

## **László Egyed: Informal learning and SSIBL – the Science Centers Mobilis and Futura**

### **Mobilis**

The interactive exhibition Mobilis in Győr concentrates basically on car industry and traffic. This is a really socio scientific issue, regarding environmental questions, namely pollution, fuels, energy saving and such questions. During a visit to the exhibition the problem can be discussed, how automobiles can be made more environment-friendly eg. with the control of engines, good fuel. Electric and hybrid cars are also steps towards environment-friendly vehicles. Also an important topic is tyres, the proper material – this can be important from the point of fuel saving –, and recycling. Today recycling is an important point at automobiles, not only tyres, but many other components. In Mobilis this is presented during a guided show, there is a path of environmental consciousness to follow. Also during science shows attention is called to energy saving and environmental pollution.

Though not presented directly at the exhibition, it is worth calling the attention of schoolclasses to the development of fuels. For the proper operation of the engine a fuel is needed which doesn't explode under compression (this is illustrated by an exhibit presenting the operation of the engine), only after ignition, this could be realized with former fuels only by adding plumb-tetraethyl to them, this improved compression tolerance. The research of the Nobel-prize winner chemist George Olah from Hungary made possible the production of plumb-free fuels. This decreased largely environmental pollution, because the fields along the highway were largely polluted with plumb in a wide band, so plants grown in this band were dismissed.

It is worth talking also about the beginning of the history of automobiles, at that time the electric vehicles were real alternatives of petrol driven cars. At the end internal combustion engines won. The great problem at that time was the same as today: batteries. Even today it is a great constraint that electric cars can make a limited distance with one charge. And it must be added, that though electric vehicles do not pollute directly the environment, the needed electricity to charge them is produced in polluting power plants.

Also connected to socio scientific issues that it is important to raise interest in the talented students towards a career in science and technology, and this is a definite purpose of Mobilis with the interesting exhibits and also with the science shows. Also there are programs for the talented where they are oriented in this direction.

## **Futura**

At the design of Futura the starting point was that its city, Mosonmagyaróvár lies at the foot of the Alps and here the natural forces are present in a very accented way. This gave the basis of the concept: the exhibition is built around the so-called four basic elements: earth, water, air, fire. On the basis of these many socio scientific questions can be discussed.

The first level is water, there are here exhibits in connection with water. There is a large basin with flowing water with many elements showing the use of water power. With the archimedean screw the visitor can pump water up, which flowing back drives a waterwheel. Water power where there are large waterflows has an important (and environment-friendly) role in power supply, but it has also an important role in power storage, and this will increase in the future. It is a good method for storing power produced in low consumption periods to pump water with it to a high level reservoir, and generate power with it at high consumption periods. It is known that there are types of power plants, eg. nuclear plants where it is difficult to lower the power production, and it is needed for them to operate at full power in the high consumption period, so the power produced in low consumption periods can be stored this way.

This installation also presents water transport, on the channels there are little ships; also the water flow can be directed in the right direction with small dams. There is here another exhibit where the washing out of the river basin can be observed and influenced with placing different blocks at the right place. Water transport can be an important part of environmental protection because this way transport is more energy efficient, by transporting trucks and camions on the water to the largest distance possible.

River control is another topic worth discussing at this exhibit. This is also a socio scientific question, there was a big debate concerning the dam at Bős-Nagymaros protesting against it, and it was blocked the construction of its counterpart at Nagymaros. On the other hand specialists say that if the regulation of a river began, it must be done to the end – and the Danube is regulated on the whole upper section till Bős-Nagymaros with many dams. With the aid of dams water transport can be improved too.

Also here can be discussed the history of the utilization of water power with the aid of model watermills, showing the different types of these. The visitor can even rotate these model water-wheels. It is presented here that the descent of water at the lower part of the Danube is little, but the drift is strong, for this reason ship-mills were built, the wheel rotated slowly but powerfully between the ship and the mill, it was speeded up with the proper transmission. There is an installation here with cogwheels where different transmissions can be formed and tested.

In a big aquarium different water habitats can be seen, marshland, stream, river bank, the different plants and animals living there, it can be discussed how to preserve these. For example the pollution of water harms the living creatures, plants and animals. Even closer can be seen this problematic in the model Danube explorer ship, the visitor can sit in, sink underwater (with the aid of a movie) and have an even closer look at the habitat.

Effect of the formation of the environment can be studied at the smart sand-table, where sand can be formed with hand, and one can see the altitude lines in color. If the „hills” are high, there is snow on top of them, deep valleys are filled with water. You can observe and discuss the effects of land forming.

Water supply is demonstrated with a water tower model. Water reaches users with the aid of the principle of communicating vessels. This means that the water tower must be higher than the highest building supplied with water. One can experiment here with the height, experience how it influences the water pressure at the different levels and how to assure proper pressure at the utmost story of a high building.

Another installation shows where is water from, what kind of quality it must have. For Budapest, the water is produced with coast filtered wells, this water needs no further cleaning, filtering to the well is enough. It is important to stress the importance of water, water supply will be one of the most important problems of the 21st century.

There is a transparent tube network going around in the whole building, this contains an ecosystem: leaf-cutting ants live here. The visitor can observe their life, trailing to and fro, carrying the leaf pieces, building their ecosystem, this observation reveals the operation of an ecosystem, the life of the ant society. There are big transparent balls in the system, where the social behaviour of ants can be seen.

The second level is earth. One installation demonstrates magma currents with the aid of fine sand. These magma currents played a very important role in the formation of the surface of the Earth.

We can walk in a symbolic forest, study its living world. Ground is very important for trees, they grasp in it with their roots, and it yields nutriment for them. Also trees are very important for the environment: bind carbon dioxide and release oxygen, thus it is very problematic that the area of forests decreases dramatically from year to year because of human activity.

In a terrarium the visitor can see examples of adaptation, living creatures adapt to their environment to be able to hide, walking sticks can hardly be distinguished from the trees they live on. These examples draw the attention to environmental consciousness, paying attention to the environment. It is worth asking the students to look for similar examples in their surroundings.

At this level there are tables showing the development of the environment in this district of Hungary named Szigetköz, presents its living world, plants, animals, eg. birds, the visitor can even listen to their sounds. On a smelling wall the visitor must find out the different smells.

Fuels also belong to the topic earth. From the point of environmental protection it is not indifferent what kind of fuels we use. This installation presents the energy content of the different fuels. Coal, paper-bricquet, wood splinter, hay, firewood, paraffin-oil, bio-bricquet, ethanol can be seen here. Besides energy content it is also important to use recycles or renewable fuels.

There are earthquakes in Hungary, too, though not with devastating power, but it must be known that in the transdanubian region an African plate penetrates the European crust and this caused former big earthquakes, eg. at Kecskemét or Komárom. This is interesting from the point of the nuclear power plant in Paks which can be found in this region, so the plans had to consider this possibility of earthquake too, and this must be considered at the design of Paks2, the planned new nuclear power plant. We must add, that the Paks plant was designed to tolerate an earthquake of 5,5 magnitude, and the magnitude of the Komárom earthquake was 6,8.

We can sit here in an armchair and experience the feeling of an earthquake. On a shaking table we can try to construct earthquake-resistant buildings from different building elements.

Evolution of the living world was not continuous, from time to time there were big extinctions, these are presented by a table. The reasons of the extinctions were different, from asteroids to ice ages. But it is worth to raise awareness to the large volume of extinctions resulting from human activity. Humanity destroys the habitats of a lot of species, or deteriorates its quality, some species are overhunted, also environmental pollution can play a role in extinctions, or inhabitation of non-native species, and climate change in the last time also plays an important

role in the extinction of some species. The table makes one thinking about the ways how to prevent this. The students can be asked before the visit to collect the list of presently extinct or endangered species.

At this level we can get known to the structure of the Earth's crust. Many sections show the layers of the different geologic structures, volcanic rock, sedimental layers, here one can place the rock samples to the right place, so we can see where can we find the different types of rock. A socio scientific issue is that specific minerals can be bought only from the conflict regions, where mining is done in hard circumstances, this can be discussed here, too.

We can learn here the different economical possibilities of this region, the Szigetköz, sylviculture, gravel-mining, and we can learn that once gold was washed from the water of the Danube. This gold is washed out from the minerals at the origin of the river.

Third level is air. The visitor can learn how weather forecast is made. With the aid of meteorological instruments the visitor can prepare his or her own forecast – and also learns how exactly can the weather be forecasted – as the atmosphere is a chaotic system, small differences in the start data can result in very large differences in the end result (butterfly effect). For this reason the weather models are run several times, with a little different starting data set, and the forecast is considered to be reliable to the point where the curves resulting from the different sets run together. When the visitor produces his or her forecast, can choose a background to present it. In connection with weather forecast climate change and global warming can be discussed with the students, and also the effect of weather on the society, eg. on the agricultural production. It can be discussed, too, how the African continent becomes uninhabitable because of the global warming.

Besides the meteorological station the different weather phenomena are presented here, eg. the tornado, the lightning, and the atmosphere and the weather on other planets of the solar system is presented too, this is important in view of the planned human missions to the different planets.

An exhibit demonstrates the formation of the sand deserts. At another exhibit the visitor can lift a ball with the aid of an airstream, he or she has to and can lead it through a ring.

In connection with this exhibit the socio scientific problem of scientific misbeliefs can be discussed. Even today a widespread misbelief is that airplanes are lifted to the air with the aid of the so-called Bernoulli effect, because over the curved wing of the plane the speed of the airflow is larger than under the wing - over the curved surface the air has to run a larger

distance. According to Bernoulli's law with the increase of the speed of a flow its pressure decreases, this causes the pressure difference lifting the airplane. But on one hand this law is valid only in a closed system, and though the so-called Coanda effect really exerts a lift on the wing, it is much smaller than that needed to lift the plane. Really the change of the direction of the airflow on the wing is the most important part of the lifting force. Maybe the students can be asked before the visit to look after this problem.

Though it doesn't belong to the topic of air, here are exhibited the vocational test instruments of the Struktúra Ltd. Vocation is an important socio scientific question, a student must decide how to go on after finishing the highschool. For this, it can yield a great help if the student can test his or her abilities, and these instruments make it possible. There are instruments to test concentration ability, finger skill, reflexes and many other abilities. With the aid of these the student receives points to choose the right direction.

Environmental protection, protection of the living world can be connected to the wall presenting the living world of air, the birds of this region. If the visitor finds out which bird is which, he or she can listen to its voice, this can help later the visitor during an excursion to find out, which bird is singing. This also helps to develop environmental consciousness, similarly to many other exhibits at the Futura.

Wind power plays an important role these days in environmental protection, in the extension of alternative power sources. Though in Hungary the importance of wind power is not so large as in countries with a more windy weather (it is said that if the shallow waters of the Norwegian coast were filled with wind farms, these could supply the whole Europe with electricity). But here at the foot of the Alps there is a large amount of wind power – this can be sensed seeing the wind farms along the highways.

From this point it is important the shape of the air wings, this influences the effectivity of the exploitation of the power of the wind. There is an exhibit here, where the visitor can experiment with the different shapes, which is the most effective, there is a blower blowing a strong wind, and the visitor can measure with the built in instruments the power generated by the different air wings at a given wind speed. It can be discussed with the students that the noise of the wind wheels can disturb the living creatures, so this problem must be solved where wind power is intended to be used because it influences negatively the living world.

Visitors in the cockpit of a Boeing can get acquainted to the properties of the airplane, in connection with this the effect of air traffic on the environment can be discussed. At the time of

the attack against the twin towers there was a 3 days long interruption in air traffic, and it turned out that the daily temperature became higher because the condensation trails did not block the rays of the sun to reach the surface. This shows the intensive effect of human activity on the environment.

In connection with the condensation trails also another misbelief can be discussed, namely the chemtrail theory, according to which the condensation trails contain some chemicals to influence people. While discussing this topic, it can also be discussed how these misbeliefs form, how they influence people, maybe the students can be asked to collect such misbeliefs. Even the movement against vaccination (another misbelief) and its dangers can be discussed – an important socio scientific problem.

Fourth level is fire. Here there is a Tesla transformer which presents great lightnings. The visitor here can read on a table about the life and work of Nikola Tesla, who was a really excellent inventor, inventing a lot of things. It can be asked from the students which kind of electricity is, alternating or direct current in the electric socket. Even they can be asked to look after the advantages of alternating current. Here can be discussed – and read on the table about - the „war of currents” between Edison and Tesla, presenting the advantages of alternating current. As we know, Tesla won. The alternating current made possible the transformer with which the voltage can be transformed higher and this way it can be lead to great distances with low loss. At the home it can be transformed back to the 230 V which we use.

In connection with Tesla the problem of patents is also worth to be discussed. Marconi in 1901 presented the radiation and reception of radio waves without wires, and received Nobel-prize for that in 1909. But Tesla presented a similar patent in 1896. At the end the American court of justice judged to Tesla the invention of the radio, and in this judgement they withdraw it from Marconi. In connection with this problem it is worth discussing how patents help or block technical evolution, because specific patents can block for example the spread of a good technology, or the rational price of a medicine. It is also interesting to mention that Fermi and Szilard patented the nuclear power plant, but realizing that humanity needs nuclear power very much, they sold the patent for one dollar to the state.

There is a separate section for illusions, demonstrating how unreliable are our senses, a socially sensitive point of it is the question, how reliable are witnesses. They are not always reliable, not sensing thing as they are in reality, or their memory cheats them.

At the upmost level is a solar telescope, the visitor can see the different phenomena on the surface of the sun, sunspots, flares and similar, these are important for humanity too, because these have an effect reaching the Earth.

It is worth discussing with the students what we do not see, namely the ultraviolet radiation, what was (and is) absorbed by the ozone layer in the upper atmosphere, protecting the living creatures. These can cause for humans skin cancer. But in the last time so many such gases were produced and released into the air which destroy this layer – in refrigerators, sprays etc. -, that these punched it. Today these gases are prohibited. But it must be a part of environmental consciousness that it is not irrelevant what we release into the air, these can have a long range effect.

Good topic to discuss is the problem of solariums, which also radiate the user with ultraviolet light, it must be made conscious that these can be harmful for teenagers, so it is better if the students do not use solarium, and they must use good quality sunscreens.

At this level there is a permanent exhibition presenting the different aspects of space research, in part the technical details, and in part the possibilities promised by it, e.g. minerals mined on other planets. It can be seen here the history of the Apollo missions. Many think it that for a Mars expedition a good base can be at the Moon, on the other hand, according to the opinion of Hawking the Earth sooner or later becomes uninhabitable, and we must prepare to move to another planet, and this can be the Mars. Here the visitor can see the details of the Puli Space Project which wants to send a mooncraft to the moon, which will make photographs there and send these back to the earth. Though they are not in the first five in this race (the Lunar SpaceX), they are convinced that sooner or later many Pulis will work on the Moon.