Impact of 5th and 6th Framework Programmes on Transdisciplinary Education

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Summary

New trends in technological development need more and more effort in combining different disciplines, not only engineering. The paper shows how the European Framework Programmes for Research and Development (FP5 and FP6) influence this tendency, because their priorities need transdisciplinary approach. It concerns both different fields of engineering and of non-technological science. Students and teachers involved in Framework Programme projects are forced to follow these new trends and become *Renaissance engineers*. Some examples are shown, among them the FP5 project SEWING, which combines many different branches of engineering and science. Finally some running and foreseen activities are presented.

1. Introduction

Globalization of life on our planet Earth integrates not only people, finances and industry, but also different human activities belonging to all sectors – engineering, sociology, art and humanities. In that situation there is a demand for people, whose education also integrates so many domains. We call engineers so broadly educated *Renaissance engineers.*

According to the Webster Dictionary [1] Renaissance is:

the transitional movement in Europe between medieval and modern times beginning in the 14th century in Italy lasting into 17th century, and marked by humanistic revival of classical influence expressed in a flowering of arts, literature and by the beginnings of modern science.

And:

Renaissance man is a person who has wide interests and is expert in several areas.

Through centuries Leonardo da Vinci (1452-1519) was a symbol of Renaissance. He was an *Italian painter, sculptor, architect, engineer, man of science and writer of prose and verse.* (Oxford Dictionary [2]).

Now we need such people as Leonardo da Vinci was. Do we have them around us? Can we educate such people in our Universities? It seems that we are far away from this.

The industrial époque in 19th and 20th century preferred highly specialized scientists and engineers pushing ahead the science, technology and inventing new things. Thanks to these specialists we have now all kinds of machines, telecommunications, informatics and all fantastic "gadgets" around us. But new trends in technological development need more and more effort in combining different, not only technological, disciplines. New inventions can be used for human benefit or disaster. Spectacular examples are atomic energy, genetic engineering, flood of information (also false or pornographic), pollution of water, soil and air and many others.

Simultaneously, different branches of science and engineering must be integrated to create new quality of technological infrastructure in which we must live. Electronics, informatics, robotics, medicine, environmental and chemical engineering, mechanics, transport, weapons, human safety and many more cannot be developed separately, one is strictly dependent on many others. Narrow specialization is less and less needed, people, who can see all mutual interrelations

are on the top. That means that we must educate *Renaissance engineers*, capable to integrate many branches of science and technology in such a way, as to bring the greatest possible benefit for people.

Last but not least *Renaissance engineers* should integrate also humanistic aspects with their activities. Effects of their creativity must include elements of art (aesthetics, ergonomics), ethics, social satisfaction etc.

Summarising, the modern, global world needs embedding the detailed and narrow problems in a broad technological, social and political system. An important question arises: are we prepared to meet this challenge, are some of our engineers educated broadly enough to cover all these integrated problems intellectually and technologically?

In my opinion, we haven't enough engineers educated in that way. It is a challenge for engineering educators to create curricula fulfilling these requirements. Some steps are already done. In this presentation I want to show how European Framework programmes can influence the way of engineering education towards the creation of *Renaissance engineers.*

2. 5th Framework Programme (FP5) and transdisciplinarity

The European FP5 for Research and Technical Development [3] has been established on April 9, 1997 and has started on December 22, 1998. Its main objective is to support European competitiveness and fulfil needs of European citizens.

Those, who created FP5, understood very well that modern technology cannot be developed without a broad transdisciplinarity. It is quite evident that most new technological ideas cannot be realised without the co-operation of engineers from different fields of technology. But this is not enough. It is very strongly stressed that the aim of technological development is social and it serves to make human life easier and more happy. This is why the following not-technological objectives are listed in all FP5 documents:

- European socio-economic development,
- increasing the European added value,
- raising the European standard of life.

These objectives must be well understood by those scientists and engineers who want to participate in FP5 projects. It is not enough to create a fantastic technological progress: it must be useful and beneficial for people.

In particular, each FP5 project must take into account:

- improving health
- job creation
- maintaining the environment
- improving management and economic effectiveness
- developing the European dimension, which means good understanding of common European interest
- the effects must be consumable by the whole European population
- optimal use of research infrastructure
- engaging many countries, that means internationalisation of activities.

It is very important that the evaluation of FP5 project proposals, done by the European Commission, takes into account the following criteria:

- scientific and technical level and innovation
- European added value
- meeting the social objectives
- strategy of result dissemination and implementation
- financial aspects, partners and way of management.

One can see that the scientific and technical level and innovation are on the first place and have the highest weight factor. But without meeting all 5 requirements listed above the proposal has no chance to be accepted.

My personal university education happened many years ago and my knowledge of non-technical aspects of engineering came during my professional activity as a university professor. And it occurred not sufficient! I had submitted my FP5 project 3 times until it has been accepted. Rejections were mainly because my social, economic and managerial skills were too shallow. I understood that university curricula must take these aspects of modern engineering into account. Only are *Renaissance engineers* capable to be really efficient co-coordinators of FP5 projects.

In the next sections I'll propose how this should be included in education curricula and in teachers' training.

3. 6th Framework Programme (FP6) and transdisciplinarity

The FP5 is going to be closed at the end of 2002 and only running projects will be continued. The main principles of the next Framework Programme, FP6, were discussed in March 2000 in Lisbon, with its motto: *leading role of research in knowledge-based society and competitiveness of European industry*. *European Research Area* (ERA) has been established. Opening of FP6 will happen in June 2002, projects will start in 2003 and will last till the end of 2006.

Transdisciplinarity in FP6 is even more emphasised than in the previous one. In particular, priority is given to large, interdisciplinary projects, combining many different disciplines of technology, while social, economic and human aspects remain as important as they were before.

These aspects of FP6 will be realised through European Networks of Excellence and through very large projects integrating many problems, aiming towards one important European goal, fulfilling all technological, social, economic and other objectives of the programme. It becomes obvious that a new kind of *Renaissance engineer* will be a crucial demand and it makes an important challenge for the European universities of technology.

4. How to educate in a transdisciplinary way

The necessity of extending the engineering education beyond technology has been stated some time ago. An excellent, brief review of this problem can be found in [4]. It is shown there that not only different fields of technology should be familiar to *Renaissance engineers,* but also knowledge of non-technical disciplines. This fact had been known long ago, before the priorities of FP5 and FP6 bring this to work.

I'll cite here several important statements from [4].

Transdisciplinary education shifts the focus away from transient technological facts to developing the ability to collect, analyse and synthesise data into information – skills that do not become obsolete.

Most engineering degree programs focus on solving to-day's problems with to-day's technology, but this information is quickly outdated.

Later it is shown that students must learn how to work in *teams composed of members from different background* and to get *ability to reduce stress, resolve conflicts, increase motivation and develop positive attitudes and team unity.* It is also stressed that engineers must be responsible for social demands, take responsibility for the technology created and its ethical aspects.

So *a good teacher must be redefined.* We *must stop looking at engineering curricula as a four year fact-filled curriculum, but as a 40-year curriculum.*

It is very interesting to face these statements with priorities of FP5 and FP6. The statements simply show, how the *Renaissance engineer* should be educated, how the curricula and teachers of 21st century should look like. While FP5 and FP6 priorities show evidently, why it is necessary.

Even more, economical aspects are shown: the activities of scientists and engineers without broad transdisciplinary education simply will not be financed!

Three conditions should be met to obtain engineering education according to the requests of the 21st century:

- revised curricula
- redefined teachers
- students capable to accept transdisciplinary education.

It is not easy to find a compromise creating effective curricula. The basic engineering education in a given discipline of technology is also necessary. Some teachers must be capable to integrate knowledge of different disciplines and give the students hints how to learn in a modern way. The Bologna Declaration shows some ways of achieving this goal through international mobility of students and teachers, a flexible way of learning and two-tier system of studies.

Internationalisation gives the possibility of getting acquainted with different approaches to engineering subjects.

The flexible way of learning permits the students to choose subjects on different Faculties in different disciplines.

The two-tier system of studies educates basic engineering knowledge on the first level, while integration of knowledge is possible on the second level.

Universities, being partners in FP5 and FP6 projects, encourage students and doctor students to participate in them. The priorities shown before will simply force students to learn in a broader way, to choose subjects on other Faculties, other universities or abroad. On the other hand the university teaching staff participating in these projects will become more suitable for transdisciplinary activities. It is some sort of "push-pull" between education and research.

5. Case studies at Warsaw University of Technology

Since many years one of the objectives of the reforms of the education system at Warsaw University of Technology (WUT) was fulfilling the requirements of modern trends in engineering. This is evidently stated in the document called *Mission of WUT* and in official statements and seminars [5]. Some of these actions have been successful, some not yet.

These actions can be divided into *internal* and *external* [5].

The most important internal actions are interfaculty priority projects, funded by the University. To mention just a few:

- Photonics (Faculties of Physics, Electronics & Information Technology, Mechatronics)
- Clean energy (Faculties of Electrical Engineering, Environment Engineering and Power Engineering)
- Sensors (Faculties of Electronics & Information Technology, Chemistry, Mechatronics)

The main mission of these projects is research, but education is also considered as very important. Students engaged in them are encouraged to take courses in different Faculties, sometimes doctor theses are defended at a different Faculty than that the student is registered. Unfortunately this happen not as often as it should be.

The most important external action is participating in FP5 projects, previously in FP4 under INCO-Copernicus. As a spectacular example I can show the project SEWING, co-ordinated by myself [6]. Its objective is to create a flexible and cheap system for monitoring pollution of water by non-organic pollutants. The project combines specialists of following disciplines:

- electronics
- informatics
- semiconductor technology
- chemistry
- environmental engineering

- production (SMEs).

Among nine partners from 7 European countries there are 5 universities, and the project will give motivation to introduce transdisciplinary studies and doctor dissertations. Some are already running. Students get knowledge from many teachers, who may-be are not as *Renaissance* as expected, but the students have the opportunity to get acquainted with many disciplines, not only technological, subject their teachers are open-minded and encourage them to learn more things than particular teachers know.

6. Approach to educate a *Renaissance engineer*

As shown in the section 4 three conditions should be met to educate *Renaissance engineers.* To do that, an infrastructure should be built in the universities encouraging students and teachers to follow the new trends and make them understand the necessity transdisciplinary education.

Warsaw University of Technology together with the University of Warsaw and the Academy of Economics established the Institute of Contemporary Civilisation Problems. A similar unit exists at Eindhoven Technical University: Stan Ackermann's Institute. Their objective is to build broad understanding of problems beyond technology, like sustainable development, ethics, aesthetics, safety, competition etc. Students can join these Institutes and make their knowledge broader and more humanistic.

At the end I would like to emphasise very strongly that engineering specialists are ALSO necessary. They will be lead by more generally educated people, showing WHAT should be done, and they should know HOW to do things. So, all the ideas given in this paper concern some part of the engineering students.

7. Conclusions

In the paper the mutual influence of modern research and engineering education is shown, with particular emphasis on European Framework Programmes of Research and Development. The need of *Renaissance engineers* in the 21st century technology is shown, but the old style specialists will also be necessary in some engineering disciplines.

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