками
rotation – вращение
mirror-drum scanner – зеркальный барабанный сканер
cathode ray tube – электроннолучевая трубка
resolution – разрешение
interlacing – чересстрочная развёртка
pickup device – передающая трубка
broadcast – вещание
OLED – органический светодиод (сокр. от organic light-emitting diode)

ACHIEVEMENTS AND DISASTERS

The London Underground

"No room, no room!" The cry was heard over the roaring din of the thousands of people gathered at the railway stations for the opening of the world's first underground – the Metropolitan Line. The gloomy words had a slight effect on those who assembled near the dark, echoing tunnels that led the trains under the earth. In spite of the cries that the trains were full, the crowds of people who came out to experience riding under the city remained in line, hoping for a ticket. It was January 10, 1863, and at 6:00 A.M. the rides began. The public had been waiting for this opening day for twenty-one months.

The early 19th century was a period of remarkable growth in England. With the onset of the Industrial Revolution, London began the construction of factories. As these factories sprang up, increasing amounts of people began to move from the country-side into London for work. This tremendous increase in the population of the city created an immense demand for public transportation.

The idea of building an underground railway to link the City of London with the mainline terminals had first been proposed in the 1830s, but it was not until the 1850s that the idea was taken seriously as a solution to traffic congestion.

The early tunnels were dug mainly using cut-and-cover construction methods. This caused widespread disruption and required the demolition of several properties on the surface. Sometimes in the making of approximately two miles of railroad, nine hundred houses were destroyed.

The first trains were steam-hauled, which required effective ventilation to the surface. Ventilation shafts at various points on the route allowed the engines to expel steam and bring fresh air into the tunnels.

The art of architecture and the science of engineering were advanced remarkably in the construction of the Underground. The cut and cover method of tunneling in which a trench of about fifteen feet would be dug out of the ground, the sides supported by the construction of walls, roofing would be built overhead, and then covered with dirt, reinstating the road, had become too expensive and too slow. Innovations in tunneling and excavation were pioneered with heroic determination. Following the Victorian compulsion of efficiency, tube construction was invented.

Following advances in the use of tunnelling shields, electric traction and deep-level tunnel designs, later railways were built even further underground. This caused much less disruption at ground level and it was therefore cheaper and preferable to the cut-and-cover construction method.

During the Victorian period it had profound economic and social effects. Its construction increased the demand for coal, iron, bricks and other building materials. Large companies backed the railways and made them into huge profit producing corporations. The railways sparked the fire of competition, and men worked harder to try and conquer more, own more, and be more. The Brits of Victorian times described the Underground as the greatest building operation since the pyramids were accomplished, still astonishing people today at what the human mind and body can produce. Every line finished was a triumph for England, and as more railways were constructed, England grew in strength and confidence. The railway lines mapped out not only the places to be traveled by the cars; they also mapped out the ambition, drive, perseverance, and ability of England.

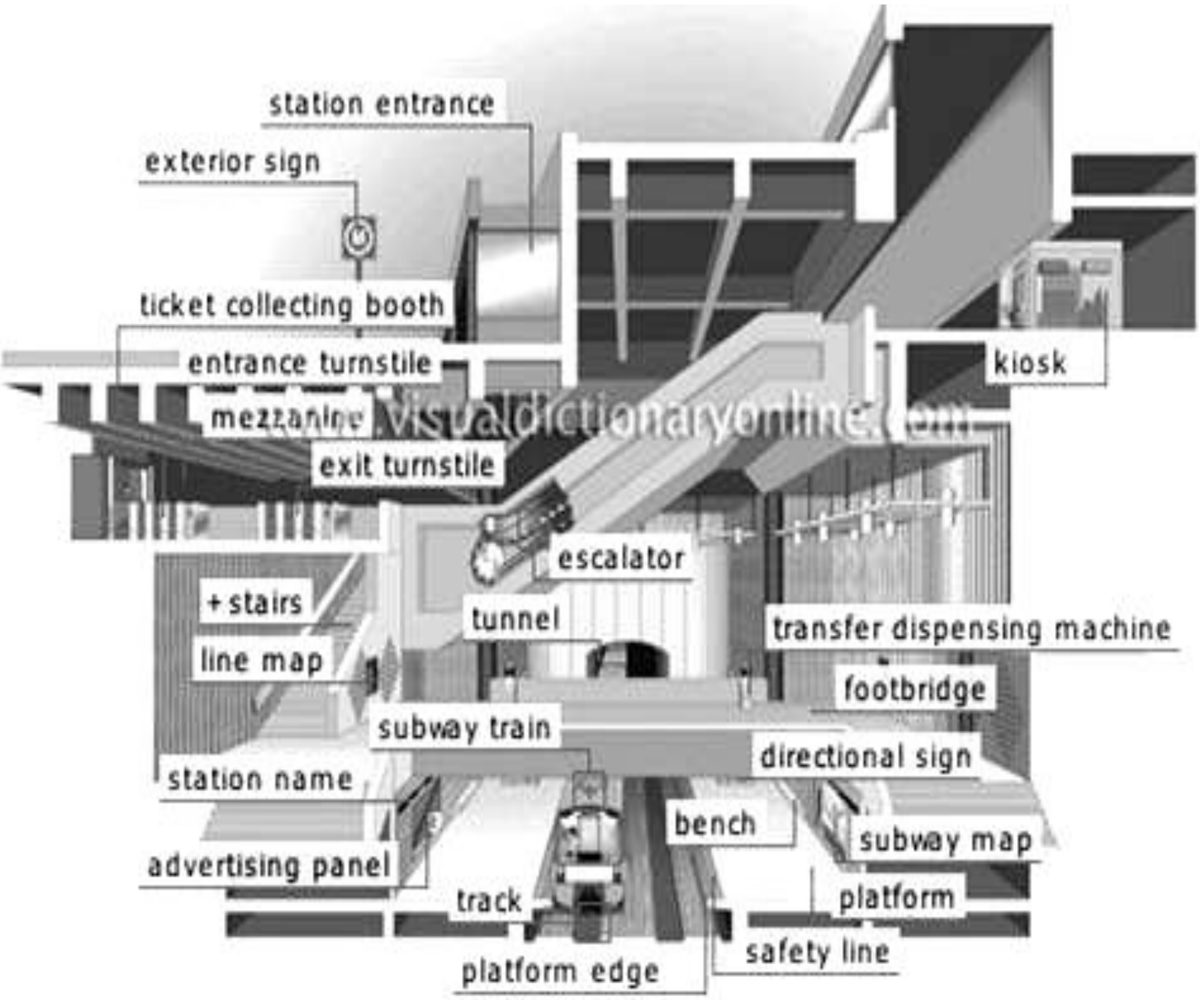
Today, the London Underground is a rapid transit system serving a large part of Greater London and neighbouring areas. With its first section opening, it was the first underground railway system in the world. In 1890 it became the first to operate electric trains. Despite the name, about 55% of the network is above ground. It is usually called officially as "the Underground" and in informal talk it is called the Tube. The nickname "the Tube" comes from the circular tube-like tunnels through which the trains travel.

The Underground has 270 stations and 402 kilometres of track, making it the second longest metro system in the world after the Shanghai Metro. It also has one of the highest number of stations. In 2007, more than one billion passenger journeys were recorded, making it the third busiest metro system in Europe after Paris and Moscow.

The Underground and the railways of London amazed the people. They put the spectacle of speed and motion in front of the people's lives and it was intoxicating to them. Nature was conquered and now there was a way also to conquer space and time!

Vocabulary Notes

roaring din – сильный неутихающий гул
underground – метро
gloomy – мрачный
in line – в очереди
remarkable – поразительный
onset – начало
to spring up – расти
tremendous – громадный
immense – огромный
mainline terminals – главные станции
traffic congestion – транспортный затор
cut-and-cover – открытый способ строительства
disruption – разрушение
demolition – снос
steam-hauled – на паровой тяге
shaft – шахта
to expel – удалять
trench – траншея
dirt – грунт
to reinstate – восстанавливать
excavation – разработка грунта
to pioneer – впервые открыть
compulsion – одержимость
tunnelling shield – проходческий щит
to back – *зд.* финансировать
to conquer – покорять
astonishing – поразительный
confidence – доверие
to map out – планировать
perseverance – настойчивость
to nickname – дать прозвище
intoxicating – опьяняющий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footbridge
subway train
directional sign
station name
bench
subway map
advertising panel
track
platform
safety line
platform edge

The Deepwater Horizon (BP) Oil Spill

On April 20, 2010, a combination of mud, seawater and gas from methane hydrates erupted from the oil well of the Deepwater Horizon oil rig. The Deepwater Horizon was a platform searching for oil deposits. Once it found oil, the workers on board the rig capped the newly-drilled well in preparation to move on in search of more oil.

The oil rig floated in more than 1,524 meters of water in the Gulf of Mexico. The well itself went much deeper – more than 3,962 meters. The workers on the rig and the companies involved – British Petroleum (BP), Transocean and Halliburton – say that there was some disagreement on the capping procedure. Normally, at least two cement plugs would be poured and hardened in the piping before removing the drilling mud from the well bore. The mud helps block sudden bursts of gas and oil.

Finally, engineers decided to remove the mud before adding a second cement plug. A burst of gas rushed up the pipe and caused a massive explosion, killing 11 of the workers in the process. Oil began to pour out of the well in enormous volumes – estimates of the amount of oil spilling into the Gulf of Mexico range from 12,000 to 60,000 barrels of oil per day. A barrel of oil is equal to 159 liters.

A BP document revealed that in a worst case scenario, the oil well could spill as much as 100,000 barrels of oil into the ocean per day. Governments were spending millions of dollars while engineers tried to find a way to stop it. BP abandoned an attempt to plug the oil well with mud – the so-called top kill procedure – when engineers began to worry about the integrity of the well bore itself. If the well bore has leaks along its length, oil could continue to spill even if the top is plugged with mud. On September 19, 2010 the relief well process was successfully completed and the federal government declared the well "effectively dead". Oil recovery efforts have reduced, but not eliminated, the total amount of oil hitting the environment.

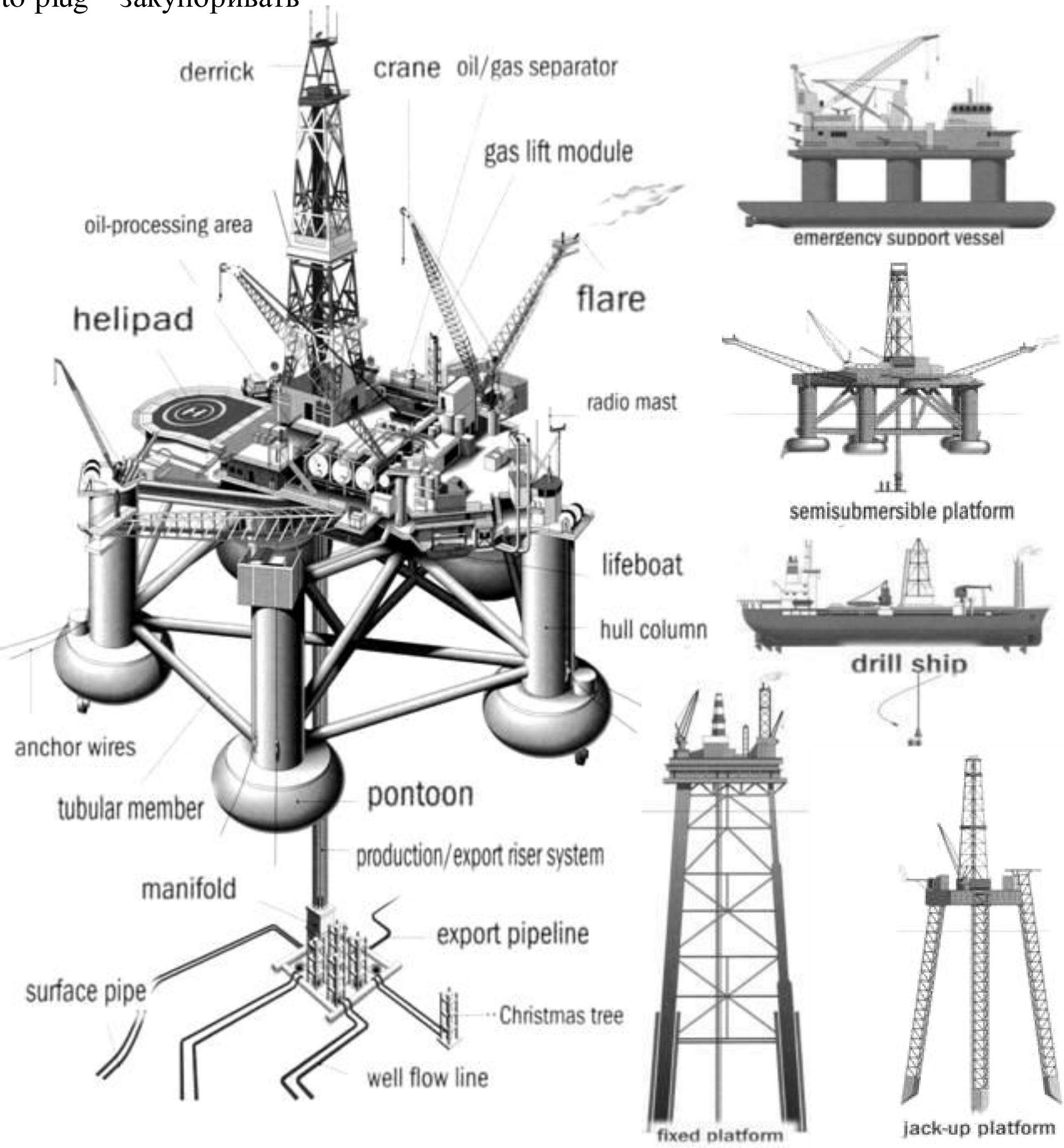
What is the environmental impact? It's difficult to estimate. Because the oil spill happened in deep water miles from land. Some of the oil clumps together to form tar balls. These balls of tar can wash up on beaches and impact the local wildlife. Plumes of oil are drifting thousands of feet beneath the ocean's surface. The impact this oil might have on deep sea life isn't fully understood. There are complex ecosystems deep beneath the ocean that might die out as a result of being flooded with oil.

It may be years or even decades before we know the extent of the environmental damage the Deepwater Horizon accident caused. While rescue efforts are working hard to minimize the effects, it's clear that there's no way to estimate the harm this oil spill will do to the environment.

Vocabulary Notes

methane hydrate – гидрат метана
erupt – извергать
oil well – нефтяная скважина
oil rig – нефтяная вышка
oil deposits – залежи нефти
cap – колпак

capping procedure – закупоривание
cement plug – цементная пробка
to pour – вливать
piping – трубопровод
well bore – буровая скважина
burst – прорыв
to rush up – стремительно течь
to pour out – выливаться
barrel – баррель
to reveal – показывать
to abandon – оставить
to plug – закупоривать
top kill – закупоривание вершины
integrity – целостность
leak – утечка
relief well process – бурение разгрузочной скважины
effectively dead – фактически заглушен
to eliminate – устранять
oil recovery – сбор нефти
to clump together – собираться вместе
tar ball – нефтяной сгусток
oil spill – разлив нефти



HOW THINGS WORK

How CD Works

CDs and DVDs are everywhere these days. Whether they are used to hold music, data or computer software, they have become the standard medium for distributing large quantities of information in a reliable package. Compact discs are so easy and cheap to produce that some companies send out millions of them every year to attract new users. And if you have a computer and CD-R drive, you can create your own CDs, including any information you want.

A CD can store up to 74 minutes of music, so the total amount of digital data that must be stored on a CD is:

44,100 samples/channel/second x 2 bytes/sample x 2 channels x 74 minutes x 60 seconds/minute = 783,216,000 bytes

To fit more than 783 megabytes (MB) onto a disc only 12 cm in diameter requires the individual bytes to be very small. By examining the physical construction of a CD, it's easy to understand just how small these bytes are.

A CD is a simple piece of plastic, about 1.2 mm thick. Most of a CD consists of an injection-molded piece of clear polycarbonate plastic. During manufacturing, this plastic is impressed with microscopic bumps arranged as a single, continuous, extremely long spiral track of data. Once the clear piece of polycarbonate is formed, a thin, reflective aluminum layer is sputtered onto the disc, covering the bumps. Then a thin acrylic layer is sprayed over the aluminum to protect it. The label is then printed onto the acrylic.

A CD has a single spiral track of data, circling from the inside of the disc to the outside. The fact that the spiral track starts at the center means that the CD can be smaller than 12 cm if desired.

The data track is incredibly small – it is approximately 0.5 microns wide, with 1.6 microns separating one track from the next. (A micron is a millionth of a meter.) And the bumps are even more miniscule...

The elongated bumps that make up the track are each 0.5 microns wide, a minimum of 0.83 microns long and 125 nanometers high. (A nanometer is a billionth of a meter.).

The incredibly small dimensions of the bumps make the spiral track on a CD extremely long. If you could lift the data track off a CD and stretch it out into a straight line, it would be 0.5 microns wide and almost 5 km long!

Vocabulary Notes

to hold – хранить
package – упаковка
injection-molded – изготовленный литьём под давлением
to impress – отпечатывать
to sputter – напылять
miniscule – крошечный

How Blu-Ray Discs Work

A single-sided, standard DVD can hold 4.7 GB (gigabytes) of information. That's about the size of an average two-hour, standard-definition movie with a few extra features. But a high-definition movie, which has a much clearer image, takes up about five times more bandwidth and therefore requires a disc with about five times more storage. As TV sets and movie studios make the move to high definition, consumers are going to need playback systems with a lot more storage capacity.

Blu-ray is the next-generation digital video disc. It can record, store and play back high-definition video and digital audio, as well as computer data. The advantage to Blu-ray is the sheer amount of information it can hold. A single-layer Blu-ray disc, which is roughly the same size as a DVD, can hold up to 27 GB of data – that's more than two hours of high-definition video or about 13 hours of standard video. A double-layer Blu-ray disc can store up to 50 GB, enough to hold about 4.5 hours of high-definition video or more than 20 hours of standard video. And there are even plans in the works to develop a disc with twice that amount of storage.

Blu-ray discs not only have more storage capacity than traditional DVDs, but they also offer a new level of interactivity. Users will be able to connect to the Internet and instantly download subtitles and other interactive movie features. With Blu-ray, you can: record high-definition television (HDTV) without any quality loss, instantly skip to any spot on the disc, record one program while watching another on the disc, create playlists, edit or reorder programs recorded on the disc, automatically search for an empty space on the disc to avoid recording over a program, access the Web to download subtitles and other extra features.

Discs store digitally encoded video and audio information in pits – spiral grooves that run from the center of the disc to its edges. A laser reads the other side of these pits – the bumps – to play the movie or program that is stored on the DVD. The more data that is contained on a disc, the smaller and more closely packed the pits must be. The smaller the pits (and therefore the bumps), the more precise the reading laser must be.

Unlike current DVDs, which use a red laser to read and write data, Blu-ray uses a blue laser (which is where the format gets its name). A blue laser has a shorter wavelength than a red laser. The smaller beam focuses more precisely, enabling it to read information recorded in pits that are twice as small as the pits on a DVD.

The Blu-ray disc overcomes DVD-reading issues by placing the data on top of a 1.1-mm-thick polycarbonate layer. Having the data on top prevents readability problems. And, with the recording layer sitting closer to the objective lens of the reading mechanism, the problem of disc tilt is virtually eliminated. Blu-ray also has a higher data transfer rate – 36 Mbps (megabits per second) – than today's DVDs, which transfer at 10 Mbps. A Blu-ray disc can record 25 GB of material in just over an hour and a half. Because the data is closer to the surface, a hard coating is placed on the outside of the disc to protect it from scratches and fingerprints.

Vocabulary Notes

high-definition – высокое разрешение
bandwidth – ширина полосы
playback – воспроизведение
sheer – исключительный
double-layer – двусторонний
instantly – мгновенно
subtitles – субтитры
to skip – переходить
spot – место
to reorder – изменять порядок
pit – канавка
groove – паз
bump – выпуклость
to overcome – преодолеть
issue – проблема
readability – считывание
disc tilt – сбой диска
coating – покрытие
scratch – царапина

How Flash Memory Works

We store and transfer all kinds of files on our computers – digital photographs, music files, word processing documents, PDFs and countless other forms of media. But sometimes your computer's hard drive isn't exactly where you want your information. Whether you want to make backup copies of files or if you worry about your security, portable storage devices that use a type of electronic memory called flash memory may be the right solution.

While your computer's BIOS chip is the most common form of Flash memory, removable solid-state storage devices are also popular. SmartMedia and CompactFlash cards are both well-known, especially as "electronic film" for digital cameras. Other removable flash-memory products include Sony's Memory Stick, PCMCIA memory cards, xD-Picture Cards and Secure Digital cards, and memory cards for video game systems.

There are a few reasons to use flash memory instead of a hard disk:

- It has no moving parts, so it's noiseless.
- It allows faster access.
- It's smaller in size and lighter.

So why don't we just use flash memory for everything? Because the cost per megabyte for a hard disk is drastically cheaper, and the capacity is substantially more.

Flash memory is a type of EEPROM chip, which stands for Electronically Erasable Programmable Read Only Memory. It has a grid of columns and rows with a cell that has two transistors at each intersection.

The two transistors are separated from each other by a thin oxide layer. One of the transistors is known as a floating gate, and the other one is the control gate. The floating gate's only link to the row is through the control gate. As long as this link is in place, the cell has a value of 1. To change the value to a 0 requires a curious process called Fowler-Nordheim tunneling. Tunneling is used to alter the placement of electrons in the floating gate.

A special device called a cell sensor monitors the level of the charge passing through the floating gate. If the flow through the gate is above the 50 percent threshold, it has a value of 1. When the charge passing through drops below the 50-percent threshold, the value changes to 0. A blank EEPROM has all of the gates fully open, giving each cell a value of 1.

The electrons in the cells of a flash-memory chip can be returned to normal ("1") state by the application of an electric field, a higher-voltage charge. This erases the targeted area of the chip, which can then be rewritten. Flash memory works much faster than traditional EEPROMs because instead of erasing one byte at a time, it erases a block or the entire chip, and then rewrites it.

You may think that your car radio has flash memory, since you're able to program the presets and the radio remembers them. But it's actually using flash RAM. The difference is that flash RAM has to have some power to maintain its contents, while flash memory will maintain its data without any external source of power. Even though you've turned the power off, the car radio is pulling a tiny amount of current to preserve the data in the flash RAM. That is why the radio will lose its presets if your car battery dies or the wires are disconnected.

Vocabulary Notes

hard drive – накопитель на жёстких дисках
backup copy – резервная копия
portable – переносной
solution – решение
solid-state – твёрдый
PCMCIA – Международная ассоциация производителей карт памяти для персональных компьютеров
drastically – радикально
capacity – ёмкость
EEPROM – электрически стираемое программируемое постоянное запоминающее устройство
grid – сетка
intersection – пересечение
floating gate – плавающий затвор
Fowler-Nordheim tunneling – переход Фаулера-Нордхейма
alter – изменяться
cell sensor – клеточный датчик
threshold – порог
application – применение
to erase – стирать
car battery – аккумулятор

How 3-D TV Works
Part 1: Passive 3D Glasses

Television, like most technology, has evolved since its debut. First, there was the switch from black and white to color TV. Then manufacturers began to offer televisions in larger formats using various projection methods. Over the last two decades, we've seen LCD and plasma technologies advance to the point where you can go out and buy a 61-inch (about 155 centimeters) television that's only a few centimeters thick. And high-definition television (HDTV) provides us with a picture that's so vibrant and sharp it's almost as if we weren't looking at a collection of pixels. So what's next in television technology? The answer may end up right in front of your face – or at least appear to be there, anyway. We're talking about 3-D television.

Why can you look at an object in the real world and see it as a three-dimensional object, but if you see that same object on a television screen it looks flat?

It all has to do with the way we focus on objects. We see things because our eyes absorb light reflected off of the items. Our brains interpret the light and create a picture in our minds. When an object is far away, the light traveling to one eye is parallel with the light traveling to the other eye. But as an object gets closer, the lines are no longer parallel – they converge and our eyes shift to compensate. You can see this effect in action if you try to look at something right in front of your nose – you'll attain a lovely cross-eyed expression.

The secret to 3-D television and movies is that by showing each eye the same image in two different locations, you can trick you brain into thinking the flat image you're viewing has depth. But this also means that the convergence and focal points don't match up the way they do for real objects. While your eyes may converge upon two images that seem to be one object right in front of you, they're actually focusing on a screen that's further away. This is why you get eye strain if you try to watch too many 3-D movies in one sitting.

The classic 3-D glasses have anaglyph lenses. Anaglyph glasses use two different color lenses to filter the images you look at on the television screen. The two most common colors used are red and blue. If you were to look at the screen without your glasses, you would see that there are two sets of images slightly offset from one another. One will have a blue tint to it and the other will have a reddish hue. If you put on your glasses, you should see a single image that appears to have depth to it.

What's happening here? The eye behind the red lens will only see the blue images while the eye behind the blue lens sees the red ones. Because each eye can only see one set of images, your brain interprets this to mean that both eyes are looking at the same object. But your eyes are converging on a point that's different from the focal point – the focus will always be your television screen. That's what creates the illusion of depth.

Today, a more popular type of passive lenses in movie theaters can be found in the polarized glasses. Again, if you look at a screen that uses this technology you'll see more than one set of images. The glasses use lenses that filter out light waves projected at certain angles. Polarized lenses are becoming more popular than anaglyph glasses because the glasses don't distort the color of the image as much. But it's very difficult to use the polarization technique for home theater systems – most methods would require you to coat your television screen with a special polarizing film first.

Vocabulary Notes

to evolve – развиваться
debut – дебют, начало
switch – переход
projection method – метод проецирования
advance – достижение
high-definition television – телевидение с высоким разрешением
vibrant – живой
sharp – чёткий
pixel – пиксель, минимальный элемент изображения
3-D television – телевидение с пространственным (3-мерным) изображением
flat – плоский
to absorb – поглощать
to converge – сводить в одну точку
shift – смена
cross-eyed – косоглазый
to trick – вводить в заблуждение
convergence – сближение, схождение в одной точке
eye strain – чрезмерное напряжение зрения
anaglyph lenses – двухцветные (анаглифические) линзы
to offset – отходить, смещаться
tint – оттенок
hue – тон
focal point – точка фокусировки
to distort – искажать
film – плёнка

How 3-D TV Works
Part 2: Active 3D Glasses

In the last few years, engineers have come up with a new way to create three-dimensional images in movies and on television sets. You still wear 3-D glasses with this method, but they don't use colored lenses. The method doesn't compromise the color quality of the image as much as anaglyph glasses do. It also doesn't require you to put a polarization film on your television screen. What it does do is control when each of your eyes can view the screen.

The glasses use liquid crystal display (LCD) technology to become an active part of the viewing experience. They have infrared (IR) sensors that allow them to connect wirelessly to your television or display. As the 3-D content appears on the screen, the picture alternates between two sets of the same image. The two sets are offset from one another similar to the way they are in passive glasses systems. But the two sets aren't shown at the same time – they turn on and off at an incredible rate of speed. In fact, if you were to look at the screen without wearing the glasses, it would appear as if there were two sets of images at the same time.

The LCD lenses in the glasses alternate between being transparent and opaque as the images alternate on the screen. The left eye blacks out when the right eye's image appears on television and vice versa. This happens so fast that your mind cannot detect the flickering lenses. But because it's timed exactly with what's on the screen, each eye sees only one set of the dual images you'd see if you weren't wearing the glasses.

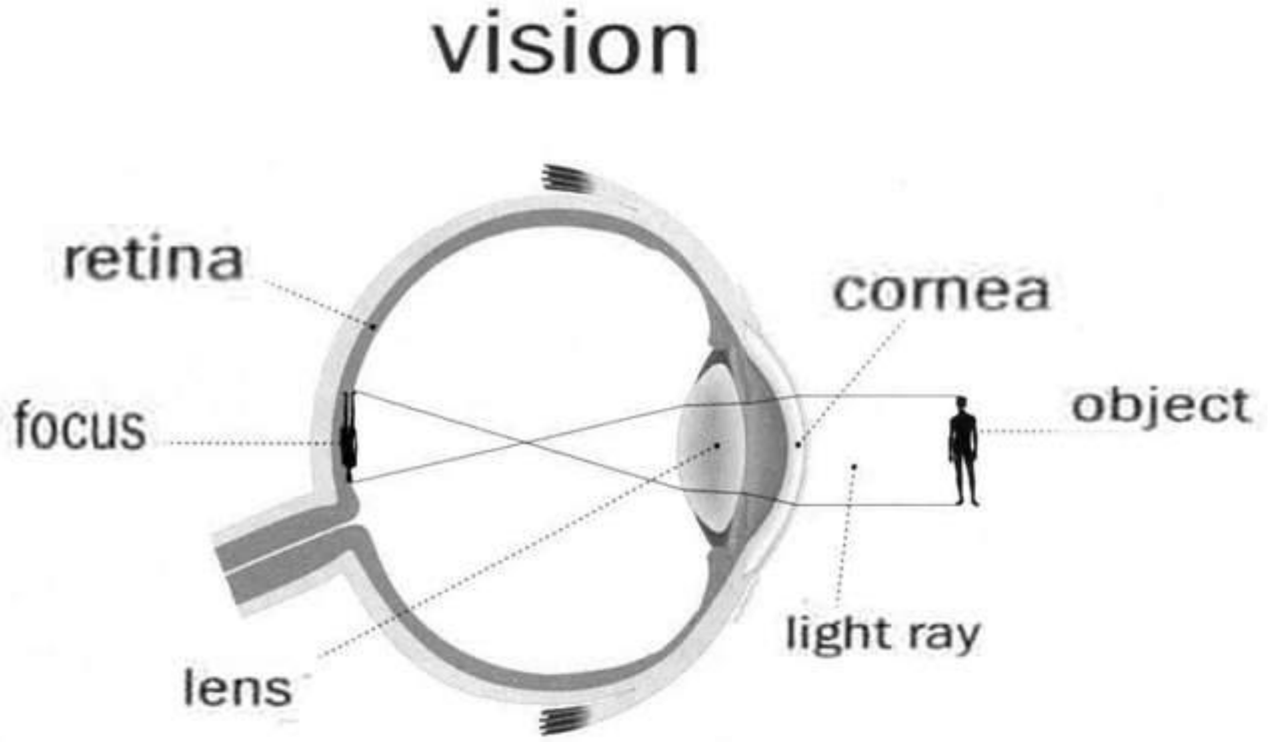
For several years, LCD and plasma screens weren't good candidates for this kind of technique. The refresh rates – the speed at which a television replaces the image on the screen – were too low for the technology to work without the viewer detecting a flicker from the glasses. But now you can find plasma and LCD displays with incredibly fast refresh rates.

You can't use a standard television and expect active glasses to work. You must have some way to synchronize the alternating images on the screen with the LCD lenses in the glasses. That's where the stereoscopic sync signal connector comes in. It's a standardized connector with three pins that plugs in to a special port on a 3-D-ready television or monitor. The other end of the cable plugs into an IR emitter. The emitter sends signals to your active 3-D glasses. This is what synchronizes the LCD lenses with the action on the screen.

While 3-D technology is impressive, some people still want a solution that doesn't require them to wear glasses. There have been several attempts at creating a display capable of projecting images into a three-dimensional space. Some involve lasers, some project images onto a fine mist or onto artificial smoke, but these methods aren't that common or practical.

Vocabulary Notes

to come up – сталкиваться
to compromise – ухудшать
infrared – инфракрасный
wireless – беспроводной
to alternate – чередовать
transparent – прозрачный
opaque – непрозрачный
to black out – затемнять
vice versa – наоборот
flickering – мерцающий
to time with – совпадать по времени
dual image – двойное изображение
refresh rate – частота обновления
alternating image – чередующееся изображение
pin – штекер
to plug in to – подсоединять
IR emitter – ИК-порт
stereoscopic sync signal connector – разъём синхронизации стереоскопического сигнала
three-dimensional space – 3-мерное пространство
fine mist – лёгкий туман, пыль



PROBLEM SOLVERS

The Laser: A Solution Looking for a Problem

"Star Wars", "Star Trek", "Battlestar Galactica" – laser technology plays a pivotal role in science fiction movies and books. It's no doubt because of these sorts of stories we now associate lasers with futuristic warfare and sleek spaceships. But lasers play a central role in our everyday lives, too. They appear in an amazing range of products and technologies. You'll find them in everything from CD players to dental drills from high-speed metal cutting machines to measuring systems. Tattoo removal, hair replacement, eye surgery – they all use lasers.

When lasers were invented in 1960, they were called "a solution looking for a problem". Since then, they have become ubiquitous, finding utility in thousands of highly varied applications in every section of modern society, including consumer electronics, information technology, science, medicine, industry, law enforcement, entertainment, and the military.

In everyday life we're more or less surrounded by laser applications. Carpenters use laser instead of spirit levels, hunters use laser instead of ordinary telescopic sights and most likely, you use laser when you listen to music.

The first use of lasers in the daily lives of the general population was the supermarket barcode scanner, introduced in 1974. The laserdisc player, introduced in 1978, was the first successful consumer product to include a laser but the compact disc player was the first laser-equipped device to become common, beginning in 1982 followed shortly by laser printers.

In science, lasers are used in many ways. Most types of laser are an inherently pure source of light. This makes the laser a very useful source for spectroscopy where lasers are used to make extremely sensitive detectors of various molecules, able to measure molecular concentrations. Holographic techniques employing lasers also contribute to a number of measurement techniques in geology, seismology, remote sensing and atmospheric physics. In astronomy, lasers have been used to create artificial laser guide stars, used as reference objects for adaptive optics telescopes.

Lasers' very accurate point and solid state construction make it ideal for industrial production. When the material is exposed to laser it produce intense heat thus the material is heated and melted. Lasers allow better cuts on metals and the welding of dissimilar metals without the use of a flux. Also lasers can be mounted on robotic arms and used in factories. This is safer then oxygen and acetylene, or arc welding. Laser line levels are used in surveying and construction.

Medical lasers can be used as a scalpel. Since the laser can be controlled and can have such a small contact area it is ideal for fine cutting and depth control. Medical lasers can also be used to reattach retinas and can be used in conjunction with fiber optics to place the laser beam where it needs to be. Medical lasers can also be used to stitch up incisions after surgery, by fusing together skin.

In consumer electronics, telecommunications, and data communications, lasers are used as the transmitters in optical communications over optical fiber and free space. They are also used to store and retrieve data in optical discs. Laser lighting displays accompany many music concerts.

Vocabulary Notes

pivotal – центральный
sleek – обтекаемый
solution – решение
ubiquitous – повсеместный
utility – применение
spirit level – спиртовой уровень
telescopic sight – оптический прицел
barcode – штрих-код
inherently – по сути
spectroscopy – спектроскопия
remote sensing – дистанционное зондирование
guide star – ведущая звезда
reference objects – объект отражения
to melt – плавить
flux – флюс
arc welding – электросварка
surveying – геодезия
retina – сетчатка глаза
incision – надрезание
to retrieve – восстанавливать

High-performance Materials

Earlier eras were characterized as the ages of stone, iron, and copper. "The age of engineered materials" may be the term that best characterizes the 20th century. But choosing just one material to define the century would be difficult. Steel for skyscrapers? Copper for electrical conduction? Silicon for chips? Plastics and polymers? Biomaterials for medical implants? In one way or another, all of these materials have been crucial to the inventions and innovations that have transformed the century.

The materials revolution that took hold in 1900 began with the heavy building blocks of iron and steel and ended with lighter weight metal alloys and exotic high-strength composites. Throughout the century, engineers learned new methods to analyze, process, refine, and add to materials in ways that maximized their properties, enhanced their performance, and met design challenges. They began to reshape skylines with sleek architecture of steel and glass, forge great sheets of metal for airplane wings, fabricate plastics into heart valves and computer circuits, and create new composites for spacecraft.

It is a major engineering enterprise to design, analyze and test materials. Analytical methods that allow detailed imaging and simulation have completely revolutionized materials research. And we can see the results everyday.

Computers using plastic photonic circuits handle data more rapidly than electronic devices – photons travel much faster, and plastic components are lighter than metals, can store information more compactly, and are not subject to magnetic interference.

The interior of a jet engine is one of the most ferocious environments on Earth, reaching temperatures of 1 982,22 ^{o}C while exhaust gases rush past turbine blades, making them spin thousands of times per minute. The material for the blades must be strong enough to withstand the stress and force of the gases and heat, light enough to maximize efficiency, and durable enough for extensive use.

Copper is a highly conductive metal, but it is soft. Mixing it with a minute amount of silver makes it strong enough conduct electricity without melting. The wrong material, or the wrong amount of copper to silver, could spell disaster in many areas, including disconnecting a telephone call or causing the lights to go out.

Adjusting carbon and other elements in steel produces many new alloys, allowing steel to be used in countless industries from shipbuilding to watchmaking. Additives can turn some materials into shapeshifters – for example, polyvinylchloride (PVC) used in gutters, pipes, and panels can be turned into clothing by adding plasticizers, or be used as the tubing that forms the circuit of the heart-lung machine.

More of the world’s products are made with composites that combine different types of strength or resilience. These include exotic amorphous metals and shape-memory alloys – “smart” materials that can actually respond to changes in their environment and “remember” their shape. They are being applied to many products, such as stents used to keep human arteries open.

The space age has spawned important new materials and uncovered new uses for old materials. Fiberglass-reinforced plastics have been molded into rigid shapes to provide car bodies and hulls for small ships.

New analytical techniques, molecular and atomic imaging, and quantum calculations for atomic and molecular systems are available to help optimize materials choices and manufacturing approaches. Materials development today is much closer to engineering science than in the past. The engineer's ability to translate that science into applications is now approaching the level of atomic and molecular design – the frontier of the future.

Vocabulary Notes

high-performance – высокоэффективный
engineered – созданный
implant – имплантат
enhance – улучшать
challenge – вызов, испытание
to forge – ковать
spacecraft – космический корабль
to handle – обрабатывать
rapidly – быстро
interference – воздействие
jet engine – реактивный двигатель
ferocious – агрессивный
to spin – вращаться
turbine blade – лопасть турбины
to adjust – подгонять
additive – добавка
shapeshifter – изменяющий форму
gutter – шланг
plasticizer – пластификатор
heart-lung machine – аппарат "сердце-легкие"
resilience – эластичность
shape-memory alloy – сплав с эффектом запоминания формы
stent – стент
to spawn – рождать
rigid – твёрдый
hull – корпус
frontier – граница

Robots and Artificial Intelligence

Artificial intelligence (AI) is the most exciting field in robotics. It's certainly the most controversial: Everybody agrees that a robot can work in an assembly line, but there's no consensus on whether a robot can ever be intelligent.

Like the term "robot" itself, artificial intelligence is hard to define. AI would be a recreation of the human thought process – a man-made machine with our intellectual abilities. This would include the ability to learn just about anything, the ability to use language and the ability to formulate original ideas. Roboticists are near achieving this level of artificial intelligence, but they have made a lot of progress with more limited AI. Today's AI machines can replicate some specific elements of intellectual ability.

Computers can already solve problems in limited fields. The basic idea of AI problem-solving is very simple, though its execution is complicated. First, the AI robot or computer gathers facts about a situation through sensors or human input. The computer compares this information to stored data and decides what the information signifies. The computer runs through various possible actions and predicts which action will be most successful based on the collected information. Of course, the computer can only solve problems it's programmed to solve – it doesn't have any generalized analytical ability. Chess computers are one example of this sort of machine.

Some modern robots also have the ability to learn in a limited capacity. Learning robots recognize if a certain action achieved a desired result. The robot stores this information and attempts the successful action the next time it encounters the same situation. In Japan, roboticists have taught a robot to dance by demonstrating the moves themselves.

Some robots can interact socially. Kismet, a robot at Artificial Intelligence Lab, recognizes human body language and voice inflection and responds appropriately. Kismet's creators are interested in how humans and babies interact, based only on tone of speech and visual cue. This low-level interaction could be the foundation of a human-like learning system.

The real challenge of AI is to understand how natural intelligence works. Developing AI isn't like building an artificial heart – scientists don't have a simple, concrete model to work from. We do know that the brain contains billions and billions of neurons, and that we think and learn by establishing electrical connections between different neurons. But we don't know exactly how all of these connections add up to higher reasoning, or even low-level operations. It seems complex and incomprehensible.

Because of this, AI research is largely theoretical. Scientists hypothesize on how and why we learn and think, and they experiment with their ideas using robots. Just as physical robotic design is a handy tool for understanding animal and human anatomy, AI research is useful for understanding how natural intelligence works.

A number of robotics experts predict that robotic evolution will ultimately turn us into cyborgs – humans integrated with machines. Conceivably, people in the future could load their minds into a sturdy robot and live for thousands of years!

In any case, robots will certainly play a larger role in our daily lives in the future. In the coming decades, robots will gradually move out of the industrial and scientific worlds and into daily life, in the same way that computers spread to the home in the 1980s.

Vocabulary Notes

artificial intelligence – искусственный интеллект
robotics – робототехника
roboticist – робототехник
to replicate – копировать
problem-solving – решение проблемы
to encounter – сталкиваться
inflection – изменение, перепад
visual cue – визуальный сигнал
challenge – испытание, вызов, задача
incomprehensible – необъяснимый
conceivably – вероятно
sturdy – прочный

GRAND CHALLENGES FOR ENGINEERING

New Millennium: New Challenges

"Make the world better,
and the world will make someone better than you"

Throughout human history, engineering has driven the advance of civilization. From the metallurgists who ended the Stone Age to the shipbuilders who united the world's peoples through travel and trade, the past witnessed many marvels of engineering prowess. As civilization grew, it was nourished and enhanced with the help of increasingly sophisticated tools for agriculture, technologies for producing textiles, and inventions transforming human interaction and communication. Inventions such as the mechanical clock and the printing press irrevocably changed civilization.

In the modern era, the Industrial Revolution brought engineering's influence to every niche of life, as machines supplemented and replaced human labor for countless tasks, improved systems for sanitation enhanced health, and the steam engine facilitated mining, powered trains and ships, and provided energy for factories.

In the century just ended, engineering recorded its grandest accomplishments. The widespread development and distribution of electricity and clean water, automobiles and airplanes, radio and television, spacecraft and lasers, antibiotics and medical imaging, and computers and the Internet are just some of the highlights from a century in which engineering revolutionized and improved virtually every aspect of human life.

For all of these advances, though, the century ahead poses challenges as formidable as any from millennia past. As the population grows and its needs and desires expand, the problem of sustaining civilization's continuing advancement, while still improving the quality of life, looms more immediate. Old and new threats to personal and public health demand more effective and more readily available treatments. Vulnerabilities to pandemic diseases, terrorist violence, and natural disasters require serious searches for new methods of protection and prevention. And products and processes that enhance the joy of living remain a top priority of engineering innovation, as they have been since the taming of fire and the invention of the wheel.

In each of these broad spheres of human concern – sustainability, health, vulnerability, and joy of living – specific grand challenges await engineering solutions. The world of engineers will seek ways to put knowledge into practice to meet these grand challenges. Applying the rules of reason, the findings of science, the aesthetics of art, and the spark of creative imagination, engineers will continue the tradition of forging a better future.

Foremost among the challenges are those that must be met to ensure the future itself. The Earth is a planet of finite resources, and its growing population currently consumes them at a rate that cannot be sustained. Widely reported warnings have emphasized the need to develop new sources of energy, at the same time as preventing or reversing the degradation of the environment.

And the external world is not the only place where engineering matters; the inner world of the mind should benefit from improved methods of instruction and learning, including ways to tailor the mind's growth to its owner's propensities and abilities. Some new methods of instruction, such as computer-created virtual realities, will no doubt also be adopted for entertainment and leisure, furthering engineering's contributions to the joy of living.

The spirit of curiosity in individual minds and in society as a whole can be further promoted through engineering endeavors enhancing exploration at the frontiers of reality and knowledge, by providing new tools for investigating the vastness of the cosmos or the inner intricacy of life and atoms.

Vocabulary Notes

prowess – мастерство
marvel – чудо
to nourish – кормить
to enhance – улучшать
irrevocably – безвозвратно
accomplishment – успех
challenge – вызов, испытание, проблема
formidable – огромный и страшный
to loom – становиться
vulnerability – уязвимость
taming – укрощение
sustainability – устойчивое развитие
forging – создание
propensity – пристрастие
curiosity – любознательность

Make Solar Energy Economical

As a source of energy, nothing matches the sun. It out-powers anything that human technology could ever produce. Only a small fraction of the sun's power output strikes the Earth, but even that provides 10,000 times as much as all the commercial energy that humans use on the planet.

For a long-term solar power offers an attractive alternative. Its availability far exceeds any conceivable future energy demands. It is environmentally clean, and its energy is transmitted from the sun to the Earth free of charge. But exploiting the sun's power is not without challenges. Overcoming the barriers to widespread solar power generation will require engineering innovations in several arenas – for capturing the sun's energy, converting it to useful forms, and storing it for use when the sun itself is obscured.

Many of the technologies to address these issues are already in hand. Dishes can concentrate the sun's rays to heat fluids that drive engines and produce power, a possible approach to solar electricity generation. Another popular avenue is direct production of electric current from captured sunlight, which has long been possible with solar photovoltaic cells.

But today's commercial solar cells, most often made from silicon, typically convert sunlight into electricity with an efficiency of only 10 percent to 20 percent. To make solar energy economically competitive, engineers must find ways to improve the efficiency of the cells and to lower their manufacturing costs.

However advanced solar cells become cheap and efficient, a major barrier to widespread use of the sun's energy remains: the need for storage. Cloudy weather and nighttime darkness interrupt solar energy's availability.

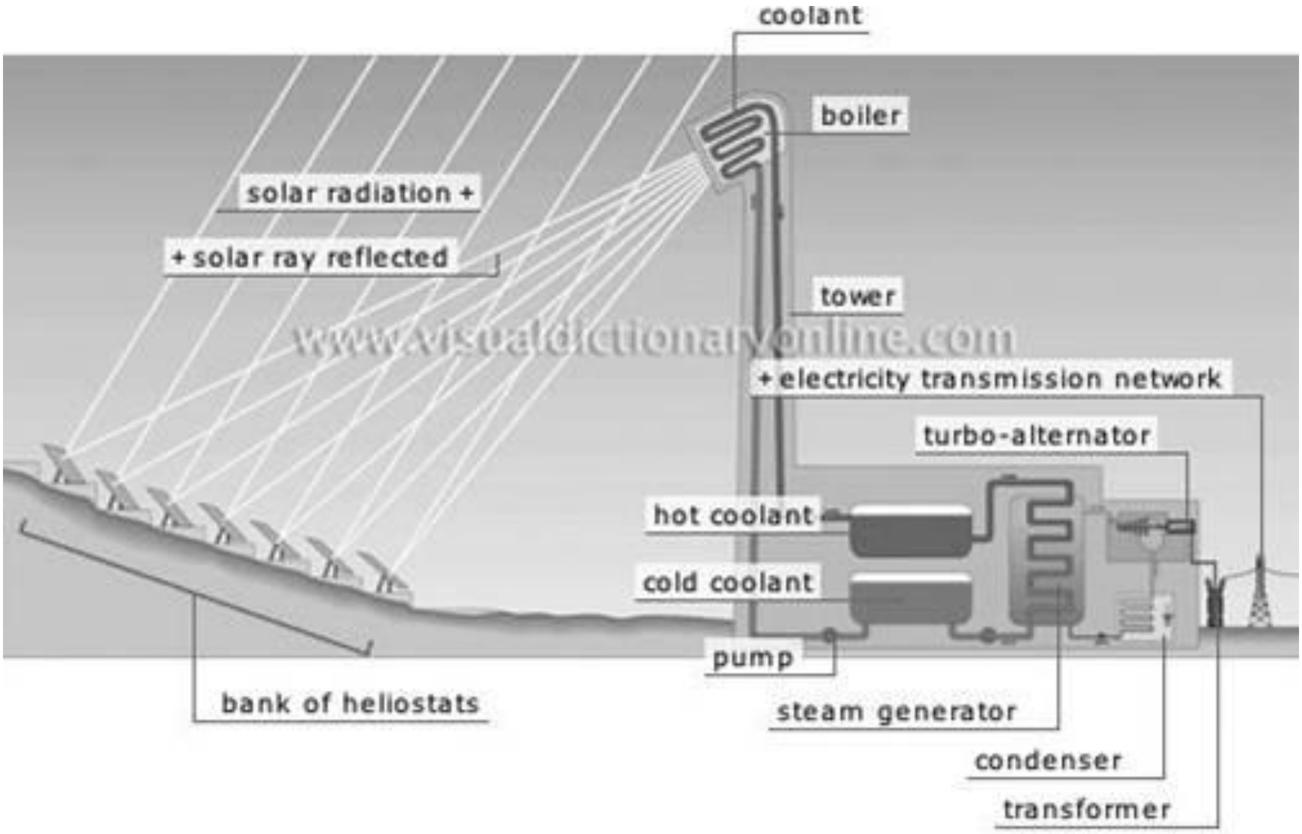
Many technologies offer mass-storage opportunities. One possible solution to the storage problem would mimic the biological capture of sunshine by photosynthesis in plants, which stores the sun's energy in the chemical bonds of molecules that can be used as food. The plant's way of using sunlight to produce food could be duplicated by people to produce fuel. For example, sunlight could power the electrolysis of water, generating hydrogen as a fuel. Hydrogen could then power fuel cells, electricity generating devices that produce virtually no polluting byproducts. Nature's catalysts, enzymes, can produce hydrogen from water with a much higher efficiency than current industrial catalysts. Developing catalysts that can match those found in living cells would dramatically enhance the attractiveness of a solar production-fuel cell storage system for a solar energy economy.

Fuel cells have other advantages. They could be distributed widely, avoiding the weaknesses of centralized power generation. If the engineering challenges can be met for improving solar cells, reducing their costs, and providing efficient ways to use their electricity to create storable fuel, solar power will assert its superiority to fossil fuels as a sustainable motive force for civilization's continued prosperity.

Vocabulary Notes

to out-power – превосходить по силе
conceivable – вероятный
issue – проблема
fluid – жидкость
avenue – способ
advanced – современный
to interrupt – прерывать
to mimic – копировать
chemical bond – химическая связь
to duplicate – копировать
byproduct – побочный продукт
enzyme – фермент
fossil fuel – ископаемое топливо
sustainable – устойчивый

PRODUCTION OF ELECTRICITY FROM SOLAR ENERGY



Provide Energy from Fusion

If you have a laptop computer, its battery probably contains the metallic element lithium. In theory, the lithium in that battery could supply your household electricity needs for 15 years. Not in the form of a battery, of course. Rather, lithium could someday be the critical element for producing power from nuclear fusion. Power plants based on lithium and using forms of hydrogen as fuel could in principle provide a major sustainable source of clean energy in the future.

Fusion is the energy source for the sun. To be sure, producing power from fusion here on Earth is much more challenging than in the sun. There, enormous heat and gravitational pressure compress the nuclei of certain atoms into heavier nuclei, releasing energy. The single proton nuclei of two hydrogen isotopes, for example, are fused together to create the heavier nucleus of helium and a neutron. In that conversion, a tiny amount of mass is lost, transformed into energy.

Earthbound reactors cannot achieve the high pressures of the sun's interior but temperatures much higher than the sun's can be created to compensate for the lesser pressure, especially if heavier forms of hydrogen, known as deuterium and tritium are fused.

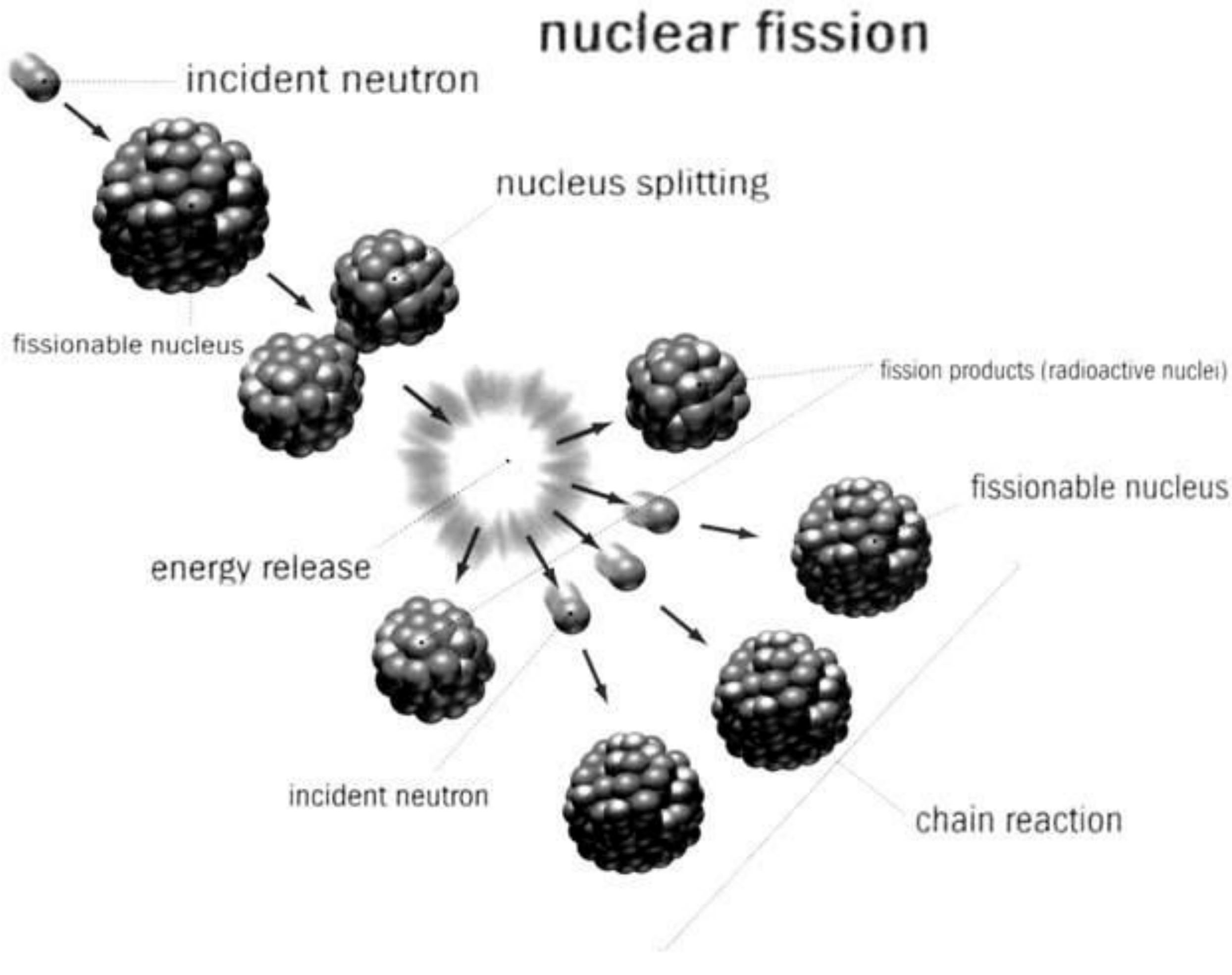
Tritium is radioactive and is extremely scarce in nature. That's where lithium comes in. Lithium is more abundant than lead or tin in the Earth's crust, and even more lithium is available from seawater. A 1,000 megawatt fusion-powered generating station would require only a few tons of lithium per year. As the oceans contain trillions of tons of lithium, supply would not be a problem for millions of years. Deuterium is a relatively uncommon form of hydrogen, but water – each molecule comprising two atoms of hydrogen and one atom of oxygen – is abundant enough to make deuterium supplies essentially unlimited. Oceans could meet the world's current energy needs for literally billions of years.

Human-engineered fusion has already been demonstrated on a small scale. The challenges facing the engineering community are to find ways to scale up the fusion process to commercial proportions, in an efficient, economical, and environmentally friendly way. A major demonstration of fusion's potential will soon be built in southern France. Called ITER (International Thermonuclear Experimental Reactor), the test facility is designed to reach a power level of 500 megawatts. It will be the first fusion experiment to produce a long pulse of energy release on a significant scale. Construction of ITER is scheduled to start by 2009, with plasma to be first produced in 2016, and generation of 500 megawatts of thermal energy by 2025.

In safety terms, it poses no risk of a runaway nuclear reaction – it is so difficult to get the fusion reaction going in the first place that it can be quickly stopped by eliminating the injection of fuel. Of course, fusion's success as an energy provider will depend on whether the challenges to building generating plants and operating them safely and reliably can be met in a way that makes the cost of fusion electricity economically competitive. In any case, fusion fuels offer the irresistible combination of abundant supply with minimum environmental consequences.

Vocabulary Notes

lithium – литий
household – домашний, бытовой
sustainable – устойчивый
nuclear fusion – ядерный синтез
earthbound – наземный
tritium – тритий
deuterium – дейтерий
to scale up – увеличивать масштаб
runaway – неуправляемый
injection – поступление
irresistible – привлекательный



Access to Clean Water

Lack of clean water is responsible for more deaths in the world than war. About 1 out of every 6 people living today do not have adequate access to water, and more than double that number lack basic sanitation, for which water is needed. In some countries, half the population does not have access to safe drinking water, and hence is afflicted with poor health.

It's not that the world does not possess enough water. Globally, water is available in abundance. It is just not always located where it is needed. For example, Canada has plenty of water, far more than its people need, while the Middle East and northern Africa – to name just two of many – suffer from perpetual shortages. And in some developing countries, water supplies are contaminated not only by the people discharging toxic contaminants, but also by arsenic and other naturally occurring poisonous pollutants found in groundwater aquifers.

Water for drinking and personal use is only a small part of society's total water needs – household water usually accounts for less than 5 percent of total water use. In addition to sanitation, most of the water we use is for agriculture and industry. Of course, water is also needed for ecological processes not directly related to human use. For a healthy, sustainable future for the planet, developing methods of ensuring adequate water supplies pose engineering challenges of the first magnitude.

From digging wells to building dams, engineers have historically been prime providers of methods for meeting the water supply and quality needs of society. To meet current needs, which increasingly include environmental and ecosystem preservation and enhancement demands, the methods will have to become more sophisticated.

One large-scale approach used in some countries has been to divert the flow of water from regions where it is plentiful to where it is scarce. Such diversion projects provide some short-term relief for cities, but do not appear practical as widespread, long-term, ecologically sound solutions, and this method generally will not be able to meet agricultural needs. Furthermore, diverting water to some people often means less for others and can become an explosive political issue.

Another approach is desalination. Desalination is extracting the salt from seawater. Desalination is not a new idea and is already used in many regions, particularly in the Middle East. Modern desalination plants employ a method called reverse osmosis, which uses a membrane to separate the salt. But desalination plants are expensive to build and require lots of energy to operate, making desalination suitable mainly for seaside cities in rich countries. It therefore has limited value for impoverished countries, where water supply problems are most serious.

Technologies are being developed, for instance, to improve recycling of wastewater and sewage treatment so that water can be used for nonpersonal uses such as irrigation or industrial purposes. Recycled water could even resupply aquifers. But very effective purification methods and rigorous safeguards are necessary to preserve the safety of recycled water. Various nanotechnology approaches may be helpful in this regard, such as nanofiltration membranes that can be designed to remove specific pollutants while allowing important nutrients to pass through.

Yet another strategy for improving water availability and safety would be small decentralized distillation units, an especially attractive approach in places where infrastructure and distribution problems are severe. One of the main issues is economical distribution of water to rural and low-income areas. Some current projects are striving to produce inexpensive distillation units that can remove contaminants from any water source. A unit smaller than a dishwasher could provide daily clean water for 100 people.

Vocabulary Notes

lack – нехватка
afflicted – страдающий
sanitation – санитария
abundance – изобилие
perpetual – непрекращающийся
shortage – недостаток
pollutant – загрязняющее вещество
arsenic – мышьяк
toxic contaminant – токсичное загрязняющее вещество
aquifer – водоносный пласт почвы
sustainable – жизнеспособный
magnitude – величина
enhancement – увеличение
sophisticated – сложный
large-scale approach – широкомасштабный подход
desalination – опреснение
osmosis – осмос, односторонняя диффузия через полупроницаемую мембрану
impoverished – бедный
sewage treatment – очистка сточных вод
recycled water – повторно используемая вода
rigorous – строгий
nutrient – питательное вещество

Create Thinking Machines

For decades, some of engineering's best minds have focused their thinking skills on how to create thinking machines – computers capable of emulating human intelligence. While some of thinking machines have mastered specific narrow skills – playing chess, for instance – general-purpose artificial intelligence (AI) has remained vague.

Part of the problem, some experts now believe, is that artificial brains have been designed without much attention to real ones. Pioneers of artificial intelligence approached thinking the way that aeronautical engineers approached flying without much learning from birds. It has turned out, though, that the secrets about how living brains work may offer the best guide to engineering the artificial variety. Discovering those secrets by reverse-engineering the brain promises enormous opportunities for reproducing intelligence the way assembly lines produce cars or computers.

Figuring out how the brain works will offer rewards beyond building smarter computers. Advances gained from studying the brain may in return pay dividends for the brain itself. Understanding its methods will enable engineers to simulate its activities, leading to deeper insights about how and why the brain works and fails. Such simulations will offer more precise methods for testing potential biotechnology solutions to brain disorders, such as drugs or neural implants. Neurological disorders may someday be circumvented by technological innovations that allow wiring of new materials into our bodies to do the jobs of lost or damaged nerve cells. Implanted electronic devices could help victims of dementia to remember, blind people to see, and crippled people to walk.

The progress so far is impressive. But to fully realize the brain's potential to teach us how to make machines learn and think, further advances are needed in the technology for understanding the brain in the first place. Modern noninvasive methods for simultaneously measuring the activity of many brain cells have provided a major boost in that direction, but details of the brain's secret communication code remain to be deciphered. Nerve cells communicate by firing electrical pulses that release small molecules called neurotransmitters, chemical messengers that hop from one nerve cell to a neighbor, inducing the neighbor to fire a signal of its own (or, in some cases, preventing the neighbor from sending signals). Because each nerve cell receives messages from tens of thousands of others, and circuits of nerve cells link up in complex networks, it is extremely difficult to completely trace the signaling pathways.

Furthermore, the code itself is complex – nerve cells fire at different rates, depending on the sum of incoming messages. Sometimes the signaling is generated in rapid-fire bursts; sometimes it is quieter. And much of mental function seems based on the firing of multiple nerve cells around the brain in synchrony. Teasing out and analyzing all the complexities of nerve cell signals, their dynamics, pathways, and feedback loops, presents a major challenge.

Today's computers have electronic logic gates that are either on or off, but if engineers could replicate neurons' ability to assume various levels of excitation, they could create much more powerful computing machines. Success toward fully understanding brain activity will, in any case, open new avenues for deeper understanding of the basis for intelligence and even consciousness, no doubt providing engineers with insight into even grander accomplishments for enhancing the joy of living.

Vocabulary Notes

to emulate – соперничать
vague – неясный
to approach – подходить
reverse-engineering – обратная инженерия, проектирование по образцу
reward – вознаграждение
to circumvent – обходить
wiring – монтаж, присоединение
dementia – слабоумие
crippled – травмированный, хромой
noninvasive – бесконтактный
deciphered – раскодированный
neurotransmitter – нейротрансмиттер
to hop – прыгать
to trace – отслеживать
rapid-fire burst – серия быстрых вспышек (как пулемётная очередь)
to tease out – выбирать из
to replicate – копировать
excitation – возбуждение
accomplishment – достижение
enhancing – усиление

Prevent Nuclear Terror

"We shouldn't think that terrorists or other groups
wishing to make nuclear weapons are illiterate."

From the beginnings of the nuclear age, the materials suitable for making a weapon have been accumulating around the world. Even some actual bombs may not be adequately secure against theft or sale in certain countries. Nuclear reactors for research or power are scattered about the globe, capable of producing the raw material for nuclear devices. And the instructions for building explosive devices from such materials have been widely published, suggesting that access to the ingredients would make a bomb a realistic possibility.

Nuclear security therefore represents one of the most urgent policy issues of the 21st century. In addition to its political aspects, it poses acute technical issues as well. In short, engineering shares the formidable challenges of finding all the dangerous nuclear material in the world, keeping track of it, securing it, and detecting its diversion or transport for terrorist use.

Concern for nuclear security complicates the use of nuclear energy for peaceful purposes, such as generating electricity. Ensuring that a nation using nuclear power for energy does not extract plutonium for bomb building is not easy. Diversion of plutonium is much more difficult when a country opts for a "once through" fuel cycle that keeps the plutonium with the highly radioactive spent fuel, rather than a "closed" fuel cycle where spent fuel is reprocessed and plutonium separated out. Simple record keeping could be faked or circumvented. Regulations requiring human inspection and video monitoring are surely not foolproof.

Of course, if dangerous nuclear materials are diverted from a power reactor, or probably more likely from some other source, preventing their transportation to a possible point of use remains a serious problem. Protecting countries' borders from nuclear transgression poses a formidable challenge, because so many imports are legitimately shipped into the country within large shipping containers. Individual inspection of each container would be costly and very disruptive – each can hold 30 tons, and roughly 10 million arrive in countries every year. Various ways of detecting nuclear materials hidden in such containers have been proposed or tested, but most are ineffective.

There are already real-time mutual surveillance systems in operation between Russia and the U.S.'s Sandia National Laboratories to ensure that there is no unauthorized access to storage containers of weapons-usable materials. A challenge for engineers would be to expand such schemes at a reasonable cost.

No doubt other nuclear challenges will surface and additional engineering methods will be needed to protect against the variety of possible nuclear assaults. But the ingenuity of systems and nuclear engineers, and the deep understanding of nature's nuclear secrets provided by basic physics research, offer encouragement that those challenges can be met in the 21st century.

Vocabulary Notes

to scatter – разбрасывать
raw material – сырьё
acute – острый
formidable – громадный
“once through” fuel cycle – однократный топливный цикл
“closed” fuel cycle – замкнутый топливный цикл
to reprocess – перерабатывать
to circumvent – обмануть
to fake – подделать
foolproof – надёжный
to divert – отводить, удалять
transgression – правонарушение
disruptive – разрушительный
unauthorized – несанкционированный
to surface – возникать
ingenuity – находчивость, изобретательность
encouragement – поощрение
surveillance – надзор, наблюдение

Secure Cyberspace

Personal privacy and national security in the 21st century both depend on protecting a set of systems that didn't even exist until late in the 20th – the electronic web of information-sharing known as cyberspace.

Electronic computing and communication pose some of the most complex challenges engineering has ever faced. They range from protecting the confidentiality and integrity of transmitted information and deterring identity theft to preventing the scenario in which hackers take down the transportation system, then communications, and finally the power grid.

Networks of electronic information flow are now embedded in nearly every aspect of modern life. From controlling traffic lights to routing airplanes, computer systems govern virtually every form of transportation. Radio and TV signals, cell phones, and e-mail all provide vivid examples of how communication depends on computers – not only in daily life, but also for military, financial, and emergency services. Utility systems providing electricity, gas, and water can be crippled by cyberspace disruptions. Attacks on any of these networks would potentially have disastrous consequences for individuals and for society.

In fact, serious breaches of cybersecurity in financial and military computer systems have already occurred. Identity theft is a burgeoning problem. Viruses and other cyber-attacks plague computers small and large and disrupt commerce and communication on the Internet.

Historically, the usual approach to computer protection has been what is called "perimeter defense." It is implemented by placing routers and "firewalls" at the entry point of a sub-network to block access from outside attackers. Cybersecurity experts know well that the perimeter defense approach doesn't work. All such defenses can eventually be penetrated or bypassed.

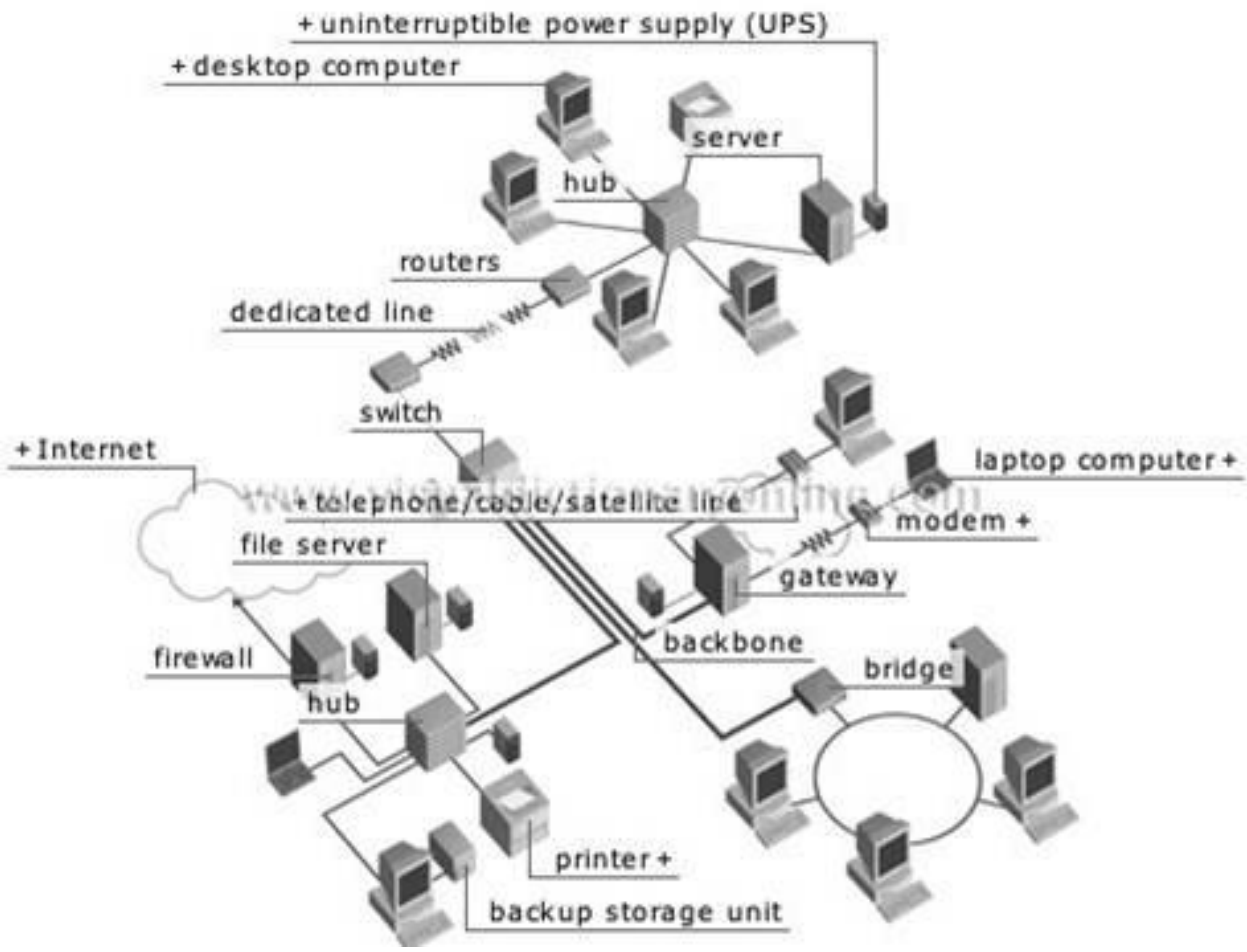
The problems are currently more obvious than the potential solutions. It is clear that engineering needs to develop innovations for addressing a long list of cybersecurity priorities. For one, better approaches are needed to authenticate hardware, software, and data in computer systems and to verify user identities. Biometric technologies, such as fingerprint readers, may be one step in that direction.

A critical challenge is engineering more secure software. One way to do this may be through better programming languages that have security protection built into the ways programs are written. And technology is needed that would be able to detect vulnerable features before software is installed, rather then waiting for an attack after it is put into use.

All engineering approaches to achieving security must be accompanied by methods of monitoring and quickly detecting any security compromises. And then once problems are detected, technologies for taking countermeasures and for repair and recovery must be in place as well. Part of that process should be new forensics for finding and catching criminals who commit cybercrime or cyberterrorism.

Vocabulary Notes

cyberspace – киберпространство
deterring – предотвращение
to take down – разрушать
power grid – электроэнергетическая система
embedded – встроенный
routing – регулирование движения
utility systems – коммунальные системы
to cripple – наносить ущерб
disruption – разрушение
breach – брешь, слабое место
to burgeon – расцветать, распускаться
firewall – брандмауэр (защита от распространения влияния ошибки)
to bypass – обходить
to authenticate – подтверждать
hardware – детали компьютера
software – программное обеспечение
forensics – спор
countermeasures – меры противодействия
cybercrime – киберпреступность



Engineer the Tools of Scientific Discovery

In the popular mind, scientists and engineers have distinct job descriptions. Scientists explore, experiment, and discover; engineers create, design, and build. But in truth, the distinction is blurry, and engineers participate in the scientific process of discovery in many ways. Grand experiments and missions of exploration always need engineering expertise to design the tools, instruments, and systems that make it possible to acquire new knowledge about the physical and biological worlds. In the century ahead, engineers will continue to be partners with scientists in the great quest for understanding many unanswered questions of nature.

Biologists are always seeking, for instance, better tools for imaging the body and the brain. Many mysteries also remain in the catalog of human genes involving exactly how genes work in processes of activation and inhibition. To explore such fields, biologists will depend on engineering help – perhaps in the form of new kinds of microscopes, or new biochemical methods of probing the body's cellular and molecular machinations. New mathematical and computing methods may show the way to better treatments of disease and better understanding of healthy life.

When we speak about the universe, the main question is whether there is life anywhere else in the universe than on Earth. Systems capable of probing the cosmos for evidence surely represent one of engineering's grandest challenges. Even apart from the question of extraterrestrial life, the exploration of space poses a considerable challenge. Long-distance human space flight faces numerous obstacles, from the danger of radiation to the need to supply sustainable sources of food, water, and oxygen. Engineering expertise will be critical to overcoming those obstacles, and many efforts to expand that expertise are underway. One line of research, for example, envisions a set of connected bioreactors populated by carefully chosen microbes. But the allure of space extends well beyond the desire to seek novel life and explore new phenomena. Space represents the mystery of existence itself. The universe's size and age exceeds most people's comprehension. Matter and energy are united into such structures as galaxies, stars, and planets supporting the even more intricate atomic arrangements making up minerals, plants, and animals. However, scientists do not know what most of the universe is made of. We only understand a small percentage of all the matter and energy in the cosmos.

Engineers have continually been at work on better, and cheaper, ways to search space for answers to these questions. New and improved telescopes, both on the ground and in space, make up part of the investigatory arsenal. Other devices measure waves of gravity rippling through space, or detect the flux of the elusive lightweight particle known as the neutrino. Engineers and physicists are already collaborating to develop computers based on quantum principles. Such computers, in addition to their possible practical value, may reveal new insights into the quantum world itself. Perhaps engineers will be able to devise smaller, cheaper, but more powerful atom smashers, enabling physicists to explore fields beyond the reach of current technology.

Vocabulary Notes

description – набор признаков
blurry – расплывчатый
expertise – опыт, знания
imaging – создание изображения, визуализация
gene – ген
inhibition – подавление
probing – зондирование
machination – схема, переплетение
extraterrestrial – внеземной
obstacle – препятствие
sustainable – устойчивый
to underway – идти полным ходом
to envision – представлять
allure – вовлечение
novel – неизвестный
to ripple – с лёгкостью продвигаться
flux – поток
elusive – неуловимый
neutrino – нейтрино
atom smasher – ускоритель ядерных частиц

PUSHING THE BOUNDARIES

Cities on Rails

Most architect design buildings with permanence that will last decades if not centuries. Swedish architecture firm thinks the city of the future shouldn't be permanent. The firm has won third place in a contest to develop a Norwegian city of Andalsnes with a plan to create a configurable city that rolls buildings around on rails.

The idea is to make best use of the city's existing infrastructure to create an efficient city that changes to accommodate the season. In Andalsnes' case, that requires an ability to accommodate lots of tourism and cruise liner traffic in the warm seasons and provide shelter and lots of indoor activity space in the colder months.

Given the fact that Andalsnes is an old railway city with miles of leftover track from a bygone oil boom era, the solution presented itself: create buildings that can be moved around on the existing to best accommodate the season, events, and the evolving needs of a modern city.

To quote the jury in its notes on the competition: "The proposer has seen the importance of the railway for the development of the city and taken this element and created a new future for the city. The railroad's fundamental contradiction between the permanence of the tracks and the mobility and flexibility of the wagons is playfully and elegantly exploited in the planning proposal."

Particularly impressive to the jury was the emphasis on exploiting the existing rail rather than designing new city blocks, promenades, or public squares – after all, if your city is readily configurable you can do the city planning later. In an era where most developed nations are building fewer brand new cities and spending more resources on improving aging, existing ones, new flexible, efficient design could be preview of the smart city of the future.

Vocabulary Notes

permanence – постоянство
to last – продолжаться, длиться
configurable city – перестраиваемый город
to roll – катить
rails – рельсы
to accommodate – приспосабливаться
leftover – неиспользуемый
bygone – прошлый
to evolve – развиваться
to quote – цитировать
contradiction – противоречие
playfully – шутливо
smart city – умный город

‘Road Train’ Automobile Takes a Successful First Test Drive

Technology that links a chain of semi-autonomous vehicles to a lead car has undergone its first trials at a Volvo test track in Sweden. The “road train” system, which allows cars to link into “trains” in which the lead car sets the pace and direction for the cars linked behind it, could be deployed on European roadways by the end of the decade.

The idea is to cut fuel use, cut congestion, and make highways safer by allowing those traveling long distance on highways to link up with other drivers going the same way. Once a driver falls in line behind the lead vehicle and establishes a wireless link, an adaptive cruise control system kicks in to match the leader’s speed while a battery of sensors ensure all vehicles in the train maintain a safe distance from each other.

The following vehicles then follow the leader autonomously, leaving the drivers behind to take their hands off their wheels, and relax until it’s time to retake control of the vehicle and leave the convoy.

In this initial test a single Volvo car was linked to a truck using the EU-backed SARTRE system (Safe Road Trains for the Environment), which is being developed by a larger European partnership involving universities, technology companies, and, of course, Volvo. The test was a success at the low speeds tested – you can see the driver taking his hands from the wheel of the Volvo and, somewhat nervously, reading a newspaper – but because of the complicated differences in traffic laws across more than two dozen EU nations, it could take several years to iron out a legal framework enabling the deployment of the tech.

Vocabulary Notes

to link – соединять, связывать
semi-autonomous – полуавтономный
to undergo – проходить
trial – испытание
to set the pace – устанавливать темп
to deploy – использовать
to cut – сокращать
in line – в ряд
wireless link – беспроводное соединение
to kick in – активироваться
to maintain – сохранять
EU-backed – финансируемый Евросоюзом
traffic law – правила дорожного движения
legal framework – правовые рамки

Matter Can Be Made Up from a Vacuum

It is often said that you can't get something for nothing, but a handful of scientists from the University of Michigan think differently. Theoretically speaking, they say, you can make particles from a vacuum under the right conditions. All you need is an ultra-high-intensity laser, a particle accelerator, and an open mind about what exactly "nothing" is (hint: it's something).

The first step in understanding their line of thinking is to change the way you look at a vacuum; rather than being an empty void, they say, a vacuum is a balanced combination of matter and antimatter, or particles and antiparticles. These particles have tremendous density but we cannot observe them.

The researchers have devised a set of equations that suggest a high-energy laser pulse can rip apart the nothingness of a vacuum, turning it into its constituent particles and antiparticles and setting off a chain reaction that actually generates additional matter-antimatter pairs.

How? When matter and antimatter annihilate each other, gamma photons are produced, and these high-energy particles of light can produce additional electrons and positrons (positrons being the antimatter foil to electrons). But that's not the whole trick. In a strong laser field, these electrons produced from matter-antimatter annihilation can become a combination of three other particles plus a number of photons.

Calculations show that from a void one can produce electrons and those electrons can become a number of other particles, and when it's all said you have more particles than you started with (because you started with a vacuum). The researchers think this happens in nature near pulsars and neutron stars. Something for nothing.

Vocabulary Notes

handful – небольшое количество
particle – частица
ultra-high-intensity laser – ультрамощный лазер
particle accelerator – ускоритель частиц
open mind – воображение
hint – подсказка
void – вакуум
matter – материя
density – плотность
to devise – изобретать
equation – уравнение
to rip apart – разбивать
nothingness – ничто
to annihilate – уничтожать
foil – фон
pulsar – пульсар

New Space Race

The space plane design is a departure from prevailing capsule-based designs favored by SpaceX and other big contractors. At about one-quarter the size of the space shuttles, the unnamed space plane has no engines like the shuttles, and it can only carry a crew of four. Like the shuttles, it would ride into orbit on a rocket. It would dock with the ISS via a hatch in the rear, and after departing the ISS it would glide to a runway landing below.

NASA sees a reusable space plane design as the cheaper and safer way to move crews to and from the ISS; its “blended lifting body” allows it to move from its orbital trajectory as it reenters and place its point of landing where the pilot wishes. Capsules, of course, come screaming through the atmosphere more or less at their orbital trajectory and rely on parachutes to soften the “splash down” and a recovery crew to locate and pick up the crew.

Both capsules and space planes have their advantages, and neither has a spotless safety record. But it will be interesting to see which mode NASA eventually selects for the next generation of ISS missions. For one, capsules have been fairly reliable since the 1960s, but during the development of the shuttle program the military was keen to have a craft with “cross range” – that space plane capability to move out of orbital trajectory – for possible strategic purposes. The shuttle never flew militarily, but it would be notable if such a consideration still played a role in NASA’s first post-Cold War crew vehicle.

Vocabulary Notes

departure – уход
prevailing – преобладающий
contractor – подрядчик
unnamed – без названия
crew – экипаж
to dock with – стыковаться
hatch – шлюз
to glide – планировать
runway – взлётно-посадочная полоса
to land – приземляться
space plane – космолёт
reusable – многоразовый
blended – сочленённый
to reenter – входить в атмосферу
to scream – пронзительно врываться
splash down – приводнение
recovery crew – спасательный экипаж
spotless – незапятнанный
cross range – изменяемая дальность
crew vehicle – пилотируемый аппарат

The Fastest Man-Made Device Ever Built

The European Union is funding a three-year project at the Finnish Meteorological Institute to build the fastest man-made device in the universe: an electric sail, or ESAIL, that researchers say could make Pluto in just five years' time.

Like the more well-known solar sail, the ESAIL is propelled by solar radiation and therefore requires no chemical or ion propellant. But rather than actually unfurling a huge membranous sail to catch photons from the sun to provide thrust, the ESAIL repels protons.

The ESAIL consists of a bunch of thin metallic tethers that unfurl in a huge circular array around the craft. A solar-powered electron gun aboard the tiny central spacecraft keeps the tethers charged at a high positive potential. Since particles of the same charge repel one another, the protons in the solar wind push on the tethers, propelling the sail away from the sun.

Since the sail itself is extremely lightweight, it doesn't take much to get a ESAIL-powered spacecraft flying at a respectable pace; some have estimated that after a year in flight an ESAIL could hit about 30,58 kilometres per second.

But first the team will have to make it work, a task the European Union has put $2.25 million behind. If successful, they'll have one hell of a fast spaceship. Whether it will be able to do the ESAIL that will reach 12 parsecs remains to be seen.

Vocabulary Notes

electric sail – электронный парус
propellant – ракетное топливо
to unfurl – развёртывать (парус)
thrust – движущая сила
to repel – отражать
bunch – связка, пучок
tether – фал (трос)
aboard – на борту
to propel – приводить в движение
respectable – приличный
parsec – парсек (3.262 световых лет)

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