International Professional Conference
ME4CataLOgue
4 - 5 December 2014, Slavonski Brod, Croatia

IMPORTANCE OF ENGINEERING ETHICS IN ENGINEERING EDUCATION

Neven LOVRIN, D.Sc.M.E., Professor

Faculty of Engineering, University of Rijeka

Department of Mechanical Engineering Design

Vukovarska 58

51000 Rijeka - CROATIA

WHY WE NEED TO TEACH ENGINEERING ETHICS IN ENGINEERING EDUCATION?

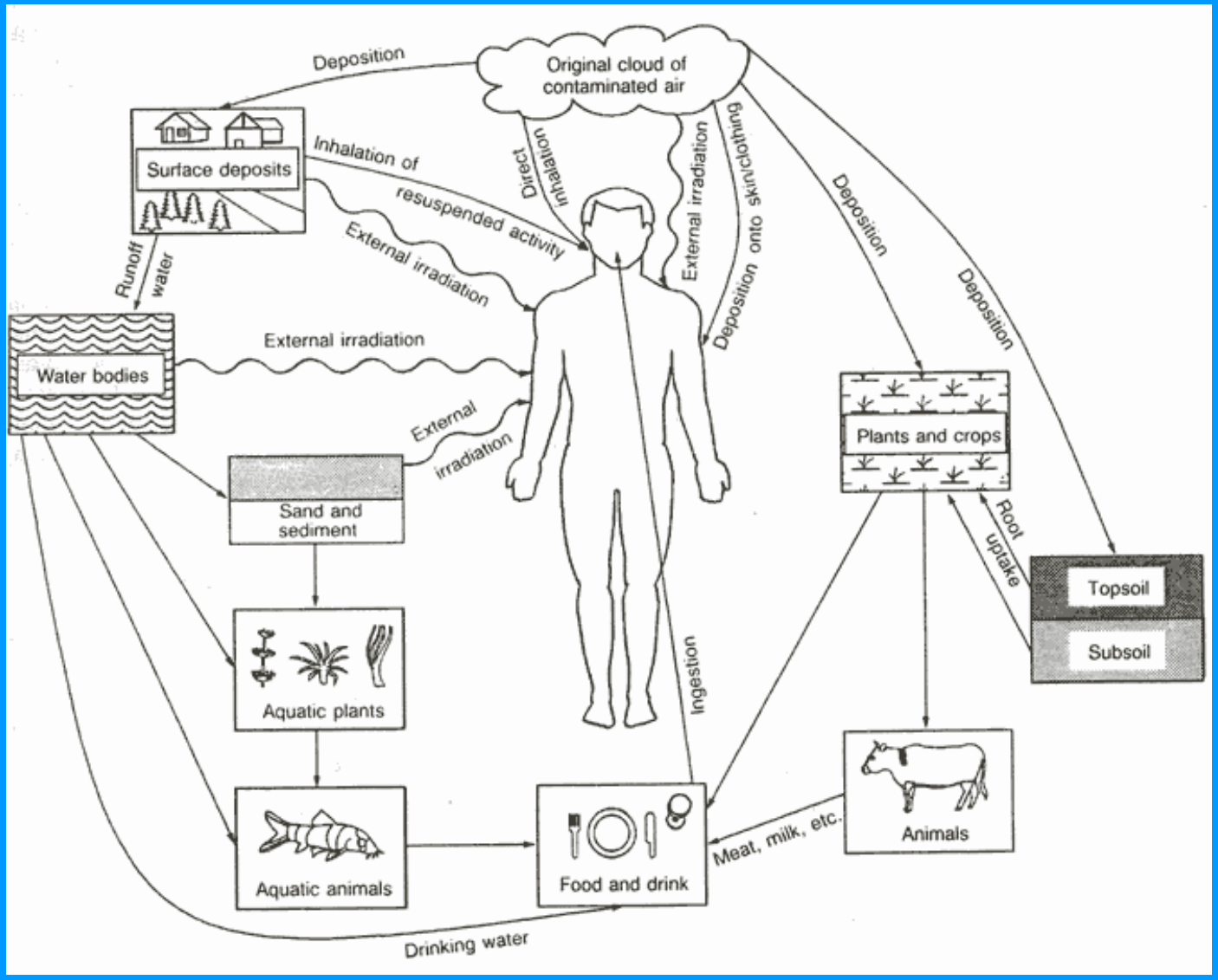
-The end of the twentieth and the beginning of the twenty-first century are marked by developments in science which is considered to be the basis of the greatest changes in history.

- We are witnesses to great benefits to mankind stemming from contemporary engineering development.

- The nuclear and space age that we live in, encourages the vigorous progress of science. Human technologies are developing very fast. Modern technology has a deep impact on humankind and all life on Earth.

- In the 19th century there was no machine, no power plant like today's nuclear power plant or oil supertanker, that was dangerous to the extend that could cause such massive destruction as today's misuse of nuclear energy or environmental disaster of oil supertanker.

The nuclear reactor No. 4 at the Chernobyl Nuclear Power Plant after the disaster in April 1986



Main environmental pathways of human radiation exposure

Red Forest **- dead forests in the 10 km² surrounding the Chernobyl Nuclear Power Plant**

The name *Red Forest* comes from the ginger-brown color of the pine trees after they died following the absorption of high levels of radiation from the Chernobyl disaster. The site of the *Red Forest* remains one of the most contaminated areas in the world today.

Exxon Valdez Environmental Disaster

The supertanker Exxon Valdez, owned by ExxonMobil Corporation, in Prince Williams Sound on the south coast of Alaska, carrying more than 53 million gallons (200 million liters) of crude oil.

The Exxon Valdez remains in place in Prince Williams Sound after running aground. The ship released some 40 million liters of crude oil, causing the biggest environmental disaster in United States history.

Prince William Sound before disaster was home to an abundance of wildlife: birds, whales, salmon, sea otters, and bald eagles.

Prince William Sound after the disaster.

Exxon and the U.S. Coast Guard on a massive cleanup effort

- Unfortunately we frequently are witnesses of more and worse or even tragic ecological consequences of scientific and technological advances markedly caused by neglecting moral principles in people's activities.

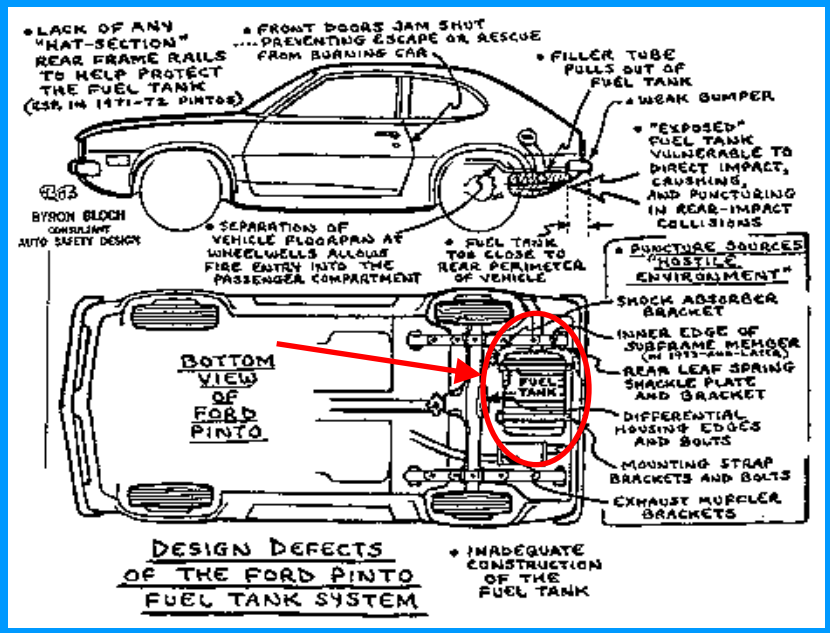
- Engineers have to be aware of their responsibility as they make choices during their professional practice.

- Not only will we need to learn complex new technologies that demand intelligence and expertise. We will also need to develop the ethical awareness to avoid the misuse of such systems, because ethical mistakes could lead to large-scale ecological disasters.

- Engineering responsibility and ethics is a crucial matter essential for our survival. It is not an option or a luxury.

- Therefore, a clear understanding of engineering responsibility and ethics is needed like never before.

A Case-study in Engineering Ethics:
The Ford Pinto Case



-In the late 1960's Ford Motor Company designed a subcompact, the Pinto.

- Anxious to compete with foreign-made subcompacts, Ford brought the car into production in a little more than two years (25 months), in 1971. The regular time to produce an automobile is 43 months.

- This shorter time-frame restricted engineering design more than usual. As a result, it was decided that the best place for the fuel tank was between the rear axle and the bumper (inside the red ellipse).

- Before the production, however, Ford engineers discovered a major flaw in the car's design. In nearly all rear-end crash test collisions (at the speed of over 48 kmph) the Pinto's fuel system would rupture extremely easily. Now all that is needed is a spark from a cigarette, ignition, or scraping metal, and both cars would be engulfed in flames.

- If a Pinto was struck from behind at higher speed of over 65 kmph, its doors would possibly jam shut and its trapped passengers inside would burn to death.

-Because the assembly-line machinery was already tooled when engineers found this defect, top Ford officials decided to manufacture the car anyway in 1971, even though Ford owned the patent on a much safer fuel tank. A confidential company memo directed that the safety features would not be adopted at that time until required by law.

-The best method for improving the safety of the Pinto was to line the gas tank with a rubber bladder, to protect it from rupture. It would cost only $5.08 per car and could have saved the lives of several hundred innocent people.

-Ford alleged that it would cost $11 per car to add any sort of a fuel tank's fire prevention device. A confidential cost-benefit analysis prepared by Ford concluded that it was not cost-efficient to add an $11 per car cost in order to correct the flaws.

BENEFITS & COSTS ANALYSIS

Excerpt: Ford Inter Office Memo, September 18, 1973

BENEFITS		
180 burn deaths	$200,000 per death	$36,000,000
180 serious burn injuries	$67,000 per injury	$12,060,000
2,100 burned vehicles	$700 per vehicle	$1,470,000
		$49.5 Million

COSTS		
11,000,000 cars	$11 per car	$121,000,000
1,500,000 light trucks	$11 per truck	$16,500,000
		$137.5 Million

- Benefits derived from spending this money were estimated to be $49.5 million.

- Each death, which could be avoided, would be worth $200,000.

- Each major burn injury, that could be avoided, would be worth $67,000

- An average repair costs $700 per car involved in a rear-end accident.

- It was assumed that there would be 2,100 burned vehicles, 180 serious burn injuries, and 180 burn deaths in making this calculation.

- When the unit cost was spread out over the number of cars and light trucks which would be affected by the design change, at a cost of $11 per vehicle, the cost was calculated to be $137.5 million, much greater than the $49.5 million benefit.

- By conservative estimates Pinto crashes have caused 500 burn deaths to people who would not have been seriously injured if the car had not burst into flames. The figure could be as high as 900.

- As deaths and injuries continued to occur, Ford stopped producing the Pinto after 1980, having sold about 3 million of the vehicles.

- Engineers involved in the Pinto's design, knew very well about the design defect of the fuel tank system, but nobody of them warned the public. They are also morally responsible for the horrible deaths of so many innocent people. Loyalty to the Company was more important than ethics and moral obligations for the public good .

- The Ford Pinto case is a classical ethics issue and an example where the ethics and public good is of little concern unless it coincides with profits.

CRUCIAL IMPORTANCE OF ENGINEERING ETHICS AND RESPONSIBILITY IN MODERN SOCIETY

- Modern engineering ethics is a crucial matter essential for our survival in the 21st century . It is not an option or a luxury.

- Modern technology has profound impact on humankind and all life on Earth. Using available engineering technologies, it is possible to provide abundance for all human beings, but also to destroy all life on Earth.

- Engineers have to be aware of ethics as they make choices during their professional practice and they should not be corruptible. They should contribute to environmental protection and to sustaining the balance in nature.

- To be a modern engineer of a high quality, one has to study, not only engineering profession, but also ethics and philosophy in order to apply ethical codes, doctrines and principles in their professional engineering practice.

- **Therefore it is necessary to teach ethics in engineering education. Engineering ethics is one of the most important concepts engineering students must become familiar with. Students have to study the basis of ethics, i.e. philosophy, and history of ethics as well as contemporary engineering ethical canons and codes.**

- **Students should discuss the canons of ethics for engineers and general standards or principles by which the engineering profession is judged. Students have to recognize the importance of ethical and professional standards of conduct and the sociological and cultural context of the engineering profession.**

- Modern engineers, of a high quality, also have to develop spiritual intelligence, (often abbreviated as "SQ“). The language of SQ is the language of the heart.

- Growing in SQ, engineers grow in their action logic from the perception of "What I can get ?" to "What I can contribute ?".

-The practice of self-reflection and contemplation enhances development of SQ, and a depth of compassion and benevolence to all life on Earth develops as well. Thus, modern engineer will develop the ability to act with wisdom and compassion, while maintaining inner and outer peace, regardless of the circumstances.

- All these qualities are necessary for modern engineer, in order to become a humanist who, while working in his profession, understand relationships between man, nature and the universe, and in this way respects, protects and welcomes all life on Earth.

Thank you for your attention! Any questions?

If engineers will not respect ethics and responsibility in their profession, it will directly affect the quality of life on Earth, bring more environmental pollution, affect welfare of humankind as well as the future of our children and the future of our home in the universe, our blue planet, the Earth.