for better
education
& training
for engineers

ideas

EDUCATION FOR THE FUTURE

Number 16

December 2009

WFEO

Committee on Education and Training

World Federation of Engineering Organizations

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WORLD FEDERATION OF ENGINEERING ORGANIZATIONS
FEDERATION MONDIALE DES ORGANISATIONS D'INGENIEURS

COMMITTEE ON EDUCATION AND TRAINING

JOURNAL IDEAS No 16, December 2009

IDEAS is a publication of the WFEO Committee on Education and Training, addressed to engineering educators, educational officers at Universities and leaders responsible for establishing educational policies for engineering in each country. The articles it contains reflect the concern of people and institutions linked to WFEO, to provide ideas and proposals with the object of improving formation of engineers.

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Editor: Prof. Włodzimierz Miszalski,
PL-00-043 Warszawa, ul. Czackiego 3/5. phone: +4822 3361 279
e-mail: wmiszalski@wat.edu.pl

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EDITORIAL

Education for the Future

Prof. Włodzimierz Miszalski – President of the WFEO Committee on Education And Training

In the past, numerous discussions on engineering education focused on how to share the total university education time into general domains of knowledge necessary for future engineer and after long arguing about shifting a few credit hours here or there – ended with less or more acceptable compromise. Although the limited education time versus proposed amounts of particular components of engineer's knowledge should be continually subject of optimization – the future of engineering education goes far beyond the question of proportions of particular components in the academic curriculum.
The question how should the engineering education ethos change facing the requirements of contemporary world and challenges of future civilization – is still open – particularly when opinions appear that engineering is undergoing an identity crisis (e.g. starting from the dilemma: conquest of nature versus creating sustainable habitat).

On one hand – engineering education seems to be the key to increase the awareness of factors threatening the survival of humans and other living species (natural and human caused disasters, pollution of air and water, accumulation of wastes, destruction of forests, erosion of soils etc.) – the key for implementing the recommendations of UN and other international organizations concerning sustainable development. On the other hand – the demands of the employers of engineering graduates often seem still to be the results of unsustainable and inequitable patterns of production, consumption large amounts of resources and energy, creation pollution and waste. Compromise on the two contradictory approaches seems not to be the problem of optimization – but the problem of ethics.

In a paper presented during the 5th World Congress on Engineering Education in September 2006 [1] I distinguished six generations of engineers taking into account the roles played by engineers on different stages of evolution of engineering during last two centuries. Since the end of XVIII-th century the set of the roles has increased significantly from the role of inventor or constructor of a single machine – to the role maintainer, manager or logistician of a large scale human-technical system like for instance: computer network, satellite communication system, spaceships launching, guidance and landing system, disaster monitoring and relief system etc.. The set of technical objects with which contemporary engineer has to deal – extends from micro-machine, microchip or nanorobot invisible by naked eye – to the worldwide technical system which is also "invisible" in the sense of transparency and direct visibility of all the systemic relations, energy or information flows. I left open the questions: what will the VI-th generation of engineers be

like?, what challenges will shape the VI-th generation engineer's personality?, what needs and requirements will influence his/her professional profile?.
After almost one decade we can only partially answer the questions. In many recent publications, articles, conferences' and congresses' proceedings one may find attempts and proposals of the answers. Many authors try to distinguish characteristic features of the new generation engineers. Gradually a picture of our heroes is beginning to emerge: "globally oriented, free from national or regional biases, prepared to handle global challenges, to deal with the worldwide scale engineering projects, to work in international and intercultural teams, flexible, able to work effectively in any country, any region of the world …".

Mobility is mentioned frequently as a feature of future generation engineers and one of the reasons for this is the non-balanced distribution of engineering intellectual potential in different parts of the world. Some of the considered characteristics seem to be contradictory (e.g. the "ability to work in integrated global enterprises" and "entrepreneurship" – understood as ability to start and maintain small businesses, small scale enterprises etc.) – other emphasize "practical orientation" rather than allegedly existing so far – "theoretical bias".

Ability "to carry out an idea for a new product into practice" or – in other words – "innovative characteristics" of future engineer's personality – appear in many publications usually together with the mentioned above "entrepreneurship". "Dedication to development" is the characteristic which seems to run through all the six generations of engineers but recently has acquired particular significance in the context of sustainable development. Timeless seem also: "passion for technology" and "self-improvement capacity" revealed by surveys conducted in different circles of engineers and engineering students. Shaping future generation of engineers is the mission of engineering education but it is also great responsibility of educators. Civilization addicted to technology requires high ethical standards from its engineers.

Since at least 15 years engineering education community aware of these challenges has made efforts to respond them and WFEO Committee on Education and Training has acted as a forum for exchanging ideas and promoting activities oriented towards the new paradigm of engineering education.

Following list of the CET activities reflects our attempts to meet the requirements of educating future generation engineers:
– working out and developing foundations of WFEO policy on mobility;
– promoting the idea of internationalization of engineering education (encouraging educational institutions to extend the idea to global scale, remove barriers such as restrictive visa and work permits for foreign students during studying and after receiving degree as well as for educational personnel, promoting international engineering education programs and curricula);
– analyzing the issues of life-long learning and distance learning in the international context;

- developing guidelines to facilitate regional and interregional recognition of engineering qualifications;
- initiating discussion on the assumptions, limitations and barriers on the way to creation worldwide accreditation system;
- promoting the co-operative projects between companies and universities going beyond a national framework;
- supporting small- and medium-sized enterprises in engineering and technological innovation activity;
- analyzing the differences between the recommendations of UN and other international organizations concerning sustainable development and the demands of employers of engineering graduates (working out conclusions for engineering education programs);
- supporting and stimulating projects creating new international engineering education institutions;
- developing the idea of World University of Technology as a source of inspirations, patterns and standards, promoting global engineering education, funding scholarships.

At the end of my four year term as President of WFEO Committee on Education and Training I would like to thank all the Distinguished Committee Members and particularly those who during past four years participated in the mentioned above activities for their excellent work and contribution to international co-operation in the area of engineering education and to shaping new generation engineers.
The subtitle “Education for the Future” of the 16th number of IDEAS reflects the views and attitudes of the Authors of papers.

Prof. Vollrath Hopp continues the considerations from his previous articles on the necessity of interdisciplinary and international approach to the issues of energy production, consumption and atmosphere pollution from education of future engineers point of view. Dr Peter Greenwood – leader of the CET Working Group on Mobility of Engineering Professionals presents the results of the Group’s works, which were approved by the WFEO General Assembly in Kuwait in November 2009 as WFEO Policy on Mobility. The document is important for future engineering education and particularly for its international aspects.

In my paper – subsequent in a series devoted to the idea of World University of Technology (WUT) I am trying to present the status and some conclusions of the initiated in 2006 discussion on the idea in the context of internationalization of engineering education and then to discuss the proposals of missions tasks and structures of two organizational units o future WUT.

Particularly interesting and thought provoking seems Dr Arnold Warchał’s article on the mutual relations between engineers and politicians and implications for future both: engineering and political education.

The Chronicle of Events covers the period between January 2009 and December 2009 and records the most important WFEO-CET events and activities.

I would like to thank Mr. Stanislaw Konieczny CET Secretary for preparing IDEAS No. 16 for printing and putting on the WFEO webpage.

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Energy, Atmosphere, Carbon dioxide and Climate – an example of interdisciplinary thinking

Prof. Dr.-Ing. Vollrath Hopp – Honorary Member of University Rostock/Germany
Chairman of the department environmental technology of the VDI-Bezirksverein Frankfurt-Darmstadt, Germany

Prof. Vollrath. Hopp has studied chemistry and technology at the Technical University of Berlin, and received a doctorate in 1960. He worked in the chemical industry in Germany. In 1966 he joined Hoechst AG as head of vocational and advanced training in science and engineering. He was offered a guest lectureship at the Tongji University, Shanghai, in 1986, subsequently becoming a Honorary Professor. In 1991 he was appointed Professor at the University of Rostock in the areas of chemical technology. He is a full member WFEO-CET. 1998 he became an Honorary Member at the University of Rostock. Prof. Hopp has published extensively in journals on issues of chemical engineering. He is the author of five chemical engineering textbooks. He has received several prizes and decorations for contributions to co-operation between education and industry.

INTRODUCTION

At present the biggest problems in our world are the care of mankind with sufficient technical and physiological (food) energy, fresh water, protection against diseases and epidemics and the maintenance of nature's power of regeneration.

Al though many scientific and cultural organizations try hard to cooperate internally. The differences of opinions and the conflicts of interests became bigger. The top politicians of many powerful nations e.g. North and South America, Africa, Asia, Australia European Union and especially Brasilia, China, India, Japan, Russia. United States of America travel from one summit conference to another summit meeting. The results are less and disappointing.

The participants of the international summit conference for "Nutrition and Agriculture" have acknowledged in Rome in November 2009 that the number of hungry people in the world has increased to 1 billion. The responsible politicians expressed their disappointment and horror that their efforts to alleviate famine were unsuccessful. They decided to support and to activate the small farmers in the world and reminded the rich nations to give more subsidy. But in this conference no new ideas were formulated for better working methods in agriculture which must be adapted to the different regions, for more effective irrigation in semi-arid regions and for a fair distribution of food. Nevertheless cereal, maize, sugar and vegetable oil are converted into bioethanol for petrol. This is a wrong and sinful way to substitute fossil materials to minimize the alleged dangerous carbon dioxide emission.

The construction of nuclear power plants is demonized by some rich nations. But all kind of energy sources are needed to provide industry as well as private sector with sufficient net energy; that means energy for practical application. The experts discuss controversially whether an increasing carbon dioxide emission into the atmosphere causes a change in climate.
The European Union would like to minimize the CO_2-emission and has created a system in which carbon dioxide in various countries may be traded in so called Carbon Dioxide-Certificates. The French President would like to tax that CO_2 which is produced by industry. The opinions of much respected scientists and international research institutes are widely lie apart, whether the emission of carbon dioxide basically influences the change in climate.

In the conference in Singapore in November 2009 the Asian politicians together with the US President Barack Obama didn't agree that a carbon dioxide emission would lead to warming of the lower layers of the atmosphere.

From December 7–18, 2009 Copenhagen has hosted the 15th Conference of the Parties to the United Nations Framework Convention on Climate Change. This conference was one of the most important and most complex in the history of climate policy negations. The objective was to form an agreement as a successor for the Kyoto Protocol. The Kyoto Protocol adapted in 1997 aimed to reduce industrial nations emission of greenhouse gases from their 1990 levels by about 5 % by 2012 at the latest.

The Climate Conference in Copenhagen ended in the usual way that is without significant results as was expended.

Schooling, vocational training, further education, studies, sciences and research are very important bases to improve the basis of life in a modern society.

All governments of the nations in the world demand these essentials. But these are often lip services. During the present economic crisis at first the budgets of the educational institutions have been cut directly and indirectly. Economic efficiency (production and financing) environmental protection (maintenance of nature's power of regeneration), education and social considerations are not mutually exclusive. They complement each other and need to be optimized.

Bachelor and Master degrees were introduced worldwide at the universities by the Bologna recommendations. The idea is to compare the international standards and contents of the courses of studies. The result of this international course reform is that the courses are organized along school lines. Independent thinking of the students is much neglected. The topical problems in the world become more and more complicated e.g. the population growth; the scarcity of fresh water, the shortage of the energy reserves, the hunger and the infectious diseases. All these individual problems interact with each other. Thinking and research is not developed thorough and broad.

In all disciplines and courses at the universities should be taught a broad scientific basic knowledge in the first half of the student days, e.g. mathematics, natural sciences, philosophy, logic, informatics and economic. These courses should be completed with a second foreign language besides English. The latter is for students who only speak the English language. Many scientific disciplines have to cooperate for understanding the influences of the weather on living systems on the Earth's surface and also in the atmosphere's lowest layer. Meteorologists, geologists, oceanologists, physicists, chemists, biologists, engineers, mathematicians, computer specialists are needed to explain the complex interaction between the different weather determining factors. At the universities all these students should be trained in interdisciplinary thinking and they should have an extensive basic knowledge in natural science. This is necessary for a successful working together in future. For that the contents of lectures, seminars and practical training in the departments must be completely revised. This may be a long way? National barriers are only reduced if young people have learned very early to appreciate foreign cultures and the ways of thinking in other countries.

Otherwise our world is furthermore involved in hunger after power, greed and corruption. *The importance of interdisciplinary thinking is demonstrated with the following subject: Energy, the Atmosphere and Carbon dioxide, Climate.*

1. CARBON DIOXIDE, CO_2; PHYSICAL, CHEMICAL AND BIOLOGICAL PROPERTIES

Carbon dioxide is a colourless, odourless and non-poisonous gas. The part in the Earth's atmosphere is 0.038 vol. %.

Decomposition point $2\ CO_2 \rightleftharpoons 2\ CO + O_2$	above 2000 °C
Molar mass	44.01
in comparison with oxygen	31.99
nitrogen	28.01

Standard enthalpy of formation	$\Delta_F H^0_{298}$ = -393.5 kJ/mol
Free standard enthalpy of formation	$\Delta_F G^0_{298}$ = -395.2 kJ/mol
Density at 0 °C	1.977 g/L
In comparison	1.429 g/L for oxygen
	1.250 g/L for nitrogen
Solidification point	-57 °C at 5.185 bar
Sublimation point	-78.5 °C
Critical temperature	+ 31.06 °C
Critical pressure	73.83 bar
Critical density	0.464 g/L

Carbon dioxide is the most important starting material of inorganic and organic compounds. It determines the short-time and long-time carbon cycles in the nature between the oceans, Earth's atmosphere and surface of the continents.
In human, animal, plant and microorganism catabolism the energy for vital processes comes from a series of oxidation reactions. The final product of the combustions of foodstuffs in carbon dioxide, which is exhaled.

Occurrence of carbon dioxide in the atmosphere
Carbon dioxide in Earth's atmosphere is considered a trace gas currently occurring at an average concentration of about 386 parts per million by volume or 594 parts per million by mass. The molar mass of CO_2 is higher than the masses of oxygen, 32, and nitrogen, 28. Therefore CO_2 occurs predominantly in the atmosphere's lower layer. The mass in the Earth's atmosphere is $5.14 \bullet 10^{15}$ tonnes. So the total mass of atmospheric carbon dioxide is $3053 \bullet 10^9$ tonnes. This value corresponds to $833 \bullet 10^9$ tonnes carbon. The CO_2 concentration varies seasonally and also considerably on a regional basis. E.g. in urban areas it is generally higher and indoors it can reach 10 times the background atmospheric concentration.

In the oceans $1.3 \bullet 10^{14}$ tonnes CO_2 are dissolved. It is partly dissociated in hydrogen carbonate und carbonate ions:

$$CO_2 + HOH \rightleftharpoons H^+ + HCO_3^- \rightleftharpoons 2H^+ + CO_3^-$$

It exists a chemical equilibrium between the two steps of dissoziation. The equilibrium establishments depends of the temperature of the sea water and of other dissolved ions e.g. Ca^{++} or Mg^{++}.

Calcium ions react with carbonate ions to insoluble calcium carbonate.

$$Ca^{++} + 2\,OH^- + 2H^+ + CO_3^- \rightarrow CaCO_3 + 2\,HOH$$

It sediments on the ocean bed and forms big layers of limestone.

Large amounts of carbon dioxide and calcium carbonate respectively are bounded by marine unicellular organisms (foraminifera), sea urchins (echonoids), crustaceans, corals and coral reefs, sea shells and other carbonate binding marine organisms. The carbonate layers protect the sensitive bodies of mollusca. Foraminifera are among the most abundant organisms in the world's ocean and their shells represent a major and globally significant sink for calcium carbonate. *Carbon dioxide* is part of a bicarbonate buffer and stabilises the pH-value in the blood.

carbonic acid		hydrogen ion		hydrogen carbonate ion
H2CO3	$\rightleftharpoons$	H^+	+	HCO_3^-

The following reaction detoxifies the bodies of mammalians including of man. Ammonia is released by the catabolism of proteins.

carbon dioxide		ammonia		urea		water		physiological energy
CO^2	+	2 NH^3	$\longrightarrow$	NH_2–C(=O)–NH_2	+	H–OH	+	123.69 kJ

Carbon dioxide is a decomposition product of the aerobic (cellular respiration) and anaerobic (fermentation) metabolism e.g. sugar, starch, cellulose.

Polysaccharides, which have been broken down into monosaccharides can be further split up by fermentation in the presence of enzymes.

The alcoholic fermentation is a biochemical degradation of carbohydrates or sugar respectively in the presence of saccharomyces. Ethyl alcohol, carbon dioxide and exergonic energy of 236.4 kJ/mol are developed.

glucose from beet and cane sugar, wheat, maize		ethyl alcohol		carbon dioxide
C_6H_6(OH)6	yeast $\longrightarrow$	2 H_3C–CH_2–OH	+	2 CO_2
180 g		2 x 46 g		2 x 44 g
				$\Delta_R G$ = –236,4 kJ/mol

Besides the alcoholic drinks 32 million tonnes bio-ethanol are produced for petrol world-wide.

30.6 million tonnes carbon dioxide are developed as by-product, these correspond to 8.3 million tonnes carbon [C_x].

– Calculation of the daily exhaled amount of carbon dioxide by a man

It is assumed that 10000 kilojoule the daily physiological energy requirement of a man.

This amount of energy corresponds to 625.9 g starch per day. This results of the chemical reaction equation:

starch (polymerised glucose)		oxygen		carbon dioxide		water		physiological energy
$C_6H_6(OH)6$	+	$6\ O_2$	$\longrightarrow$	$6\ CO_2$	+	6 H–OH	+	2876 kJ
180 g				264 g				

$$2876\ \text{kJ} : 180\ \text{g} = 10000\ \text{kJ} : x[g]$$

$$x[g] = 625.9\ \text{g Stärke}$$

During the oxidizing catabolism 625.9 g starch releases 918 g carbon dioxide

$$180\ \text{g} : 264\ \text{g} = 625.9 : x[g]$$

$$x[g] = 918\ \text{g}\ CO_2$$

From that 700 g CO_2 = ≙ 365.3 litres are exhaled by man. The rest of 218 g CO_2 reacts with ammonia, NH_3, to urea.

About 700 g carbon dioxide is exhaled daily by a man. This amount corresponds to a volume of 356.4 litres. The world population are 6.5 bn. people. The result of which is that

$$700\ \text{g} \bullet 365\ \text{days} \bullet 6.5 \bullet 10^9\ \text{man} \approx 1.6\ \text{bn. tonnes carbon dioxide per year}$$

are exhaled by the world population. These amounts are 4.3 % of 39.7 bn. tonnes carbon dioxide which are emitted by the combustion of the fossil energy source.

2. SOME PHYSICAL BASIC LAWS FOR UNDERSTANDING OF THE CONVERSION OF SOLAR ENERGY IN OTHER KINDS OF ENERGIES

Newtons's law of cooling (Isaac Newton 1642–1727)

An object in an open air space with a higher temperature than its environment becomes gradually colder when it is put up in an open airstream. Its heat is mainly transmitted to the environment by convection and adjection.

The heat transfer occurs the quicker the higher the temperature difference is.

Fraunhofer lines

Josef Fraunhofer (1787–1826) discovered the black absorption lines in the solar spectrum. These lines are known as Fraunhofer lines. The absorption spectrum itself was first discovered in sunlight, in which the noble gas helium, present in the outer layer of the sun's mantel, was found to be missing. The dark lines registered in the solar spectrum are caused by the ionised gaseous atmosphere of its mantel which absorbs certain wavelengths in the continuous spectrum.

Einstein equation (Albert Einstein, 1879–1955) of mass-energy-equivalence is expressed, $E = m \cdot c^2$. Where energy E is measured in joules, mass (rest mass) m in kilograms and the velocity of light c in metres/sec.

The law of radiation
Josef Stefan (1835–1893) and Ludwig Boltzmann (1844–1906) formulated their law of radiation as follows:

> The total radiation of a black body over all wave lengths for a given area and within a given time interval is proportional to the fourth power of the absolute temperature.

Gustav Robert Kirchhoff (1824–1887) discovered that

$$\frac{E}{A} = \frac{\text{emissive capacity}}{\text{absorptive capacity}} = f(\lambda; T)$$

i.e. it is a function of the absolute temperature and the wavelength of the radiation.

Photochemical reactions

<u>Light that means electromagnetic waves is released energy by matter.</u>

There are several fundamental laws for photochemical reactions:
- Only those rays which are absorbed in a system can act photochemically (***Theodor Grothus***, 1785–1822).
- The photochemical activity of a radiation is proportional to the intensity of the photochemically
- active light which is absorbed, and to the radiation time (***Robert Wilhelm Bunsen***, 1811–1899; ***Henry Enfield Roscoe***, 1833–1915).
- The amount of energy which is absorbed by one molecule in an elementary photochemical reaction amounts to one energy quantum.

Light emitted as fluorescence or phosphorescence is as a rule of longer wave length than the absorbed (exciting) radiation, Stoke's rule (***Georg Gabriel Stokes***, 1819–1903).

Wilhelm, K. W. Wien's (1864–1928) Law of displacement

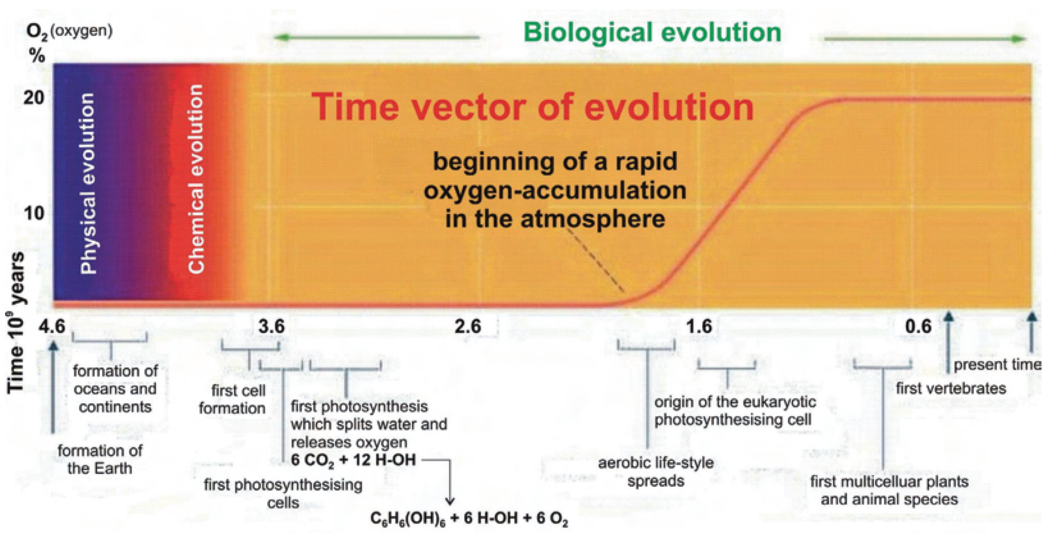
The law is the mathematical connection between the temperature and the radiation of a black body. The maximum of an emission of a black body postpones itself to shorter wave lengths.

W. K. W. Wien considered the spectral distribution of black body radiation and concluded that

$\lambda_{max} \cdot T$ = constant = 2,898 • 10^{-3} m • k Wien's constant of displacement

Max Planck (1858–1947)
was able to show that energy could only be radiated in integral numbers of discrete units, or quanta, corresponding to the natural frequency of the oscillator, i.e. $E = h \cdot \nu$. Where "h" is Planck's constant with a value h = 6.625 • 10^{-3}4 W · s^2.

Milutin Milankovich (1879–1958)
was Professor of Applied Mathematics at the University of Belgrade/Serbia. His work on the effects of orbital variations on climate was collected in 1941 into *Kanon der Erdbestrahlung und seine Anwendung auf das Eiszeitenproblem*, published by the Royal Serbian Academy and translated into English in 1969 under the title *Canon of Insolation of the Ice Age Problem*.



http://www.egbeck.de/treibhaus/klima0.htm

Fig. 1: The phases of evolution

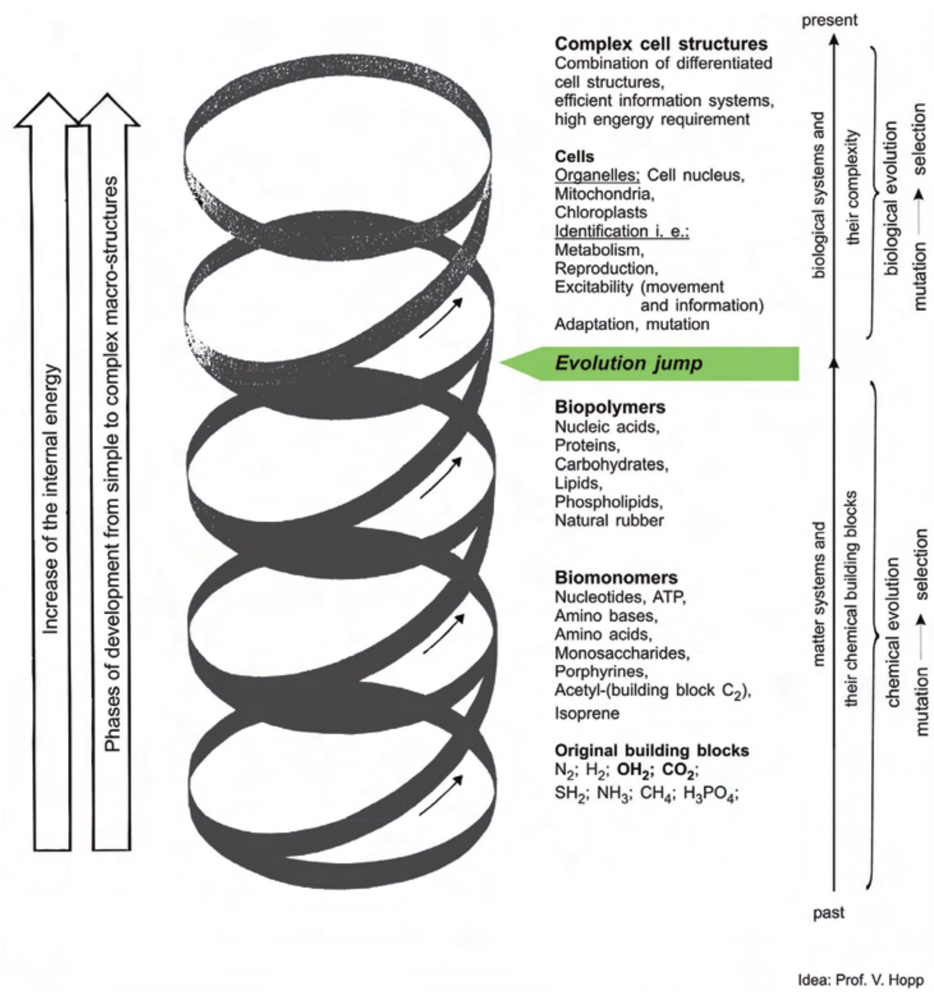


Fig.: 2: Evolutionary spiral -the cycle phases from simple to complex macro-structuresthe role of carbon dioxide and water

The chemical-biological evolutionary spiral reflects the construction molecules and active substances of Darwin's changed Tree of Life. In this new version plants find their places on the Tree of Life. Ref.: Andrew M. Sugden, Barbara R. Jasny, Elizabeth Culotta and Elizabeth Pennisi discussed this new version in Science Vol 300 pages 1691–1709.
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3. TYPES OF ENERGIES

Radiant energy (electromagnetic radiation)

Solar and cosmic energy. The primary cosmic rays consist essentially of nucleons and α-particles (helium nuclei) which by collision with the atomic nuclei of the Earth's atmosphere, give rise highly energised light quanta or very hard rays. This is observed as a cosmic shower and comprises the soft component of secondary cosmic radiation. Light that means electromagnetic waves is released energy by matter.

Stephen Hawking writes in his book
"A brief History of Time, Greenhouse Effect": "Another prediction of general relativity is that time should appear to run slower near a massive body like the earth. This is because there is a relation between the energy of light and its frequency: the greater the energy, the higher the frequency. As light travels upward in the earth's gravitational field, it loses energy, and so its frequency goes down."

Nuclear energy (Einstein-energy)
The Einstein equation of mass-energy equivalence is expressed $\Delta E = c^2 \bullet \Delta m$, where the difference of energy, ΔE is measured in joules, difference of mass Δm in kilograms and the velocity c in metres per sec. *Mass deficit:* If 1 gram of matter is completely converted into energy, then 90 gigajoule are set free. Investigations show that this nuclear reaction is responsible for the generation of energy in the Sun.

Magnetic energy
Attractive forces of special structures of iron and some other metals e.g. ferroalloys of manganese, chromium, nickel, tungsten, vanadium etc.

Elektrical energy
Power stations for conversion of kinetic or heat energy in electrical energy

Chemical energy
Storaged energy in material
e.g. fossil materials, food,
inorganic and organic materials in nature

Heat energy is a special kind of all energies*)
Vapour, geothermal heat storaged heat in gas, liquids, solid matter

Mechanical energy
Potential energy: e.g. Gravitation, mutual attraction between masses. Kinetic energy: e.g. hydroelectric power stations, tidal power stations, wind power stations.

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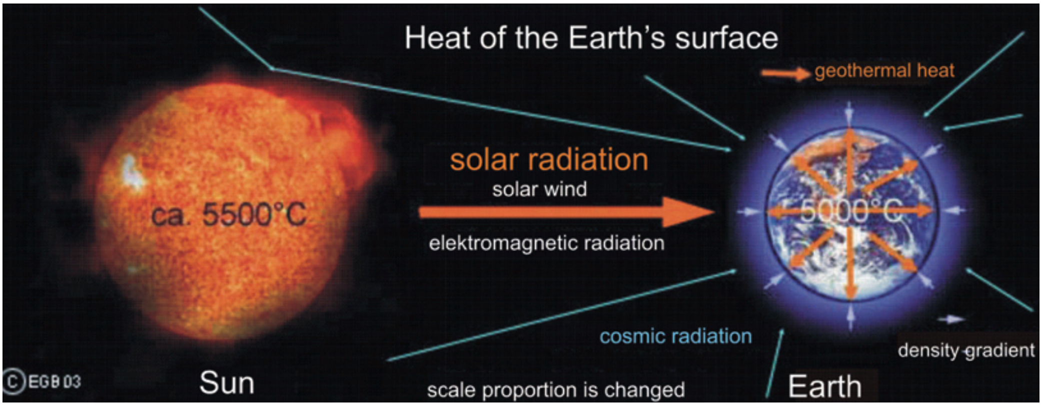
* While it is possible to convert all various kinds of energy into one another and into work, as well as the reverse processes with an efficiency of 100 %. Besides it is possible to convert these forms of energy and work into heat with 100 % efficiency. But in contrast to it is only possible to convert a fraction of the heat into other kinds of energy and work.



A quantum of light needs t = 8.32 minutes from the Sun to the Earth.
Effective temperature of the solar mantle T = 5717 K
Solar mass 1.933 • 1027 t, this corresponds to 3.33 • 105 fold mass of the Earth of 5.977 • 1021 t.

Equatorial circumference of the Earth 40075 km
Mean circumference of the Earth 40030 km
Earth's surface 510.1 • 106 km^2
Continent area 148.9 • 106 km^2 (= 29.2 %)
Area of the oceans 361.2 • 106 km^2 (70.8 %)
Mass of the Earth 5977 • 1024 kg
Mean density of the Earth 5.517 • 103 kg • m-3
Mean temperature of the Earth's surface 14.3 °C
Age of the Earth: 4.6 bn years.

Fig. 3: This figure demonstrates the different energy sources of the Earth. The most important sources are the solar radiation e.g. solar wind and electromagnetic radiation, and the cosmic radiation as protons.

The Earth's orbit is affected by the gravitational attractions of the Sun, the Moon, and the other planets. This complex interaction results in slow, cyclic changes in three important parameters of the orbit:

1. The *eccentricity* of the ellipse that the Earth describes in its orbit around the Sun each year.
2. The angle between the equatorial plane and the orbital plane (the Earth's *obliquity).*
3. The *precession* of the spin axis around the normal to the orbital plane (Fig. 10.1). The name that has come to be associated with these cycles is that of Milankovich, who showed that the periodic variations in climate deduced from glacial records can be matched to the calculated periods of these changes in the orbit of the Earth. These calculations are

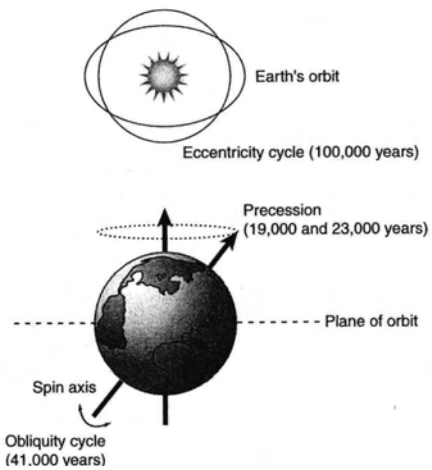


Fig. 4: The Milankovic cycles

Ref.: http://www.wasserplanet.biokurs.de

The three Milankovich cycles, in orbital ccentricity, and precession of the spin axis, and their dominant periods.

Ref: Taylor, F. W. (2007), Elementary Climate Physics, Oxford University Press, Oxford, ISBN-13: 978-019856734.:

4. WATER AND CARBON DIOXIDE – PHOTOSYNTHESIS AND CHEMOSYNTHESIS

A comparison of the reactivity of water molecules with the molecules of carbon dioxide
The photosynthesis demonstrates that water molecules are very reactive.

They are excited by the absorbed light quanta of the solar radiation and they are enzymatic splitted up into hydrogen and oxygen by the chlorophyll of plants and algae.

solar energy	+	water	chlorophyll ⟶	intermediate hydrogen	+	oxygen
2834 kJ	+	12 H–OH	⟶	24 {H}	+	6 O_2

In accordance with a postulate of Max Planck (1858 – 1947) each light quantum is a energy quantum with the effective von E = h • n (h = 6,626196 • 10^{-34} J • s Planck's elementary effective quantum; n = frequency of light (of the photon)).
Carbon dioxide reacts scarcely with the energised solar radiation. It is neither activated nor splitted up. Only intermediary free set hydrogen reacts with the oxygen of the carbon dioxide and reduces it to glucose.

chemical energy		carbon dioxide		intermediate hydrogen		glucose	water
2646 kJ	+	6 CO2	+	24 H	⟶	C6H6(OH)6	6 H OH

The molecules of carbon dioxide are less reactive in comparison with water and much other material in nature.

The photosynthesis

In our aerobic atmosphere is the driving biochemical process for all further reactions in the plants, that means e.g. for the synthesis of carbohydrates, proteins, fats, vitamins, enzymes, flavourings, odorants, drugs and others. It is estimated that 1012 kilojoules energy are stored by the photosynthesis on the Earth per year. These amounts of energy corresponds to 37 bn. Tonnes ($3.7 \bullet 10^{10}$ t) carbon dioxide as carbohydrates, fats, proteins and out of them derived compounds.

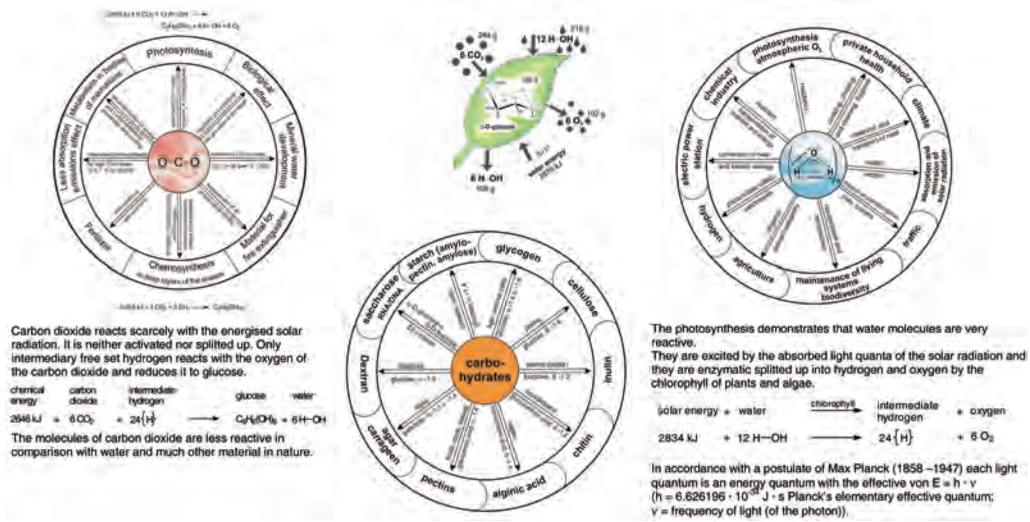


Fig. 5: The photosynthesis

The chemosynthesis

hydrogen acceptor	hydrogen donor		hydrogenation product		free enthalpy of reaction	
carbon dioxide $_{(g)}$	hydrogen $_{(g)}$	$\longrightarrow$	glucose $_{(s)}$	water $_{(l)}$		
$6\,CO_2$	$+\ 12\,H_2$	$\longrightarrow$	$C_6H_6(OH)_6$	$+\ 6\,H_2O$	$\Delta G = +\ 30.8$ kJ/mol	**(1)**
carbon dioxide $_{(g)}$	ammonia $_{(g)}$		glucose $_{(s)}$	water $_{(l)}$	nitrogen $_{(g)}$	
$6\,CO_2$	$+\ 8\,NH_3$	$\longrightarrow$	$C_6H_6(OH)_6$	$+\ 6\,H_2O$	$+4\,N_2$ $\Delta G = +\ 162.6$ kJ/mol	**(2)**
carbon dioxide $_{(g)}$	hydrogen sulphide $_{(g)}$		glucose $_{(s)}$	water $_{(l)}$	sulfur $_{(s)}$	
$6\,CO_2$	$+\ 12\,H_2S$	$\longrightarrow$	$C_6H_6(OH)_6$	$+\ 6\,H_2O$	$+12\,S$ $\Delta G = +\ 432.6$ kJ/mol	**(3)**

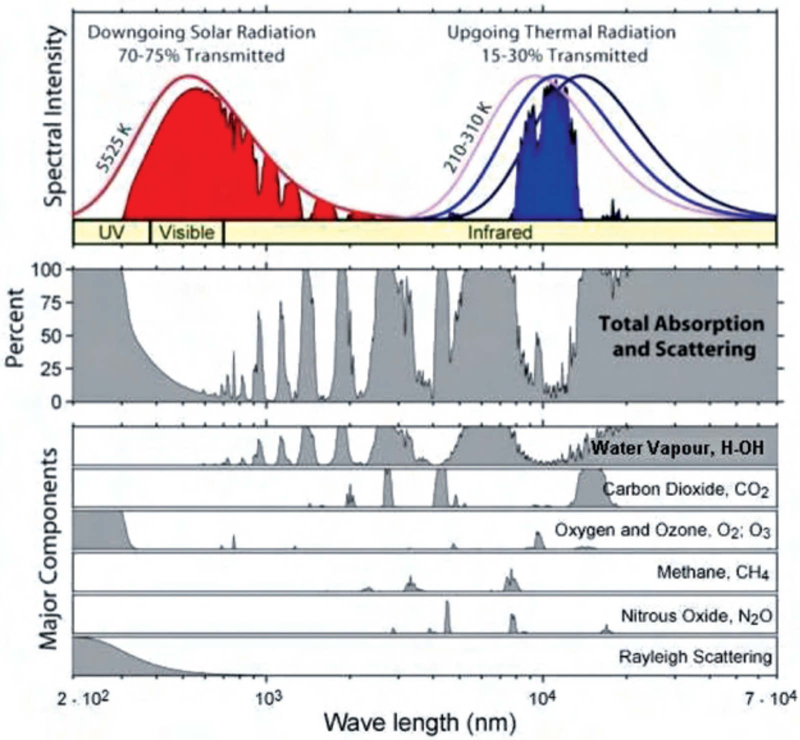
carbon dioxide $_{(g)}$	methane $_{(g)}$		glucose $_{(s)}$			
$3\ CO_2$	$+\ 3\ CH_4$	$\longrightarrow$	$C_6H_6(OH)_6$			**(4)**
					$\Delta G = +\ 420.6$ kJ/mol	
carbon dioxide $_{(g)}$	isopropyl – alcohol $_{(l)}$		glucose	acetone	water $_{(l)}$	
$\mathbf{6\ CO_2}$	$+\ 12\ H_3C\text{-}CH(OH)\text{-}CH_3$	$\longrightarrow$	$C_6H_0(OH)_6$	$+\ 6\ H_3C\text{-}C(=O)\text{-}CH_3$	$+6\ H_2O$	**(5)**
					$\Delta G = +\ 1268.4$ kJ/mol	
carbon dioxide $_{(g)}$	water $_{(l)}$		glucose $_{(s)}$	water $_{(l)}$	oxygen $_{(g)}$	
$\mathbf{6\ CO_2}$	$+\ 12\ H_2O$	$\longrightarrow$	$C_6H_6(OH)_6$	$+\ 6\ H_2O$	$+6\ O_2$	**(6)**
					$\Delta G = +\ 2876$ kJ/mol	

In the reactions of the equations 1 – 5 the energy requirement is less for the synthesis of glucose in comparison with the reaction of the photosynthesis (eq. 6). This means that the expenditure of energy is relatively low for the splitting off of the hydrogen, H_2, from the compounds methane, CH_4, ammonia, NH_3, and hydrogen sulphide, H_2S.

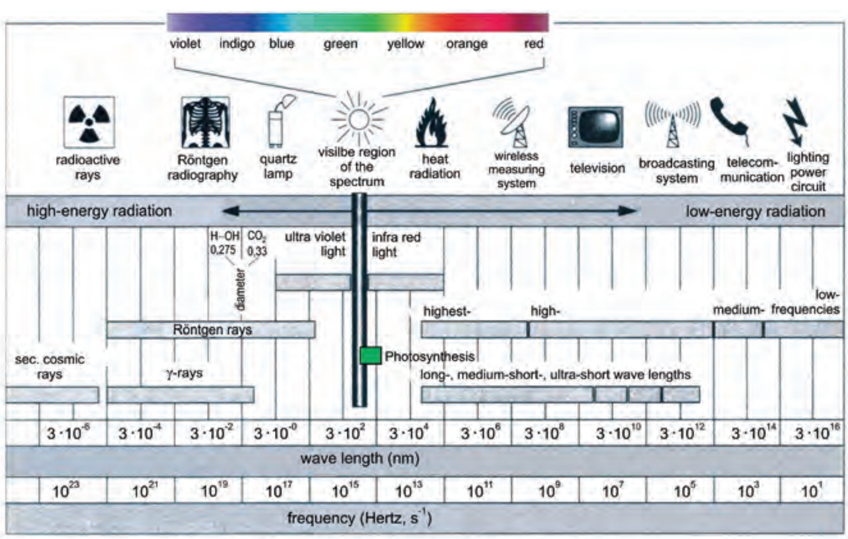
The necessary energy is contributed by hydrogen and hydrogen compounds e.g. H_2, CH_4, NH_3, $H2_S$ and others. These molecules have a high internal energy and therefore they are very reactive. The internal energy of these compounds is sufficient to hydrogenate the sluggish reactive carbon dioxide, CO_2. So it was possible for numerous anaerobe microorganisms to synthesize the essential glucose without solar energy and water.

Water makes an exception with its dipole molecules and three-dimensional structure. As 4.3 bn. years ago atmospheric vapour condensed to liquid water. The way was opened for the solar energy to split off the stable water molecules into hydrogen and oxygen. In a second step the high reactive hydrogen converts the carbon dioxide into glucose. At that point in time the oxygen atmosphere gradually developed.

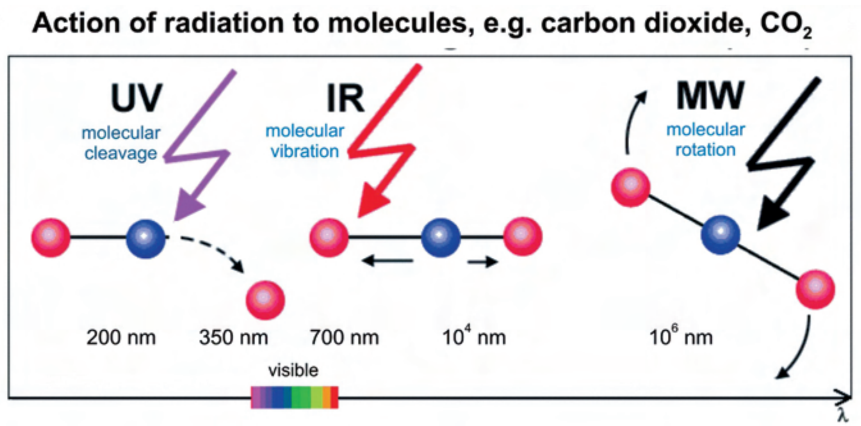
5. RADIATION TRANSMITTED BY THE ATMOSPHERE



Ref.: www.osram.com/.../poplightandradiation.jsp http://wikipedia.org./wiki/Solar_radiation



The spectrum of radiation energy in nano-dimensions
(diameter of water molecule 0.275 nm
of carbon dioxide molecule 0.33 nm kinetic; 0.4 nm static



Ref.: http://www.wasserplanet.biokurs.de/

Fig. 6: The interactions between gases and solar energy

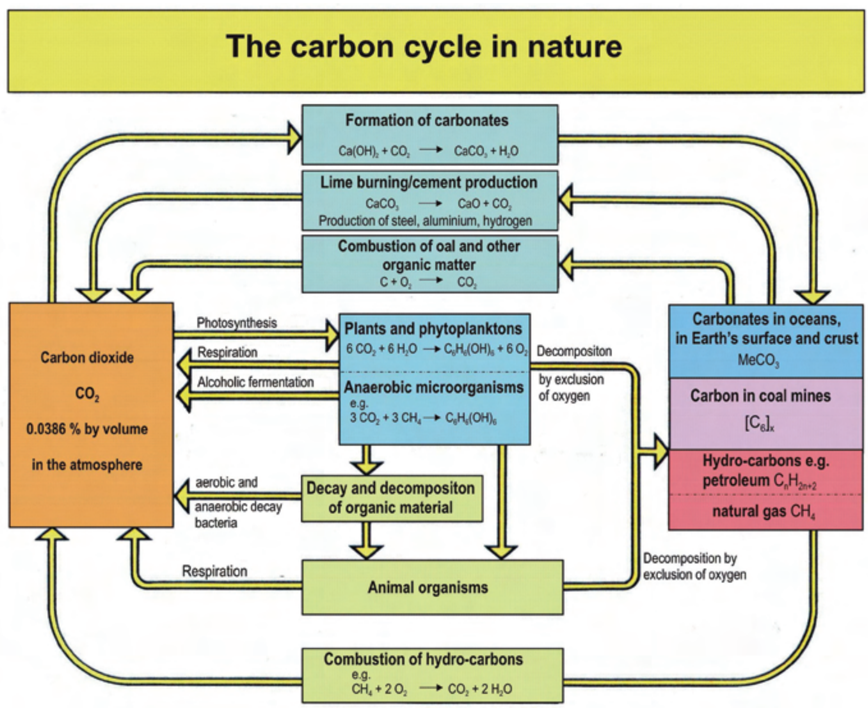


Fig. 7: The carbon cycle in nature

The carbon and carbon dioxide cycles in the nature

Carbon occurs naturally as inorganic and organic compounds.

- Naturally inorganic compounds are diamonds, hard and brown cool, carbonates and the gaseous carbon dioxide. Carbonates are limestone, calcite and marble.

In oceans, lakes and rivers carbonates are dissolved as hydrogencarbonate ions

carbonate ion — hydrogencarbonate ion

$$CO_3^{--} + H—OH \longrightarrow HCO_3 + OH^-$$

Carbon dioxide is dissolved in water. The solubility depends of the temperature. It establishes an equilibrium between carbon dioxide and hydrogen carbonate ions.

carbon dioxide — carbon dioxide ion

$$CO_2 + H—OH \rightleftharpoons HCO_3^- + H^+$$

In the atmosphere carbon dioxide occurs with 0.038 volume percentage.

- Carbon occurs as organic compounds as hydrocarbons (methane and petroleum) and in all animal and vegetable organisms.
  Large amounts of methane clathrates are stored in the depths of oceans. These are hydrates compounds which are held together by lattice forces under the influence of high water pressure.

The global carbon cycle may be subdivided in three partial cycles. They are combined one another:

1. Biosphere-atmosphere cycle
2. Lithosphere-continental plate cycle
3. Rock cycle

1. *The biosphere-atmosphere cycle* combines the regions of water (oceans, lakes, rivers), continents and atmosphere. The plant life, animal kingdom and micro organisms are formed as intermediate stage by the photosynthesis.
2. *The lithosphere-continental plat cycle* is the continental drift above the viscous Earth's crust. They are consisted of large amounts of magnesium calcium and ferrous carbonates, besides silicates e.g. aluminium silicates and other compounds. These components are melted during the subduction. Water vapour, carbon dioxide and other gases are set free by outgassing of crevices and volcanic eruption.
3. *The rock cycle* is activated by tectonic collisions of continental plates. Mountain ranges are formed. Calcareous material of limestone, clay (loam) and sand get into rivers, lakes and oceans by accompanying weathering and erosion. They sediment on the seabed and at the bottom of the lakes. The marine invertebrate organisms absorb these calcareous products and store them in their valves and skeletons e.g. crustaceans. The calcareous skeletons sediments to very dense layers of carbonates after the death of these marine organisms.

Climate is a phenomenon of complex, dynamic and energetic processes at the interfaces between continents, oceans and atmosphere

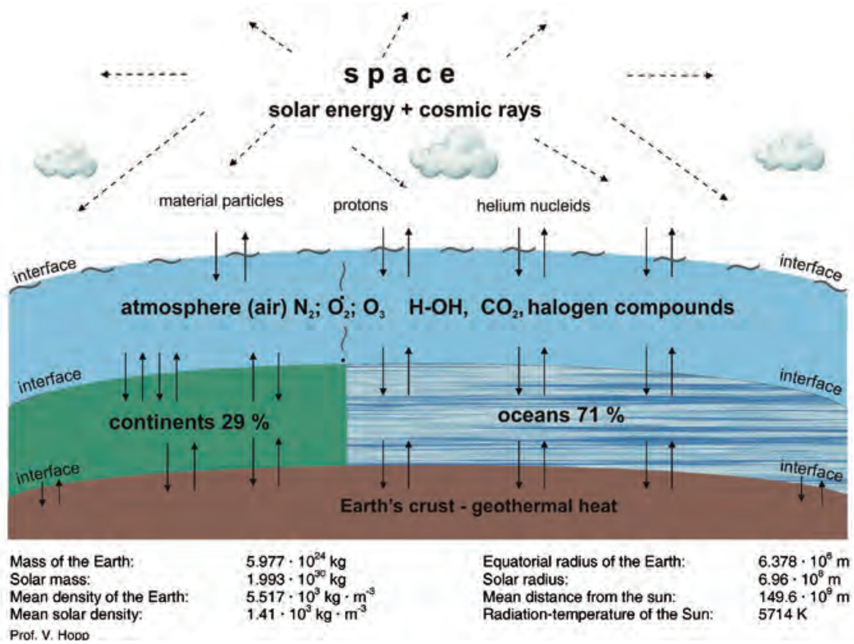
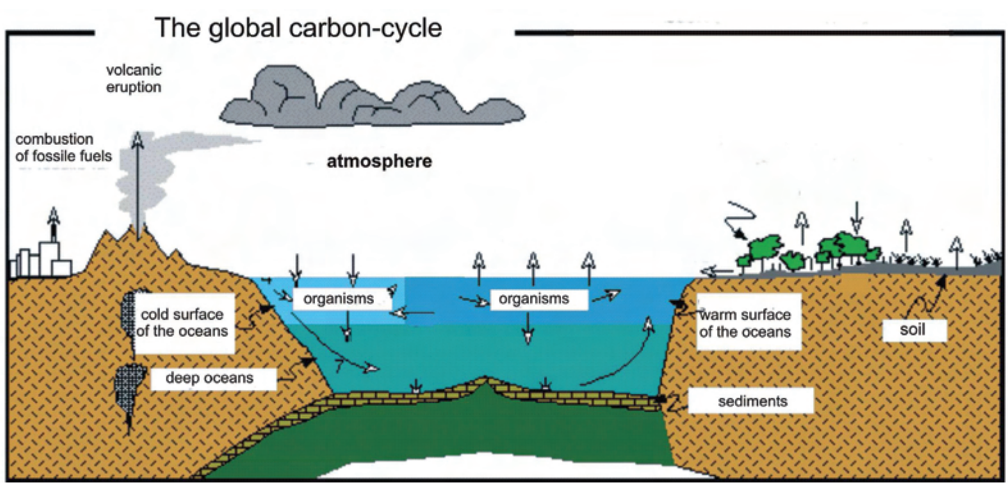


Fig. 8: The Earth's crust and atmosphere and their interfaces

The Earth is an open system,
which exchanges with itself and space energy and matter.



Ref.: htttp://wasserplanet.biokurs.de

Fig. 9: The global carbon cycle

The Earth is surrounded with an atmospheric layer of a thickness of about 500 km, which contains following gases:

gas	volume percentage	weight percentage	gas	volume percentage	weight percentage
Nitrogen, N_2	78.10	75.51	Helium, He	0.0005	0.00007
Oxygen, O_2	20.93	23.01	Krypton, Kr	0.0001	0.0003
Argon, Ar	0.9325	1.286	Hydrogen, H_2	0.00005	0.000004
Carbon dioxide, CO_2	0.0386	0.0594	Xenon, Xe	0.000009	0.00004
Neon, Ne	0.0018	0.0012			

In Addition the atmosphere contains water vapour up to 4 vol. % and, in the lower layers, solid dust particles.

The lowest atmospheric layer of 20 km contains 95 weight % of the gas masses in accordance with the density gradient of the atmosphere.

Carbon dioxide-, CO_2, parts in the Earth's atmosphere
Carbon dioxide in Earth's atmosphere is considered a trace gas currently occurring at an average concentration of about 386 parts per million by volume or 594 parts per million by mass. The mass of the Earth atmosphere is 5.14 • 1015 tonnes. So the total mass of atmospheric carbon dioxide is 3053 • 109 tonnes. This value corresponds to 833 • 109 tonnes carbon. The CO_2 concentration varies seasonally and also considerably on a regional basis. E.g. in urban areas it is generally higher and indoors it can reach 10 times the background atmospheric concentration.

Absorption effect activating gases in the atmosphere

Water vapour,	HOH	Ozone,	O_3
Methane,	CH_4	Carbon dioxide,	CO_2
Nitrogen oxides,	N_yO_x	Nitrogentrifluoride,	NF_3

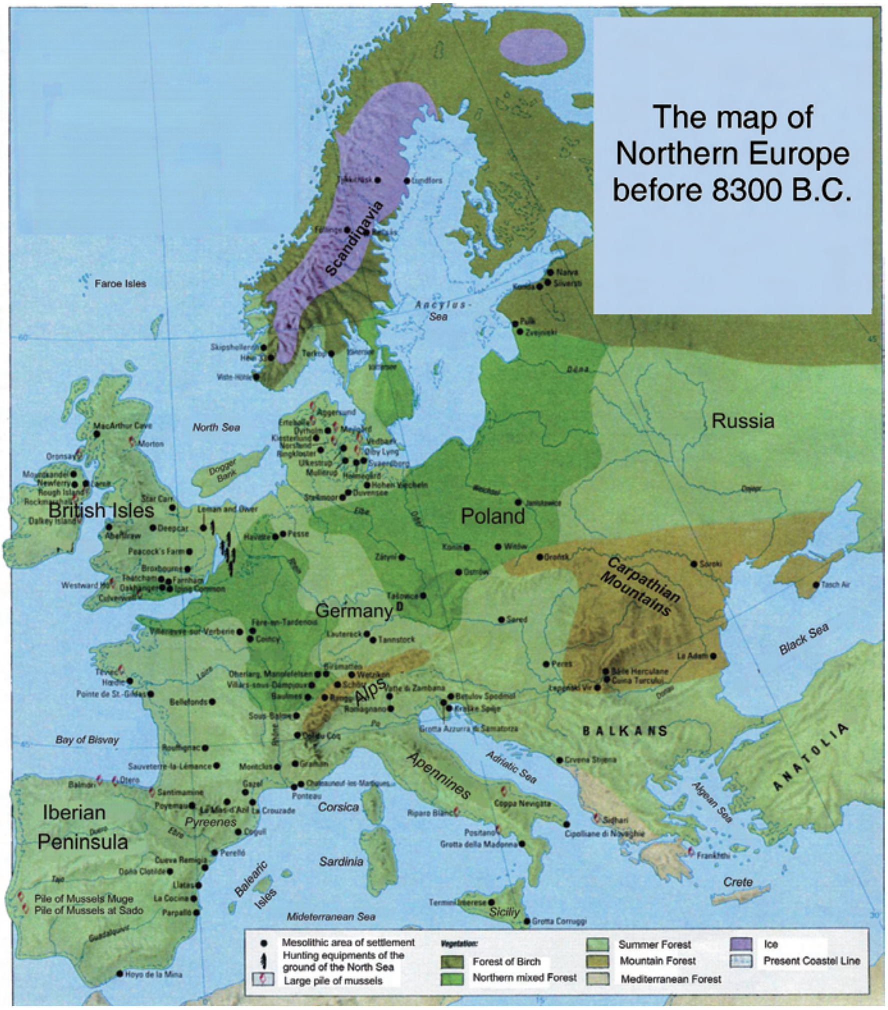


Fig. 10: The map of Northern Europe before 8300 B. C.

12000 B.C. (Before Christ).	End of the last ice age. During the Holocene there have been numerous sub-periods with dramatically varied climate For example.
8300 B.C.	Temperature increasing. Sheets of ices melted off in North Europe and North Germany, It began an extension of forests.
7000 B.C.	It began a period of warming. The East Coast of England was connected still with the European Continent and the Baltic Seas was still a fresh water Sea.
6500 B.C.	England and the European Continent are separated. The land bridge between England and the European Continent is flooded and the Island of England is separated.
800 B.C.	In the Centre of Europe, the low lands are populated at first time.
200 B.C. to 450 A.D.	The warm Roman Optimum. A time of abundant fruits and crops, that promoted the Roman Empire.

450 A.D.	Flooding of North Europe. Villages of North Europe are deserted by the inhabitants because of flooding.
400 A.D. to 900 A.D.	Cold Dark Ages. In this age the Nile River froze, major cities abandoned, The Roman Empire fell apart, and pestilence and famine were widespread.
900 A.D. to 1300 A.D.	The Medieval Warm Period. The agriculture began to flourish, wealth increased.
1300 A.D. to 1850 A.D.	Little Ice Age. This period is characterized by much of plagues, crops failures, witch burnings, food riots.
1850 to present	Time of relative warmth. The population has increased rapidly from 1.5 billion to 6.6 billion people.

Ref.: Past Worlds, The Times Atlas of Archaeology, Times Books Ltd. UK, Copyright.

6. WARMING AND COOLING PHASES

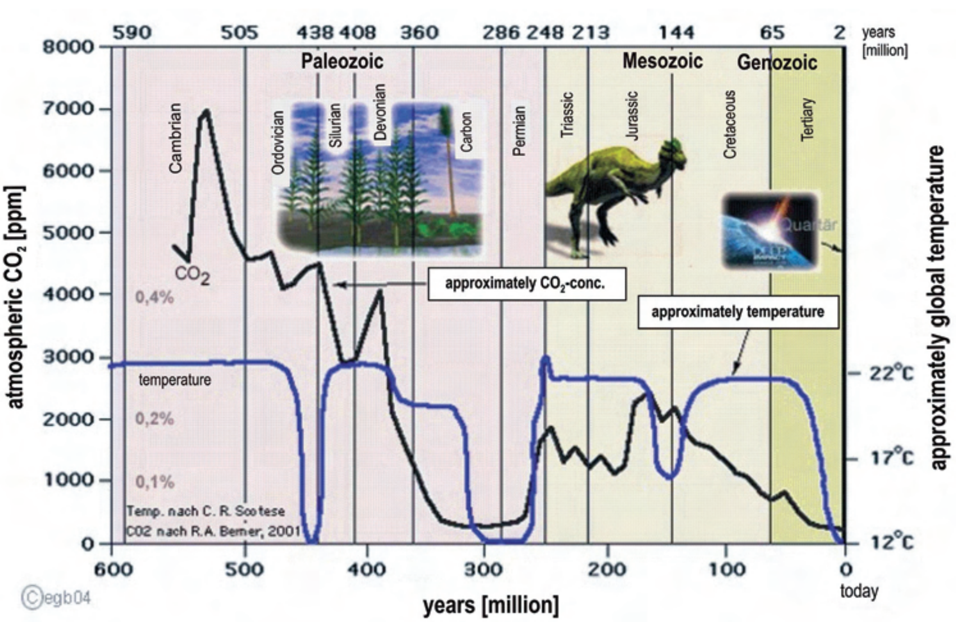


Fig. 11: Warming and cooling phases in past millions years

The figure demonstrates:

The global cycles in climate were caused by cyclic fluctuation of the cosmic rays (e.g. protons and helium nuclei).*)

- A cyclic occurrence of ice and warm age in change of 150 million years.
- During the most time of the geological history the average global temperature is about 22 °C.

* (http://www.pm.ruhr-uni-bochum.de/pm2003ms00202.htm)

- The concentration of carbon dioxide, CO_2, doesn't correlate with the development of the temperature.
- Today we are living in the end of an ice age**)

(http://www.pm.ruhr-uni-bochum.de/pm2003ms00202.htm)

Ref.: Scotese, Paleomap: http://www.scotese.com Berner, R. A. (2001), http://www.geology.yale.de/~ajs2001/Feb./qn020100182pdf.

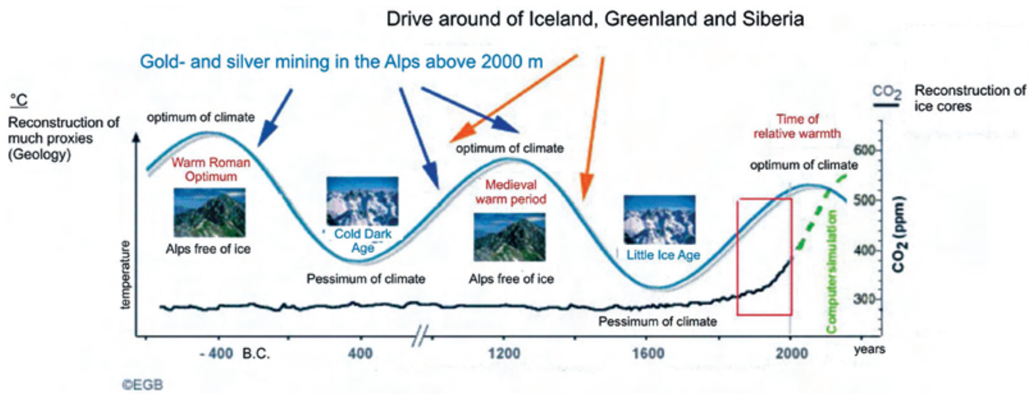


Fig. 12: Dansgaard-Oeschger Cyclus on the northern hemisphere

400 B.C. the glacier of the Alps were considerable smaller than present. The tree line was higher. In present Austria gold and silver were mined above 2000 m. During the hot summer in 2003 entrances of shafts were uncovered again.

7. METEOROLOGICAL LAWS

(Meteorology is the physics of the atmosphere)[2]

The Earth is an open system which exchanges with itself and space energy.

The most important energy sources of the Earth are solar radiation, cosmic radiation (e.g. particles of protons and helium nuclei) and geothermal heat.
The transmission of energy between the sun and cosmos as energy source and the Earth as energy receiver flows from high energy level to lower level (compare first principle of thermodynamics).

$$\text{continental } T_1 > \text{oceans } T_2 > \text{atmosphere } T_3$$

Climate (klima, gr. = regions in sky) **on the Earth is a dynamic complex process at the interfaces between the Earth's surface (oceans and continents) and atmosphere. Its energy converting processes are long-time processes.**

** IPCC, International Panel on Change in Climate
Ref.: http://www.wasserplanet.biokurs.de

[2] *Meteorology* (Greek: meteoron – atmospheric phenomenon; logos – word) *Physics* (Greek: physis-nature) is the science of the processes in nature, which to explore by ways of experiments, measuring and by depiction of mathematical models. atmosphere (Greek: atmos – mist layer; sphaira – sphere) is the aerosphere around the Earth and the gas layers around the heavenly bodies.

The climate is determined by interaction of several factors over the geological history:

- changes in solar activity
- changes in cosmic rays flux
- changes in the field of geomagnetism and in gravity
- changes in the angle of inclination of the Earth's axis between 24.5° and 22.5°in periods of about 41,000 years
- heavy volcanic eruptions
- water and water vapour as a material with a high emission-absorption effect
  The influencing factors in climate are not constant. They change themselves differently in their activities in long periods of time or in cyclic progression.

Weather is an energetic dynamic and complex change of state of the close to the Earth atmosphere within a short time in limited regions. It is accompanied by energy converting processes.

The driving processes for the origin of life and of the living systems are the chemosynthesis in the depths of the oceans and seas, and the photosynthesis on the continents and in the light transmitting layers of the seas.

solar radiation	+	water	λ = 400 –750 nm $\longrightarrow$	hydrogen	+	oxygen
286 kJ	+	H—OH	$\longrightarrow$	H_2	+	$\frac{1}{2} O_2$

Emission of carbon dioxide, CO_2, and methane, CH_4, by cows

A cow exhales 600 litres gas daily. This gas is composed of up to 70 % carbon dioxide, 20 % up to 30 % methane and a small amount of nitrogen, ammonia and others.

70 % CO_2 in 600 litres gas corresponds to 420 litres CO_2. The weight of that is

$$420 \text{ L} : x \bullet [\text{g}] = 22{,}4 \text{ L} : 44 \text{ g}$$

$$x[\text{g}] = 825 \text{ g}$$

A cow exhales daily 825 g carbon dioxide and 110 g up to 130 g methane. Milch cows exhale 200 g up to 400 g methane daily.

The number of cows in the world is estimated at 1.5 bn.

That means:

1.5 bn cows emits per year

$1.5 \bullet 10^9$ cows • 825 g carbon dioxide • 365 days = *452 • 10^6 tonnes CO_2*

This amount corresponds to *123 • 10^6 tonnes Carbon* [C_x].

20 % up to 30 % of 600 litres gas corresponds to 120 L and 180 L methane, that means 110 g up to 130 g.

$$180\ \text{L} : x \bullet [\text{g}] = 22.4\ \text{L} : 16\ \text{g}$$
$$x[\text{g}] = 128\ \text{g}$$

$1.5 \bullet 10^9$ cows • 130 g methane • 365 days = $71.2 \bullet 10^6$ tonnes CH_4.

This amount corresponds to $53.4 \bullet 10^6$ tonnes Carbon [C_x].

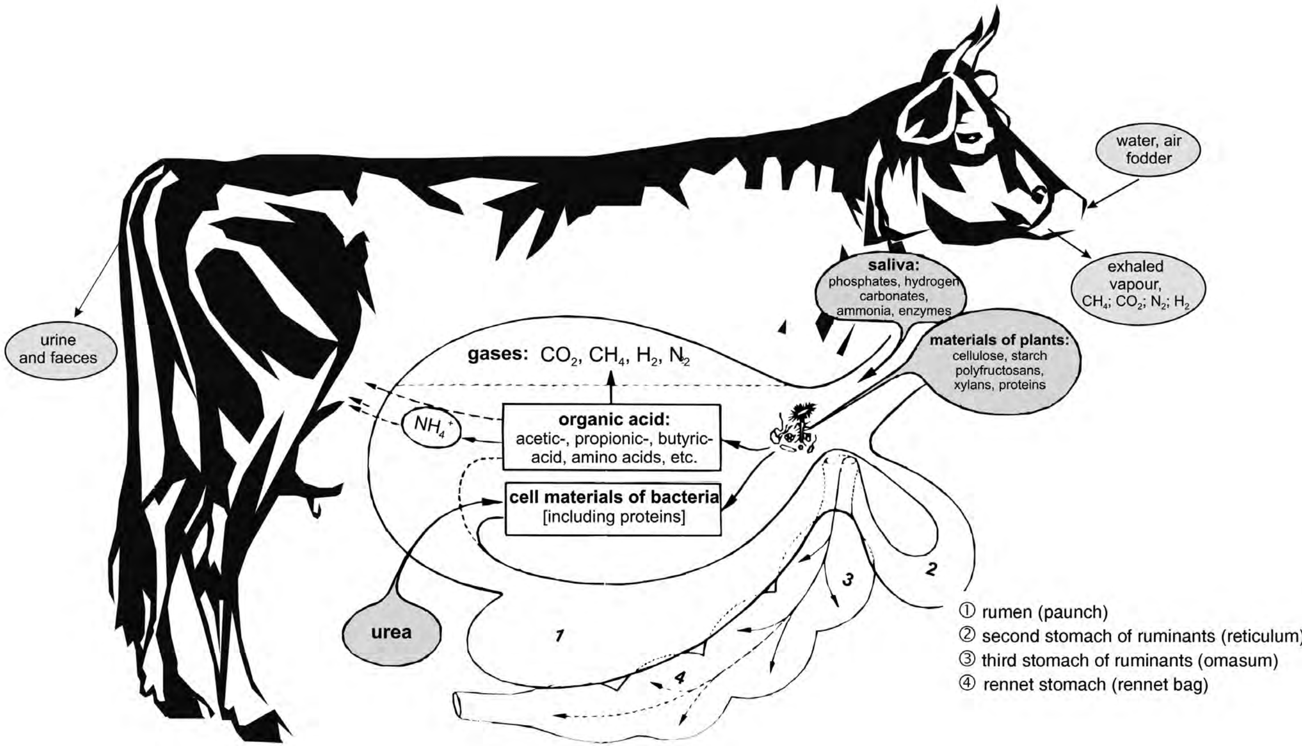


Fig. 13: Digestion in rumen – an example for living fermenter and CO_2-emission

At present there are 1.3 billion cows worldwide. Each cow uses up to 100 litres water daily. They drink per year about

1.5 bn cows x 0,1 m^3/day x 365 days = 55 bn m^3 water per year. The water which a cow consumes is returned to the environment as urine (15 litres to 20 litres), partly as faeces (about to 19 litres) and partly as exhaled vapour. Milch cows give off 30 litres water and more as milk. The exhaled vapour is mixed with a lot of gas, 600 litres daily. The gas is composed of up to 70 % carbon dioxide, 20 % to 30 % methane and a small amount of nitrogen, hydrogen, ammonia and others. That means a cow exhales daily 825 g carbon dioxide and 110 g up to 130 g methane. Milch cows no less than 200 g up to 400 g methane. It is a well known fact that methane causes a high absorption/emission effect, and that is thirty times more intensive than carbon dioxide, CO_2. A cow needs 10 kg cereals for the production of 1 kg meat. The efficiency is very low. If we want to save fresh water we will have to change our habit of nutrition. The Asian people consume only 4 kg meat per person yearly, the people of the rich industrialized countries 40 kg yearly.

8. SUMMARY

- Carbon dioxide, CO_2, and water, $\tilde{H}OH$, are the most important essential origin molecules for the developing of life in the depths of the oceans and on the Earth's surface.
- Since about 600 million years the average temperature on the Earth's surface was constant for the most part. They were interrupted by four glacial epochs.
- At present we are probably living in an interim between two glacial periods.
- The absorption and emission of radiation energy by water molecules is much stronger than by carbon dioxide molecules.
- Weather is a state of permanent transformation and exchange of energy and material between the interfaces of the atmosphere, oceans and continents.
- Climate is statistical description of state of numerous weather for a long period of time and large regions.
- A dependence is not discernible between a climatic rise in temperature and an increasing of the carbon dioxide concentration in the atmosphere.
- The temperatures of the Earth's surface are changing continually during the geological history. Global warming and cooling are natural processes.

http://www.wasserplanet.biokurs.de/

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Member of the workshop environmental protection of the department environmental technology of the VDI-Bezirksverein Frankfurt-Darmstadt, Germany

Prof. Dr.-Ing. Vollrath Hopp, chemist, Chairman of VDI Fachgruppe Umwelttechnik

Dipl.-Ing. Matthias Hugo, engineer, Vice-Chairman, Darmstadt

Dr. Hanswilhelm Bach, chemist, Pfungstadt

Prof. Dr. Hans Brunnhöfer, biologist, Hattersheim

Dipl.-Ing. SFI Walter Dannenmann, engineer, Weiterstadt

Dr. med. Michael Friedrich, physician and pharmacist, Hagenow/Mecklenburg

University lecturer Dr. med., Dipl.-Ing. René Gottschalk, Public Health Officer, Frankfurt

Dipl.-Ing. Wolf Kähler, engineer, VDI Bezirksverein

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Dr. Werner Ude, chemist, Darmstadt

Dr.-Ing. Edmund Wagner, engineer, Wiesbaden

Andreas Weber, physicist, Darmstadt

WFEO Policy on the Mobility of Engineering Professionals – a progress report

Dr Peter Greenwood, Hon FIEAust, CPEng, EngExec.
(Leader, CET Working Group on Mobility of Engineering Professionals)

Dr Peter Greenwood was Engineers Australia's National President in 2002 and 2003.

Peter Greenwood is an electrical power engineer by training. He has qualifications in engineering and management. He has worked in several countries in the electrical supply industry, research laboratories, and universities.

His main EA interests are involvement with Young Engineers, links with employers, education and training and international relations.

After many years with the Hydro-Electric Commission, Tasmania since 1991 he has been an engineering and management consultant, advising companies on power supply contracts and national grid developments, and working on major project evaluations. He is a member of the Tasmanian Electricity Regulator's Reliability Panel. Educational background: M.Sc. (Technological Economics) – Management science, economics course, 1978. Ph.D. (Elec. Eng.), 1983 M.Sc. (Elec. Eng.), 1967 Diploma in Electrical Engineering (IEE), 1963 Diploma in Electrical Engineering (1st class), 1963 Company Directors Diploma, 1991.

Affiliations: Fellow of the Institution of Engineers, Australia, Fellow of the Institution of Electrical Engineers (UK), Senior Member of the Institution of Electrical and Electronic Engineers (USA).

SUMMARY

WFEO is becoming a central information exchange between international organisations and its members, using its standing technical committees including Capacity Building, Anti-Corruption and Education and Training to achieve this goal.

In 2008 a position paper was prepared for WFEO by a CET working group on the mobility of professional engineers and published in Ideas 15. The paper was well received and has generated interest and support for further information. The paper was a good foundation for further work, but the content is already starting to date. An up-date will be prepared in a year or so, to include the outcomes of the present work and information about activities of other organisations since 2008.

The paper was used as the basis for a draft WFEO policy on the Mobility of Engineering Professionals. After wide consultation of WFEO members and external contributors the

policy was approved by the WFEO General assembly in November 2009. The Policy is shown below.

Web pages that were envisaged at the beginning of the project to publicise general information have progressed well with familiar organisations agreeing to share content. New organisations have also emerged wanting to participate.

It has also become clear that website pages will not provide sufficient space for the content and detail that interested stakeholders are asking for. Detailed information on what is being done around the world on accreditation and mobility is being expanded for an electronic handbook, which will complement the Capacity Building guidebook and other similar work among members.

WFEO is also communicating as widely as possible to invite cooperation and establish particular needs.

1. INTRODUCTION AND BACKGROUND

Leading up to the consideration of a mobility policy a position paper was prepared by a CET Working Group and circulated widely with a draft policy. The paper and the draft policy were endorsed by the CET and submitted to the Executive Council in 2008. The Executive Council received the position paper and accepted the policy in principle. The CET Working Group was asked to prepare a final draft to go to the General Assembly in 2009, seeking comment from a broad cross-section of international contributors.

The draft policy was circulated to all WFEO members and many outside organisations for information and comment. Many responses were received and the comments were incorporated into the policy.

The President–Elect wrote to a number of organisations asking them to cooperate with WFEO in implementing the policy. A number of organisations agreed to cooperate and more are expected. Cooperation has begun with contributions of material for web pages to be mounted on WFEO's web site. A separate report was widely circulated with a draft of the web pages seeking contributions.

The approved WFEO policy on Accreditation and Mobility of Engineering Professionals forms part of this paper.

2. WFEO POLICY ON ACCREDITATION OF COURSES AND MOBILITY OF ENGINEERING PROFESSIONALS – POLICY DOCUMENT

Introduction

WFEO believes in an engineering profession of well-qualified, up-to-date engineers, working ethically and responding to the needs of their clients who may have little or no engineering knowledge.

Over a long period of time major national institutions and learned societies have established and operated systems for accrediting engineering courses and for assessing the suitability of engineers for independent professional practice. Since the 1980s many of these organisations have come together formally to extend their systems internationally.

The most widely known examples of this cooperation include the Washington Accord, FEANI, the Engineers Mobility Forum and the APEC Engineer Monitoring Committee. A number of other groups have emerged to join what is now a global international framework working on standards for engineering degrees and professional engineering practice.

WFEO in its pre-eminent position in the engineering profession has a key role to play in the formation and assessment of engineers around the world. Representing its members to major international agencies, it is ideally placed to facilitate exchanges between:

1. the organisations that set the standards for engineering education and the assessment of professional competence
2. the employers of engineers and users of engineering products and services and
3. other organisations affected by the quality and number of professional engineers.

Acting as a central information source and facilitator between international organisations, such as the United Nations, World Trade Organisation, the World Bank and Transparency International, WFEO would be a major contributor to accreditation and mobility and take a significant step towards achieving its goals.

Definition

Mobility is the movement of professional engineers around the world who have the quality marks of a recognised engineering degree and the post nominals confirming an assessed competence for independent practice. Professional Engineer (PEng) and (Chartered Professional Engineer (CPEng) are examples of post nominals. The degrees and post nominals are recognised through international comparison with the benchmarks of the accords and mobility forums. International benchmarking helps engineers change employment, change country of residence and access restricted work in new jurisdictions. Benchmarking also lowers an employer's risk in hiring engineers.

The engineers are usually working in a different jurisdiction to the one in which they qualified and acquired professional standing. Not all of this work is regulated but the standards we are talking about are just as important in non-regulated engineering work.

Mutual recognition of engineering mobility standards by regulatory authorities in different jurisdictions can:

1. lead to the regulation and registration of engineers outside their home jurisdiction
2. enable engineers to practice in restricted areas of engineering outside their own countries

3. enable governments and users of engineering products and services to have confidence in engineers coming into their country
4. facilitate the migration of engineers.

Engineers operating international accreditation and mobility systems think that, numerically, migration mobility may have overtaken traditional regulated mobility. Mobile engineers may do regulated or non-regulated engineering work.

Need for this Policy

WFEO has an interest in all aspects of engineering mobility but migration mobility is particularly important to WFEO members and its stakeholder agencies.

WFEO has to have a role in fostering and helping this important global activity. WFEO must set out its role so other organisations understand what we intend to do and what we will not involve ourselves in.

Member organisations need WFEO help to achieve appropriate standards for their countries' needs

WFEO can facilitate the recognition of graduate attributes and competencies for professional engineers by the United Nations, Governments and other international agencies involved in the provision of engineering goods and services

WFEO should be a source of information for all stakeholders in the competent ethical practice of engineering.

Policy

WFEO believes in generic attributes for graduate and competent engineers practicing ethically and maintaining their up-to-date engineering knowledge. WFEO recognises the role of the world's accreditation and mobility organisations and pledges to support their activities to maintain international and regional qualifications and professional standards and registers for engineering and computer engineering professionals.

WFEO will encourage the recognition of graduate attributes and professional competencies for engineers by the United Nations, governments and other international agencies involved in the provision of engineering goods and services

WFEO will provide a source of information for all stakeholders in the competent ethical practice of engineering and facilitate exchanges between people and organisations involved in engineering activity.

Related stances

This policy is complementary and essential to WFEO work on:

1. Millenium Development Goals;
   WFEO facilitates communication and cooperation among engineering organizations and with other organizations particularly those of the UN system and international non governmental institutions dealing with science, engineering, technology and business
2. Effective and efficient capacity building;
   Building human, institutional, and infrastructure capacity to help societies develop secure, stable, and sustainable economies, governments, and other institutions through mentoring, training, education, physical projects, the infusion of financial and other resources, and, most importantly, the motivation and inspiration of people to improve their lives (Courtesy of ASCE)
3. Anti-corruption;

WFEO relates to the global movement against corruption in engineering activities and supports the Engineers Anti-Corruption Charter. WFEO has proposed zero tolerance towards bribery, fraud and corruption in engineering and construction in a clause for inclusion in a revision of its Code of Ethics.

(End of policy document)

3. WEB PAGES

Part of this project is to use the WFEO web site to share the information gathered. The content will include example material on what mobility means and the processes involved for governments, companies and individuals. Mobility pages should appear on the WFEO website soon and will be treated as a work in progress to allow entries to change and new contributions to be added. Mobility will be a "thematic issue" in a new format.

The concepts of a model engineer and a whole-of-career approach have been continued from the position paper. The sections include:

The Engineer Model

Although there may be differences in detail, there is a consensus that the engineers the world needs should be:

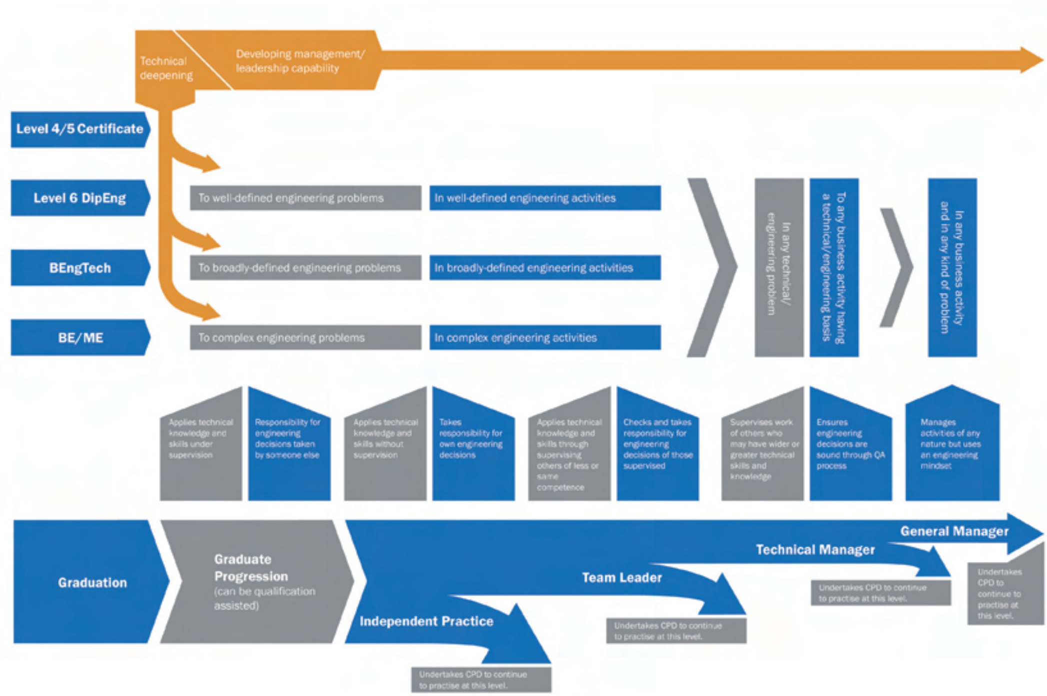
qualified	trained
assessed	up-to-date
ethical	not corrupt
good communicators	

and be all of these things throughout their careers, whether as technical engineers or engineering managers. Our vision must therefore encompass the whole of an engineer's career.

Career Model

Some learned societies have descriptions or diagrams describing the stages of an engineer's career. The most recent thinking I am aware of is that of the Institution of Engineers New Zealand (IPENZ).

The IPENZ diagram is shown below is described but more detail can be obtained directly from the IPENZ website.



(Diagram courtesy of IPENZ; see its web site for further details)

Accreditation of Engineering Degree Programs

Engineering course curricula are increasingly based on outputs and consider the attributes of an engineering graduate. An example is included from the Washington Accord criteria on its website, part of which is included here.

Washington-Accord Graduate Attributes Executive Summary

"Several accrediting bodies for engineering qualifications have developed outcomes-based criteria for evaluating programs. Similarly, a number of engineering regulatory bodies have developed or are in the process of developing competency-based standards for registration. Educational and professional accords for mutual recognition of qualifications and registration have developed statements of graduate attributes and professional competency profiles. This document presents the background to these developments, their purpose and the methodology and limitations of the statements. After defining general range statements that allow the competencies of the different categories to be distinguished, the paper presents the graduate attributes and professional competency profiles for three professional tracks: engineer, engineering technologist and engineering technician." Courtesy IEA

		… for Washington Accord Graduate
1.	Engineering Knowledge	Apply knowledge of mathematics, science, engineering fundamentals and an engineering specialization to the solution of complex engineering problems
2.	Problem Analysis	Identify, formulate, research literature and analyse complex engineering problems reaching substantiated conclusions using first principles of mathematics, natural sciences and engineering sciences.
3.	Design/ development of solutions	Design solutions for complex engineering problems and design systems, components or processes that meet specified needs with appropriate consideration for public health and safety, cultural, societal, and environmental considerations.
4.	Investigation	Conduct investigations of complex problems using research-based knowledge and research methods including design of experiments, analysis and interpretation of data, and synthesis of information to provide valid conclusions.
5.	Modern Tool Usage	Create, select and apply appropriate techniques, resources, and modern engineering and IT tools, including prediction and modelling, to complex engineering activities, with an understanding of the limitations.
6.	The Engineer and Society	Apply reasoning informed by contextual knowledge to assess societal, health, safety, legal and cultural issues and the consequent responsibilities relevant to professional engineering practice.
7.	Environment and Sustainability	Understand the impact of professional engineering solutions in societal and environmental contexts and demonstrate knowledge of and need for sustainable development.
8.	Ethics	Apply ethical principles and commit to professional ethics and responsibilities and norms of engineering practice.
9.	Individual and Team work	Function effectively as an individual, and as a member or leader in diverse teams and in multi-disciplinary settings.

		… for Washington Accord Graduate
10.	Communication	Communicate effectively on complex engineering activities with the engineering community and with society at large, such as being able to comprehend and write effective reports and design documentation, make effective presentations, and give and receive clear instructions.
11.		Demonstrate knowledge and understanding of engineering and management principles and apply these to one's own work, as a member and leader in a team, to manage projects and in multidisciplinary environments.
12.		Recognize the need for, and have the preparation and ability to engage in independent and life-long learning in the broadest context of technological change.

Courtesy IEA

Mobility – Assessment, Recognition, Certification, Registration of Engineering Professionals

Engineering practitioners are increasingly assessed in terms of professional competencies. The table is an example, which is taken from latest version of the EMF's professional competencies.

EMF-APEC Engineer Professional Competencies, Courtesy IEA

		Professional Engineer
1.	Comprehend and apply universal knowledge	Comprehend and apply advanced knowledge of the widely-applied principles underpinning good practice
2.	Comprehend and apply local knowledge	Comprehend and apply advanced knowledge of the widely-applied principles underpinning good practice specific to the jurisdiction in which he/she practices.
3.	Problem analysis	Define, investigate and analyse complex problems
4.	Design and development of solutions	Design or develop solutions to complex problems
5.	Evaluation	Evaluate the outcomes and impacts of complex activities
6.	Protection of society	Recognise the reasonably foreseeable social, cultural and environmental effects of complex activities generally, and have regard to the need for sustainability; recognise that the protection of society is the highest priority

		Professional Engineer
7.	Legal and regulatory	Meet all legal and regulatory requirements and protect public health and safety in the course of his or her activities
8.	Ethics	Conduct his or her activities ethically
9.	Manage engineering activities	Manage part or all of one or more complex activities
10.	Communication	Communicate clearly with others in the course of his or her activities
11.	Lifelong learning	Undertake CPD activities sufficient to maintain and extend his or her competence
12.	Judgement	Recognize complexity and assess alternatives in light of competing requirements and incomplete knowledge. Exercise sound judgement in the course of his or her complex activities
13.	Responsibility for decisions	Be responsible for making decisions on part or all of complex activities

Typically, national accreditation agencies have accreditation manuals, which are used to accredit university engineering courses and to achieve quality control across a number of universities.

Washington Accord signatories agree to adopt accreditation procedures that are "substantially equivalent" to their fellow signatories. The signatories also agree to periodic assessment of their accreditation processes by visiting teams of their peers.

Similarly assessment of professional engineers by an EMF member is done using a manual base on agreed procedures, which is also subject to periodic peer review.

Accreditation and assessment manuals include tables of attributes and competencies. By following such procedures graduate engineers on the International Register of Professional Engineers (of the IEA) should as far as possible be similarly competent.

Although the website will contain samples of what different organizations are doing, more information is available and sought by interested stakeholders. Preparation of the web material has also revealed many organizations that are recent participants or about to become involved in accreditation and mobility. One example is the entry of the International Standards Organization into the arena with standards for software and systems engineering.

The amount of information and the number of participants has encourage the working group to begin work on an electronic handbook with more space for the material that respondents are asking for.

4. HANDBOOKS AND MANUALS

Although this work has only just started there are some building blocks that can be drawn on from within WFEO.

WFEO's Capacity Building Committee is producing a guidebook on capacity building with UNESCO. It includes content on institution building (in a long contents list) that will be part of the facilitating the mobility of professional engineers. Detailed information on what is being done around the world on accreditation and mobility is being expanded for the electronic handbook, which will complement the guidebook. The approach will follow WFEO's aim of showcasing what specialist accreditation and mobility organisations are doing. It will also add to the examples in the web pages and give more space for regional initiatives, which are particularly important for many WFEO members.

FEIAP, a WFEO Regional Member, has started a project to help its members move step-by-step towards Washington Accord or equivalent recognition. A working group will prepare material including templates, manuals and mentoring to help its members establish accreditations structures for engineering degree providers and their courses. It may be that, as the FEIAP project progresses the outcomes could be made available to other regions

The CET contribution will aim to compile material that compliments the other approaches and responds to member requests for information.

5. COMMUNICATIONS

The annual meetings held by WFEO and the accompanying conferences have given opportunities to present the work of the CET Working Group and initiate discussion among members.

Many enthusiastic and helpful people have responded to our enquiries and in doing so have become part of the project. Their organisations are listed below. I apologise if I have inadvertently missed anyone.

WFEO President Maria Prieto Laffargue will be discussing these activities with international agencies like UNESCO to invite cooperation and establish their particular needs.

One topic, which keeps emerging, is the question of national and international data on numbers of engineers. The working group will cooperate with other units of WFEO on how to work with our members to gather this statistical information.

6. CONCLUSIONS

The Mobility of Engineering Professionals policy will be valid until a reviewed in four year's time.

The position paper provided useful information but one year on, it is already being overtaken by events. A new position paper will be prepared during the next four years.

The President is making contact with key international agencies seeking cooperation and suggestions for further work.

A new, four-year program will build on what has been achieved up to the end of 2009. It will include an electronic handbook, foreshadowed in the first plan, with more detailed information than in the web pages and content that emerges from consultation with key stakeholders.

Further attempts will be made to gather useful statistics from our members.
Web Pages

There has been widespread approval of this project and a widely expressed need for further information.

This project has involved contacting many people to establish a network and working relationships. It has taken time but I am sure the outcome will continue to be very useful and exemplify the sort of contribution WFEO is making in the global engineering environment.

7. SOURCES AND LINKS

WFEO/UNESCO Engineering Report – section on mobility – to be published

World Federation of Engineering Organisations (WFEO)
www.wfeo.org

Federation of Engineering Institutions of Asia and the Pacific (FEIAP)
see www.hkie.org.hk

European Society for Engineering Education (SEFI)
www.sefi.be,aaa
Washington Accord (WA), see IEA

Institution of Engineers New Zealand (IPENZ)
http

Organisation for Asia Pacific Economic Cooperation (APEC) Engineer forum, see IEA

Accreditation of European Engineering Programs (EUR-ACE), see FEANI site

Pan American Federation of Engineering Associations (UPADI)
http://www.upadisede.org/noticias2.htm

International Federation of Consulting Engineers (FIDIC)
http://www1.fidic.org/federation/

International Engineering Alliance including Washington Accord, Engineers Mobility Forum and Asia Pacific Economic Cooperation (APEC Engineer)
http://www.ieagreements.com/

Pan American Federation of Engineering Associations (UPADI)
http://www.upadi.org.br/COSTARICA.html

Greater Caribbean Regional Engineering Accreditation Systems (GCREAS)
http://www.caribbeaengine.org

European Network for Accreditation of Engineering Education (ENAEE).
http://www.enaee.eu/enaee/presentation.htm

Engineering Council UK
http://www.engc.org.uk/

European Federation of National Engineering Associations (FEANI)
http://www.feani.org/webfeani/

Transparency International
http://www.transparency.org/about_us

The Global Infrastructure Anti Corruption Centre (GIACC)
http://www.giaccentre.org/onlinetraining.intro.php

International Standards Organisation (ISO)
http://standards.iso.org/ittf/PubliclyAvailableStandards/c033897_ISO_IEC_TR_19759_2005(E)9.zip

Conceive Design Implement and Operate (CDIO)

National Council of Examiners for Engineering and Surveying (NCEES)

8. ACKNOWLEDGEMENTS

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Internationalization of Engineering Education and the Idea of World University of Technology

Prof. Włodzimierz Miszalski
President of WFEO-CET

Prof. Włodzimierz Miszalski Ph.D., D.Sc., Professor of the Military University of Technology (Warsaw, Poland) and Director of Institute of rganization and Management. Before receiving M. Sc. degree in Computer Science and Operations Research in 1972 worked as radar devices' engineer. In 1984 was awarded D. Sc. degree in Technological Science (Electronics) and in 1991 Ph.D. degree in Management. In 1993 graduated from National Defense University (Washington, D.C., USA). Prof. Miszalski has 25 years experience in postgraduate education of engineers – particularly in Logistics and Management. Representative of Poland in Studies, Analyses and Simulation Panel, NATO Research and Technology Organization. President of The Committee on Professional Development of Polish Federation of Engineering Associations. Chairman of the Steering Committee of the 5th World Congress on Engineering Education held in 2000 in Warsaw. Since 2005 President of the WFEO-CET Committee. Prof. Miszalski is author and co-author of more than 200 publications (books, academic manuals, scientific papers) on maintenance organization, decision systems engineering, disaster monitoring and relief systems command, postgraduate engineering education programs and curricula.

Abstract

The reasons for internationalization of engineering education have been presented as well as the appearing counterarguments to the internationalization. Development of the idea of World University of Technology (WUT) as one of the possible solutions for international engineering education has been discussed referring to the presented in IDEAS Nr 15 proposal of the organizational structure of WUT. The mission, role and structure of Institute of Organization and Management as one of the units of WUT have been proposed and discussed. The comments on Institute of Basic Technological Sciences have been also presented as well as conclusions concerning further works on the idea of WUT.

Key words: *engineering education, global, internationalization, structure, technology, university, world.*

INTRODUCTION

Global challenges for engineering, science and technology inspire the discussion on the new paradigm of engineering education [2]. Although many papers have been published so far on the requirements of the new areas and new methods of engineering education – internationalization seems to be the topic which appears more frequently and provokes disputes on its essence, its goals and on possible solutions of its problems.

The idea of international university is at least as old as the idea of the university itself (the medieval and renaissance universities were in fact international educational institutions) but universal nature of human knowledge seems not the only reason for internationalization of engineering education. Practical, concrete engineering issues have appeared solving of which is impossible without international approach and co-operation in the new context of globalization.

WAYS LEADING TO INTERNATIONALIZATION OF ENGINEERING EDUCATION

Many ways leading to the internationalization of engineering education could be distinguished: international academic mobility, exchange of students and faculty, scholarship systems, international curricula and education programs, partnership agreements and projects. agreements between educational institutions on joint or double degrees, international educational networks and consortia, regional and global accreditation systems, international rankings of universities, regional or international educational institutions and establishments.

On the other hand there have appeared numerous questions, doubts and counterarguments to the internationalization: what are its purposes, benefits, negative implications or risks, what are the relations between the internationalization of engineering education and : brain drain, eroding national identities instead of creating new hybrid ones, commercialization of education programs, market orientation etc..

Calls for monitoring the unintended or unexpected consequences of the internationalization together with the concern for working out the **policy or strategy on internationalization engineering education** – have became more and more noticeable.

There have also appeared some opinions opposing internationalization to globalization and trying to demonstrate the differences which concern rationales, objectives and benefits – particularly in the area of education.

As the internationalization of engineering education evolves to meet the new global challenges it seems important to look for the new ideas and solutions in this area.

Since at least 2006 the idea of creating World University of Technology (WUT) has been a subject of discussions starting from the 7th World Congress on Engineering Education (Budapest 2006) where author presented it for the first time [3]. The idea has been then developed in a series of papers [4,5]. Further discussion has focused on the possible options and shape of WUT, personal characteristics and professional profiles of its future graduates, educational programs and curricula, organizational and financial aspects and resources necessary for creation WUT. The differences between the European Union project (EIT) and WUT have been also subject of discussion [4].

After presentation the first proposal of the organizational structure of World University of Technology in IDEAS Nr 15 (2008) author received many critical comments and remarks. The structure composed of basic six organizational units ("faculties" or "departments" or "colleges") and two supporting units ("institutes") has been presented as a kind of inspiration only but – what surprises author – most of discussants are not arguing with the proposed structure, number or names of the suggested organizational units but are proposing their own interpretations of the names and presenting their comments on missions and even on the internal structures of particular units.

MISSION AND STRUCTURE OF INSTITUTE OF ORGANIZATION AND MANAGEMENT AS A UNIT OF WORLD UNIVERSITY OF TECHNOLOGY

As opposed to the other proposed organizational units of WUT – certain consensus on the Institute of Organization and Management appeared at the very beginning of the discussion. Nobody has denied so far the necessity of creation such unit and the most of participants of the discussion have presented similar views on the rationale, mission and tasks of the Institute.

Within the proposed structure of WUT [5] – the Institute would be responsible for providing future graduates with organizational and managerial knowledge necessary for:

- understanding the essence and role of organization and management in the area of engineering and technology;
- application of organization and management models and methods in large, medium and small scale engineering projects and enterprises;
- organization and management of international engineering projects and enterprises particularly in the areas of: environmental engineering, disaster monitoring and relief, logistics engineering, energy production, conversion and distribution, information systems and networks, international infrastructure and architecture;
- organization and management of international engineering enterprises (planning and executing enterprise's strategies in global environment, multinational financial management, international economics and trade, international marketing, international human resources management).

The second component of the Institute's mission would be conducting (or participating in) research in the mentioned above areas – particularly in the research oriented towards the UN Millennium Development Goals [2].

From the general idea of WUT point of view – organization and management of international projects in the mentioned above areas – seems to be the most important and challenging as well. Engineering projects that cover multiple countries, politics, cultures – create special challenges for future engineers – project managers : project leadership, legal, conceptual and managerial responsibilities, project management contract laws, teams and inter-organizational relationship, conflict resolution etc.

The subjects of education in this area would be also: international project phases, life cycle project management, tendering processes, risk evaluation, project realization, timing, costing, planning.

Taking into account the proposed above mission – the following four units (working name: "chairs") could be distinguished within the structure of the Institute of Organization and Management:
- Chair of Management Engineering;
- Chair of International Engineering Projects and Enterprises;
- Chair of International Economics, Trade and Marketing;
- Chair of Humanities and Social Sciences.

It seems necessary to underline that – according to the proposal presented in [5] – the Institute of Organization and Management has been determined as one of the two Institutes supporting main Faculties (Departments, Colleges) i.e. providing all the students of the University with certain knowledge common for the branches of engineering represented by the Faculties.

DISCUSSION ON THE INSTITUTE OF BASIC TECHNOLOGICAL SCIENCES

The second WUT "supporting unit": Institute of Basic Technological Sciences has been intended as responsible for the courses of mathematics and basic sciences as well as for mechanics, technical physics and chemistry, electronics, engineering graphics, applied mathematics, operations research and systems theory etc.. Many opinions and comments have appeared on the expected mission, tasks and structure of the Institute and the discussion have been prolonged.

Since long time the relationships of engineering and basic sciences have been discussed. Particularly an overlap between the sciences and engineering is still the subject of disputes as well as the distinction between the objectives and approaches of scientists and engineers (Theodore von Kármán: *"Scientists study the world as it is; engineers create the world that has never been"*).

In most of universities a typical engineering curriculum is usually built on a foundation of courses in mathematics and the basic sciences, which are taken in the first two years at the university. Frequently some additional courses (e.g. in biology) chosen from an approved list, complete the spectrum of education in the basic sciences.

In one of the papers published in IDEAS Prof. Yadarola [6] criticized saturation first years of engineering studies *"with a heap of abstract sciences"*. Boon and Mieke [1] have written that traditional picture of applying science in technology *" is inappropriate for understanding how science is used in the engineering science ; in alternative view, engineering sciences aim at models of physical phenomena in technological artifacts"*.

In further discussion on the mission, tasks and structure of the Institute of Basic Technological Sciences (as a part of WUT) – it seems difficult to avoid fundamental questions : *what will be the distinction between science, engineering and technology in* *the forthcoming future?, what will be the exact relations between science, engineering and technology?, where will be the future border between the basic and applied sciences?.*

Emerging new branches of engineering and new professional profiles of engineers are often reflected by the names of new departments and programs established by universities ("mechatronics", "computer engineering", "environmental engineering"). The proposed names of the future WUT "faculties" or "departments" reflect the challenges and requirements of new "world engineering" as well as some suggestions on the new branches of engineering.

It seems important to examine the existing and appearing overlaps between the new branches of engineering (also between the traditional and new branches) particularly in the areas of the application of sciences as well as the needs of the new branches addressed to sciences – and then to redefine the contents and methods of the sciences' "input" or "support" to the new branches.

From the point of view of the new multidisciplinary or interdisciplinary areas of engineering it seems also useful to start discussion on introducing the notion of *"basic technological sciences"* or *"general-technological sciences"* (like e.g. mechanics, electronics, automation etc.) as disciplines supporting the emerging inter- or multidisciplinary branches of engineering.

Taking into account two tendencies: integration and specialization in engineering – it seems important (also from the narrow specialization point of view) to determine the scope of basic or general technological knowledge necessary for future engineer.

The discussion on the mission, tasks and structure of the Institute of Basic Technological Sciences has turned out to more animated than the one on the Institute of Organization and Management. It seems natural because the first one has touched fundamental questions on the essence and evolution of mutual relations between engineering, science and technology. Therefore it still needs some time and continuing the discussion to work out the concrete proposals.

CONCLUSIONS

On the way to attainment of the UN Millennium Development Goals the international dimension of engineering education is one of important factors.

The achievement of sufficient engineering capacity to develop world infrastructure and provide sustainable technological development depends on involvement and dedication of the future generations' engineers. They will takeover from the present generation (according to Theodore von Kármán) – *"creating the world that has never been"*.

The idea of World University of Technology – when presented for the first time about four years ago – seemed to be utopian and difficult to be materialized in the closest future. Meanwhile however the demand for engineers of international orientation, free from national or regional biases, prepared to handle global challenges or to work within the Millennium Development projects – has increased significantly and "World

University of Technology" as a subject of discussion has evolved – from certain idealized aim of aspirations only – through some pattern or frame of reference – to the object with determined structure composed of concrete elements (institutes, departments, faculties) able to fulfill the specific educational and research tasks. Therefore the idea of WUT seems worthy continuing the discussion. Additionally the opinions and proposals concerning the structure and elements of WUT have became a kind of stimulus for asking and answering broader and deeper general questions e.g. : on the essence and scope of modern engineering, on the present and future division of engineering into branches and disciplines, on the core or basic set of technological sciences fundamental and common for several branches of engineering, on the present and future mutual relations between engineering, science and technology.

Author would be grateful Distinguished Readers for taking part in the discussion on the mentioned above issues during the forthcoming 8th World Congress on Engineering Education (Buenos Aires 2010).

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Philosophical Perspective on Engineering and Politics

Dr. Arnold Warchał
Military University of Technology, Warsaw, Poland

PDr. Arnold Warchał, graduated with B.A. in philosophy and political science from Northeastern Illinois University, and M.A. and Ph.D. from University of Warsaw. He's and adjunct at the Military University of Technology, and also a lecturer in Philosophy, Political Science, and Law at the University of Warsaw, as well as the European College of Law and Administration. He was a dean of Political Science Faculty at the Academy of Humanities and Economics in Łódź, where he also managed a Post-diploma studies in Public Safety for Municipal Police in Łódź. Member of American Political Science Association. His general academic interests, other than subjects taught, include cosmology, philosophy of science, education and changes to contemporary society. He is a co-editor and author of *Civitas Hominibus* and *Homo Politicus* – academic journals, and author of academic essays and publications.

Abstract

There is no positive change of political society without one of its most important profession, that of the engineering. The history of politics and engineering go hand in hand influencing one another and creating new goals for societies' change on a global scale. Throughout history of human civilization the questions about nature were answered on a practical level by that one of the oldest, and most important for civilization's growth, profession. The first political leaders were aware already of the importance of engineering for the growth and strength of community. Some of the first philosophers creating new form of universal education were themselves engineers or teachers and practitioners of the same specific mode of thinking that became a methodology for engineering today. The pragmatic discussion on "truths" of the cosmos using a theory and practice led to fast development and growth of technological society through education and science that always had been necessary for political reasons. Moreover, the engineering profession of global society should play a bigger role in politics not only as the "workhorse" of nations but as politically educated and active group, being able to positively influence the political realm. It is not so foreign to engineers, as it may seem at first.

Key words: *community, education, global change, history of engineering, philosophy, politics.*

It should be well understood in a global political environment, it's not just the politics that shapes the world we live in. Politics by itself means nothing. It never did. What we call politics has always been built on the foundation of other sciences – whether those pertaining to natural sciences, or dealing with different quality of values – the humanities. When practicing politics the politicians have always relied on its advisors and generals. Good politician is someone who really knows how to employ the help of professionals from any given field of expertise for the future development of entire society.

The politician by himself means nothing, even with his party, constituents and army. Only when he is able to respond with knowledge to overcome natural obstacles and boundaries, the constant change and clashes with nature's realm, for his society's advantage dealing with his environment, we can say that the politician is born. At time when he can understand the space where his community is established and when he understand the infinite potential for growth with proper division and management, his value can be established and grow. However, growth must be first envisioned, space must be understood (either on macro or micro scale) and rationalized. That is when one can become a leader and move society forward. To understand the value of space and what might become out of it is the main prerogative and education for politics, and that understanding through practice is the main idea that enables politics to rest on an ancient fundament of one of the oldest profession we know of, and that we can't do without, that of the engineering.

Engineering and politics stay side by side through a long journey of common history. Not because of choice but necessity. Especially to-day, with great number of people inhabiting this planet, and repetitious natural disasters and wars , living without the engineers would be going back to the "dark ages". Political community owes a lot to engineers. Not having enough citizens in that profession, might be potentially disastrous for everyone. Their history is intertwined with birth of society, its fall, and sometimes resurrection.

The peace and wars have been won by political communities that make historical concern of its *praxis*, the most prevalent paradigmatic and repetitious issue for different fields of human inquiry – politics, philosophy and science. It is the engineering profession that comes to mind when I think of the synthesis of the above. For engineering is made of the above, since it deals with practical reason. And it is not an overstatement, nor appeasement. Looking at history of the "political" we can notice that the first "real" politician, was not the one who spoke of a good society, but the one who was able to construct a city enabling its inhabitants to survive and prosper. Perhaps it was in Mesopotamia, Anatolia, Palestine or by the river of Indus, or in Africa. The first politician, however was preceded most likely by the first engineer.

Who was the first engineer? Someone who simply solved big practical problems? Someone who planed and rationally connected the pieces of reality to transpose its energy for the common good? Perhaps it was the first tool-maker hundreds of thousands years ago, maybe millions, at times when the energy for food and survival was already under control. It is believed that the "first tool maker" was perhaps not the *Homo sapiens* but even earlier species of *Australopithecus*, at least some paleontologist think so. The unique ability to transpose the nature was perhaps an accident, or an evolutionary change, or perhaps a gift of whatever origins. It was the first "artisan". It is no accident that from that *art* our humanity was built, and that "art" [1] is still a part of our societies to-day.

There is something both artistic and pragmatic in an engineering. It deals not just with questions of "why", but "how", at the end saying: let's check it. If it stands, it is true, if not – try again. It is also the issue of energy. It is the problem of continuous existence that engineers work on. In a same way as the first smiths used fire transforming nature, its raw mater, into something new, the first city builders created a new space that was natural to humans, through the transformation process of what is imminent in nature, but when externalized it becomes a new creation. It is thanks to those, who compared how nature works in itself, to: how this knowledge with innovation can change human life, the progress begun. From those times on, human civilization was born and began to flourish. Civilization is not much more than the mode of survival against the negative forces of nature, thanks to knowledge of how to recreate its example for the continuous existence. Those first "builders" learned from nature and possessed the *art of natures denial*. What they later planted in nature was the survival of their community.

It may seem odd, but first engineers may had been the first real politicians: they did something for the entire community. They made continuity tangible, understanding that everything can be divided into pieces and recreated. What was divisible by nature, at first diminishing the human species, thanks to the first engineers was made interconnected and continuous. Thanks to their method of measurement and discovery of determinants for harmony, they recreated the mechanism of nature, using it for human sake. Thanks to that mode of thinking we can have different engineering in different areas of human involvement. But what they have in common is that they take human survival literally out of nature itself, and sometimes against it.

Those great nations that have only shamans (the interconnected with nature) disappear with their love of nature's life and nature's way, those who can accepted it and oppose it at the same time, are the engineers the creators of great civilizations.

When the first convent for human society was made within nature, by understanding it and on some levels communicating with it, the new allocation of meaning created a society, something more than the family or tribal community. The transformation of a human mind became obvious and ancient "civil engineering" started to evolve. Possibly the first theocratic societies were established by the engineers who became the leaders because they could understand the force of nature and somehow win the survival of their community. Theocratic and the same time technocratic society of the Sumerians was created that way. The division of chaos of natural energy into the channels and rivers of life: cosmos, was another "re-creation" of human being, from its animal stage into human civility – Sumeric Enkidu, by the "man of the city", the engineer Gilgamesh – seeking the eternity, poetically speaking, realizing the words of tales of nature's fight against one of its own child a human, who survives all the nature's exhibits of raw being, that humanity can't accept.

A civilized being, is someone who is accountable, through conscientious knowledge of the surrounding on different plains of existence. Perhaps it is worth noticing that the engineers in ancient times were members of different fields of knowledge, just like today there are many fields of engineering. The father of Western philosophy, Thales of Miletus was a mathematician and engineer. The Democritus of Abdera theorized on atom and mechanical universe building a steady foundation for contemporary understanding of nature's way. The Solon, founder of Greek democracy is also a social engineer who in a space of a whole society saw its basic division, basic units of equations – the individual citizens. We can say that Solon was the architect, the engineer of Athens. His main accomplishment through political expression was a special arrangement taking into account those individual units. Equally, a theory can be implemented by the engineers into a tangible effect. The politics and engineering sometimes use basically the same mode of inquiry.

Yet, it was the social engineering of Plato, that made its deepest impact on a long period of Eurasian history, and with some negative effects. His view of the universe that recreates itself in an "idea", as an ideal, and becomes "real" beyond its own immanence, is a repetition of the old myths in a new level of rationality. When he speaks of philosophers, in his famous idea of harmonious society, corresponding to the idea of order of harmony, he talks about the smiths forging the minds on likeness of natural hierarchy of cosmic arrangements, just like in metallurgy. Transformed, it became a new ideology;

If someone thinks that the politics of the XX century was shaped only by ideology, then I dare to say, wrong. It had a twin brother: engineering. Not just in one, technical realm, but also social, biological, spatial, and so on. It was based on *praxis*, the practical solution to imaginary and real forces of nature before which we need to kneel down, but without ceremony and without fear. After that, building the fundament for the new and safer reality became possible, since it used a specific method – of "seeing" energy, whatever it is, imagined as numbers dividing spatial equations.

To me, the engineer is someone who can divide into pieces the object and space within each other, and then without being destructive, can put it back together and while doing it, can come up with something new of an imaginary quality. Someone who is a skillful artisan, the possessor of virtue and strength of the smith, who by directing the flow of energy, often destructive, can control it and create something new, even out of destruction. The first man who knew how to control the fire is the first engineer. That "fire" is still in the mind of human beings, the energy of civility.

What is so specific about the engineering that it had so much influence in the life and death of nations, yet we so rarely coincide it with politics? For starters people, who call themselves the engineers can employ two types of knowledge for the final goal accomplishment. One them is, of course, the mathematics and the other, the imagination of the intrinsic nature of the universe, and based on that application of empirical sciences for the practical purpose of progress and problems solutions. It is not only the contemporary world that uses that mindset. Any country that came out of medieval age and lasted until now, had to rely on knowledge, a specific value of science and culture [2] that today a modern world can't live without.

Nothing new in that, only the scale is much bigger today than it used to. By scale I mean that it affects, whatever the engineers do, a much bigger population across international boundaries. Today, the specific global economic, industrial and post-industrial geopolitical situation, with both, its positive and negative solutions incorporated from science to politics and human endeavor, creates the need for a fast thinking and fast acting groups of specialists in different sciences and engineering fields. Those countries that can use their skills will have a better chance of general progress for its people, for wealth and preparation for possible and harmful natural forces that seem to intensify with a globalization process. Not by accident we call our civilization a "global knowledge society". It is not only, the technology that affects us, as well as our history and way of life, it is the practice of knowledge. It can both, protect us from the forces of nature, and conversely, sometimes may destroy us with wars we create, where technology usually means death, too often.

Let it not surprise you that the impact of the engineer on our daily life is greater than that of the politician. The intertwining of society's life and new technology is obvious. The impact of one on the other is easily observed. The engineers both influence their society's ways, as well as are influenced themselves by the culture, including especially the political culture in which they live. It is even said, that they represent a conservative model o political life and values thereof. However, on the other hand they are open to innovation understood as an improvement and not as the economic consumption exchange. The technical mind can be shown to have as much poetry in it, not written as intangible abstraction of the concrete, but tangible projection of mind's creativity, as an artistic thinking. Yes, there is as much poetry in the Atom and Hydron Colliders, as there is technicality in Sumerian or Greek epics.

For that reason, engineering is not just a practical science. It is a mind in space and motion, the same mind that writes poetry, yet seeing the transcendent not to the mind but to the body. So much about the praise of the profession. We should have some critical suggestions as well.

Within the change observed during the upsurge of technological innovations, so common in the XX century, the more general goals that the professionals of the engineering should keep in mind are the education and politics. Those two fields have a lot at stake because of engineering, and engineers have a lot to gain, or lose, if they themselves will not look for some common involvement in progressive improvement of national and global situations.

It has been already understood long time ago that the significance of engineering lies not only in ability to create new tangible solutions for betterment of life in a given community or for economic development around the world. This professional field must be a part of any nation-building or improvement. In a first half of XX century, around a time of "great depression" in the United States it became obvious that the need of education of the engineers in political science is rather natural for the pragmatic reasons: “there can be no denial that the engineering profession has as deep an interest in government and public administrations as any other. The greatest engineering projects of the present day are those that only governments will undertake [...] Engineers have direct relations with legislation, administration, and adjudication.”[3] And as is understood by the author of the above statement: both mathematics and scientific subjects like physics, chemistry, biology, geology and economics, should be taught to students of engineering, as well as the study of government and its administration, and politics of society. One should remember hence, that the meaning of jobs the engineers do pertains not just to nature and mechanics of space, but especially to the change of society and its principal values. We can observe throughout the history of contemporary civilization that tangible application of scientific knowledge is one of the main reasons for the political change throughout the world. At present times there are obviously more players, not just the governments, that can sponsor big engineering projects, yet the biggest ones, those that can alter the life of citizens around the world are still sponsored by governments.

Current technological paradigm moves the world ahead making it easier for those societies, where the education of the engineers is at high level, to progress. This progression however does not just entail adding new machines or projects building, it means change of society and its life. And in today’s world the engineers have to understand the important role they play for the society. Not just for the goals of the political parties and governments who often use the successes of science and technology as their own leadership in advancement, but for the entire society and entire humanity. For they have the power of knowledge that can be practical for betterment people’s life, or the knowledge of destruction. Therefore it should be understood that not only the governments should sponsor the engineering education, for good practical reasons, but the engineers must know the mechanism of public policy making and politics of the society if they want to be a positive, creative part of the change, that often in one dimensional manner is proclaimed as a success of the politicians or historical evolution of the society, without giving a due credit to people that move and enable the society to adjust itself and survive the sheer power of nature.

Yes, even today when the economic ideology allows different players to partake in a technological race for economic reasons – mainly the big companies that hire and use their engineers for achieving their capital goals, the idea is old. Still, it is, just like in the thirties of the last century, the governments that influence change with big engineering projects changing the entire society for the purpose of positive outcome for humanity. Not just for few but for everyone.

Beside necessary concentration on complexity of nature and detailed organization of its main goals the engineers must also envision the progress in itself. Not just a progress in technology and science, but especially the influence they have and progress of their society. Without education in politics, sociology and philosophy all the great jobs the engineers do may mean nothing, for their work can be changed into the exactly the opposite from what it has been since the time of first ability to survive in harsh natural surroundings. It can be changed into the destructive force of war, and it seems the engineers in general are aware of this. Hence when it comes to a political stand we can say that the engineers are usually more conservative than the other citizens. They understand progress as an evolutionary change in nature, that can be controlled for society. The biggest engineering projects are those that change society in its details and its overall realm. And politicians who don't understand it and cut financing for the biggest engineering projects, like space projects or technological projects build just for sake of knoledge, are ideologists and bring society down, since engineering is also about economy.

The current technological advancement belongs to countries that did not rely on ideology but on the engineers – the nuclear fusion, atom colliders, space projects. Politicians not always understand it, and engineers sometimes either don't have the ability or the leverage to explain it to them. That's the necessary reason for the engineering and politics commitment through education, and the curriculum of the engineering schools and polytechnics should take this into account, since the engineering and politics are really one. Engineering mindset should include politics for the pure reason that engineering looks further down the line than the current party politics we can observe in democratic societies. They should know through the curriculum in political studies how they can affect decision making process to achieve a common goal of improving the life of the people. After all, building the industry and economic progression for the country is not possible without them. Unless those curriculums are somehow combined, without diminishing the amount engineers and scientists must spend to improve their own professional skills, the future might be slim. Ideologically inclined politicians who make cuts in engineering projects, like moon projects and others, will concentrate on the monetary economy and will not realize that economy is all about space. It is the knowledge about the space division and space building for a mankind.

One of the better examples where the engineering and politics is in unison, which creates a new space for the development of society, is China. One may wonder whether its rapid and continuous growth is possibly due to the "overrepresentation" of engineers in country's government. It is even said that China's success is due to the engineer's role in politics. The possibility to look into future of the people, thanks to the imminent rationality of the profession is what allows for that growth.[4] China is not the only one. Those countries that realize the potentiality in engineering are actually changing by 180 degrees their view on the engineers involvement, and see them not only as the builders and workers, but as the policy makers for industry and therefore education, can expect progress. Those that do not, should expect regress.

If we look at global scene we can notice that India, Arabian countries and others that have been even 20–30 years ago considered technologically backward, now because of their engineering education are creating great projects for their countries and stimulate economic growth amidst the recession in monetary economy. If by that token we look into the number of engineers in parliament we can possibly expect what might happened. For example in the US Congress there are 4% of Senators and 7% of Representatives with degree in engineering, and this means that the great number of bills that have to do with technology and industry are discussed by people who don't know much about it.[5] Things are not better in many European countries. Yet democracy should be saved.

Someone should help. We can count on the engineers and philosophers, we always did. And the engineers should learn the politics…

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16 Editions of IDEAS 1993–2009

IDEAS created in **1993** – thanks to the initiative of **Prof. Miguel Angel Yadarola** President of the WFEO Committee on Education and Training in the years 1993–1997 – has been systematically edited since that time.
It seems interesting to review the subtitles as well as number of pages of the so far published issues which reflect the development of the Committee itself and evolution of its areas of interest and activities.

1.	Distance Learning in Engineering	1993,	20 pages
2.	Accreditation of Engineering Studies	1994,	40 pages
3.	Accreditation and Professional Practice	1996,	38 pages
4.	Accreditation, Engineering Education and Practice	1997,	40 pages
5.	Continuing Professional Development	1998,	58 pages
6.	The Impact of Globalization on the Engineering Education and Engineering Practice	1999,	112 pages
7.	The Necessary Basic Knowledge and Abilities for Engineering Graduation	2000,	52 pages
8.	Internationalisation of Engineering Education	2001,	40 pages
9.	Quality of Engineering Education	2002,	56 pages
10.	Future Directions of Engineering Education and Continuing Engineering Education	2003,	78 pages
11.	Special Needs of Developing Countries in the Field of Engineering Education	2004,	40 pages
12.	University Graduates' Managerial Knowledge and Skills – Way to Global Excellence	2005,	104 pages
13.	Education for Mobility	2006,	104 pages
14.	Education for Innovation	2007,	164 pages
15.	Education for Development	2008,	88 pages
16.	Education for the Future	2009,	74 pages

Prof. Włodzimierz Miszalski
Editor

CHRONICLE OF EVENTS (January – December 2009)

January – February 2009

Publishing of IDEAS No. 15 devoted to Education for Development and results of the 38th WFEO-CET meeting in Brasilia as well as to the conclusions from the 3rd World Engineers Convention (WEC) «Brasilia 2008». It has been distributed by the Secretariat of the Committee among CET members, National Members of WFEO, authors of papers, international engineering organizations, e.g. FEANI, technical universities, libraries and others. Numerous copies were sent to Secretariat General of WFEO (for Executive Board members and other interested parties).

March 2009

- Discussions on the proposals of WFEO Documents on Mobility (coordinator – Dr. Peter Greenwood) ; putting the documents on the WFEO-CET website
- Discussion on the engineering education issues resulting from Brasilia Declaration.

April – May 2009

- Organization of the 2009 meeting of the CET on November 02, 2009 in Kuwait City in coincidence with the WFEO General Assembly and Executive Council meetings. Prof. Miszalski proposed Mr. Konieczny as a new Secretary of the Committee replacing Mrs Teresa Domańska.
- Preparing publication of IDEAS No.16 at the end of December 2009, under the main theme "Education for Development".
- Putting the electronic version of IDEAS No. 15 and 16 on the WFEO-CET website; At present visitors of the Committee webpage have access to 3 numbers if IDEAS (IDEAS No. 13, IDEAS No. 14 and IDEAS No. 15). This trend will be continued in future as well.
- Development of intensive works on the 8th World Congress on Engineering Education, which will be held on 18-20 October 2010 in Buenos Aires – working out themes and sub-themes for the Congress. The so-called Alameddine-Arenaza proposal was distributed among the CET members for further discussion and comments. There was a thorough discussion within the Committee on the mission, goals, themes and

sub-themes of the 8th WCEE. They were submitted to President of the Organizing Committee of the Congress in Argentina – Eng. Luis Vaca Arenaza.

June 2009

Continuing the discussions and works on the issue of mobility of engineering professionals. The WFEO Committee for Education and Training (WG on Mobility of Engineering Professionals under the chairmanship of Dr. Peter Greenwood) discussed and approved documents by dr. Greenwood "Draft Mobility Web Pages" and "WFEO Policy on Accreditation and Mobility of Engineering Professionals". The drafts were circulated to members of CET during 2009. The two documents were completed late in 2009 and were approved by the CET at its meeting in Kuwait, on November 2, 2009. The position paper will be published in IDEAS No.16.

July 2009

Works on the issues resulting from the "Brasilia Declaration" in the field of Engineering Education, namely: working out the ways and methods of "emphasizing in EE the relevance of engineering to the global issues and problems we face" (World University of Technology), "promotion of engineering studies", "promoting curricula and teaching methods in engineering education that emphasize relevance, applications and the problem-solving", "strengthening linkages between elementary school and engineering by enhancing partnerships between engineers, schools, government and the private sector".

September 2009

- Preparatory works on the next edition of the Committee publication – IDEAS No. 16 which is planned for the fourth quarter of 2009.
- Works on drafting the Plan of Action for 2010-2011 which have been submitted for approval by the CET members at the 39th Committee meeting in Kuwait in November 2009.

October 2009

- Developing further working contacts with IFEES and Cartagena Network of Engineering as well as establishing closer contacts with FEANI and the FEANI Committee on Continuing Professional Development (CPDC).
- Further development and upgrading the WFEO-CET website in consultations with the WFEO-CET members – (http://www.not.org.pl/wfeo). Preparing electronic version of IDEAS and link for WFEO-CET members enabling them access to the documents (minutes, agendas, reports).

November 2009

The 39th WFEO-CET meeting was held on November 2, 2009 in hotel JW Marriott in Kuwait City in coincidence with WFEO General Assembly Events and the International Engineering Conference on Alternative Energy Application organized by the Kuwait Society of Engineers.

Within the Committee Internal Organisation item the Committee members approved prof. Roger Hadgraft from Australia as a new CET member. The WFEO-CET President summed up the 4-year term of the Polish CET Presidency and Secretariat and informed about the letter of the President of the Polish Federation of Engineering Associations (PFEA) addressed to Mr. Barry Grear President of WFEO and President Elect Mrs. Maria Prieto Laffargue concerning resignation of hosting WFEO-CET because of very difficult financial situation of PFEA and asked the CET Members for their proposals of hosting the Committee for the next 4 years. Prof. Miszalski presented the Committee Members who participated in the past 4 years Committee works with the Certificates of Appreciation. He also announced that Mrs. Teresa Domańska went into early retirement and resigned from the post of CET secretary. The CET President proposal of Mr. Stanislaw Konieczny as a new secretary what was unanimously accepted.

The Agenda of the meeting covered the following items:

1. Presentation of activities of the Organizing Committee of the 8th World Congress on Engineering Education in October 2010 in Buenos Aires made by eng. Luis Vaca Arenaza (Argentina). It included integration of the subjects, organization for Congress Schedule, creation of evaluation committee, main actors, government support, preparation of conferences and other pending tasks.
2. Presentation of the WFEO documents proposals on mobility (Draft Mobility Web pages, WFEO Policy on Accreditation and Mobility of Engineering Professionals) made by dr. Peter Greenwood (Australia).
3. Presentation of status of preparations for IDEAS No.16 made by prof. Włodzimierz Miszalski (Poland).

The problem discussed by the CET members was taking over the CET Presidency. Argentina and Lebanon proposed their will to host the Committee for the next 4 years.

14 Committee members and 4 invited guests participated in the 39th CET meeting in Kuwait. WFEO Authorities: President Mr. Barry Grear, President Elect Mrs. Maria Prieto Laffargue and Executive Director Mrs. Tahani Joussef also participated in the Meeting.

The next 40th WFEO-CET meeting will be held in October 2010 in Buenos Aires in coincidence with 8th WCEE and the 41st CET meeting will held in September 2011 in Geneva in coincidence with WEC 2011.

December 2009

Preparatory works on a draft Agenda of the 40th WFEO-CET meeting in October 2010 in Buenos Aires in coincidence with the 8 WCEE. Preparing IDEAS No. 16 for printing.

WFEO-CET 39th Meeting in Kuwait, November 2, 2009

Photo 1 – Kuwait Towers

Photo 2 – CET Meeting in the JW Marriott Hotel, Kuwait City

Photo 3 – Presentation of works on 8th WCEE by eng. Luis Vaca Arenaza from Argentina (the third from the right)

Photo 4 – CET President prof. Włodzimierz Miszalski (on the left) and new CET Vice President – prof. Abdul Monhem Alameddine (the next to the right)

Photo 5 – During the break

Photo 6 – From the left to the right: eng. Mohammad Hamad Al-Hajeri, prof. Włodzimierz Miszalski and prof. Abdul Monhem Alameddine

Photo 7 – Speech of eng. Conrado E. Bauer, WFEO Past President from Argentina (the second from the right)

Photo 8 – Talks of CET President prof. Włodzimierz Miszalski with WFEO Authorities: eng. Barry Grear (President) and eng. María Prieto Laffargue (President Elect)

Photo 9 – From the left to the right: prof. Włodzimierz Miszalski (Poland), prof . Abdul Monhem Alameddine (Lebanon), dr Peter Greenwood (Australia) and dr. Wiliam Butcher (USA)

Photo 10 – WFEO Executive Director Mrs. Tahani Youssef (the second from the right) follows proceedings of CET Meeting

Alternative Energy Applications
Option or Necessity? Kuwait 2009

Kuwait Declaration Statement from World Federation of Engineering Organizations and Kuwait Society of Engineers

November 5, 2009

On the eve of Copenhagen discussions on climate change the World Federation of Engineering Organizations in partnership with Kuwait Society of Engineers assembled engineers from 100 countries worldwide to debate alternative energy options and challenges and the contributions to sustainable development. The engineering community will continue to up date the state-of-the-art of such options in future meetings in Buenos Aires Argentina October 2010 and Geneva Switzerland September 2011.

Meeting the world s growing energy demand and at the same time addressing serious concerns about greenhouse gas contributions to climate change are enormous challenges today and endangers the living conditions for future generations.

Engineers worldwide believe that to meet expected energy demand all energy options must be considered including energy efficiency renewables cleaner and les carbon intensive fossil fuel as well as nuclear. There is no one simple or uniform solution to meet the expected demand for energy. The optimum mix for a particular country will depend on available resources population distribution growth and existing technical and economic capacity and development.

The world is wasting energy; the sustainable part of the needed GHG reductions can be achieved by wiser use of energy. Energy efficiency conservation and savings in transport households and industry are very important means to accomplish this. Significant reduction in carbon emissions can be realized by increasing energy efficiency and the use of technology available today. According to some studies it has been shown that it is possible to make substantial GHG reductions cover the short and the long-term to meet the project target of 50–85% average global reduction by 2050.

The impact of climate change is posing a serious risk to infra-structure that supports the economy – natural disasters transportation energy agriculture water and wastewater treatment. All stakeholders – private sector governments professionals and civil society – must work quickly to ensure that these systems will continue to operate effectively. The engineering community has the knowledge expertise and experience needed to adapt existing technologies and systems taking into account the changing climate.

WFEO pledges:

- to activate engage with government policy makers to ensure they have relevant information on all feasible options.
- To inform decision makers about risks and how best to adapt civil infrastructure in order to avoid negative impact of climate change.
- Through national members of WFEO to strongly pursue options that will mitigate risks and reduce carbon emissions.
- To promote young engineers participation and fully engage women engineers to assure their effective involvement at all levels.

WFEO through its seven international members and eighty national members representing over 15 million engineers worldwide is an international non-governmental organization.

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