New Pedagogic Challenges in Engineering Education and the Answer of IGIP

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Abstract - Never the speed of the development in engineering was so high as today and we can observe a big (and accelerated) growth of the area of engineering. Both tendencies require powerful new efforts in engineering education - or in other words: The importance pedagogy - is growing enormous. These changes strongly request new didactic and pedagogic concepts. The International Society of Engineering Education (IGIP) offers such a concept. The IGIP Recommendations for Engineering Pedagogy Studies (in short IGIP Curriculum) are described.

Index Terms – Engineering Education, pedagogy, didactics, IGIP, challenges.

INTRODUCTION TO IGIP

The International Society of Engineering Education (IGIP) has a near 40 years tradition and was developed by the active work of its members and many activists to a leading global engineering association.

IGIP has now about 1,750 members worldwide (individual, affiliate, institutional). More than 1,100 professionals all over the globe are bearing the title of an “IGIP International Engineering Educator”. IGIP is in good partnership with international associations as IFESS, IEEE Education Society, SEFI, IELA and more.

The aims of the International Society for Engineering Education - IGIP are:
- improving teaching methods in technical subjects
- developing practice-oriented curricula that correspond to the needs of students and employers
- encouraging the use of media in technical teaching
- integrating languages and the humanities in engineering education
- fostering management training for engineers
- promoting environmental awareness
- supporting the development of engineering education in developing countries

IGIP has established a prototype curriculum for engineering pedagogy which is already used in several countries.

By passing the curriculum as proposed by IGIP in any accredited institution worldwide, IGIP states that a given engineering educator with an Ing.Paed.IGIP title has all the competencies needed to teach at the state of the art with the best available teaching technologies.

IGIP offers also symposia on national and international level, and a Summer School. Furthermore IGIP has established working groups on different topics of engineering education.

THE NEW CHALLENGES IN EDUCATION

The theme of this conference is "Monumental Innovations from Around the World". Education and pedagogy are thousand and more years old, or better as old as the human race itself.

But never before the conditions under which we work in this field changed so rapidly as today.

And if the environment changes, we have to think about changes in our
- Educational systems
- Pedagogy
- Methods and processes.

Never before the challenges in education and pedagogy were so huge as today.

Peter F. Drucker, well known Professor of Politics and Philosophy author of the book Management Challenges for the 21st Century [1] formulated there the 21st Century Challenge as:

“The most important and indeed the truly unique contribution of management in the 20th Century was the fifty-fold increase in the productivity of the MANUAL WORKER in manufacturing. The most important contribution management needs to make in the 21st Century is similarly to increase the productivity of KNOWLEDGE WORK and of the KNOWLEDGE WORKER.”

If we replace "KNOWLEDGE WORK" and "KNOWLEDGE WORKER" by EDUCATION and EDUCATOR (or teacher) then we have exactly the description of our upcoming task especially in engineering education.
In relation to this the US National Educational Technology Plan 2010 states:

“Many students’ lives today are filled with technology that
• gives them mobile access to information and resources 24/7,
• enables them to create multimedia content and share it with the world,
• and allows them to participate in online social networks where people from all over the world share ideas, collaborate, and learn new things.

Outside school, students are free to pursue their passions in their own way and at their own pace. The opportunities are limitless, borderless, and instantaneous.”

**THESIS ABOUT THE FUTURE OF LEARNING**

What are the main tendencies and requirements for future learning and teaching?

**First** of all the future of learning requires the enforcement of a new learning model.

We need more to focus on 21st century competencies and expertise such as

• critical thinking,
• complex problem solving,
• collaboration,
• multimedia communication
• and much more,

which should be woven into all content areas.

These competencies are necessary to become expert learners, which we all must be if we are to adapt to our rapidly changing world over the course of our lives, and that involves developing deep understanding within specific content areas and making the connections between them. Such new concepts as:

• Open Educational Resources
• Educational MashUps
• Learning Ecosystems
• Online Laboratories
• Living Labs
• MicroLearning
• and others

are well suited to make changes a reality.

Some weeks ago I read in a call for papers about the DULP concept, which exactly points on this. The DULP vision aims at combining

• Design inspired learning,
• Ubiquitous learning,

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• Liquid learning places (liquid society), and
• Person in place centered design,

which shall lead to challenging technologies, rethinking pedagogies, and being design inspired.

**Secondly**, the future in learning will be a balanced approach between:

• E-Learning and Face-to-Face Learning
• Formal and Informal Learning

And the future of learning revolves more around context than content!

“While traditional books are a good medium for reading the written word, computers offer users multi-media functionality and interactivity. Multi-media and online activities are the learning tools of tomorrow because you can tell so much more of a story with it than you can with the simple written word. Reading about science can be tedious and boring, but to actually watch and experience it can be amazing.” … said Joel Thierstein, Executive Director of Connexions at Rice University.

Therefore learning is in transition as shown in Table I.

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<th>Past Focus</th>
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**Thirdly**, the future in Learning will be characterized by

• Open content
• Open knowledge
• Open technology

for all!
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Two of the most important drivers of new educational possibilities are the Internet and the Web.

The Web consisted at the beginning basically of many Web sites containing only unstructured data. Web 2.0 extended the original concept of the Web to some large information silos usually backed by relational databases for storing specific content, like YouTube for videos and Flickr for photos. This concept allowed the users to start collaborating and sharing information of certain specific content types, but the data remained centralized and the metadata behind it was not machine-interpretable.

The transition from Web 2.0 to Web 3.0 implies again in a change of concepts on how data is described. It represents a transition from [3]

- receiver to producer of information,
- static to dynamic contents,
- control of the few to the wisdom of the crowds.

Therefore Web 3.0 is also known as Social Semantic Web.

In Web 3.0's 3D interactive technology (3Di) the motivation is real-life like interaction, and learning is the result of visualization and collaboration.

Social Web describes how people interact with each other over the Web and provide the so called social networks by integrating new web technologies as: blogging, social tagging and other communication features.

Famous examples of social networks in the current Web are MySpace, Facebook and Twitter where people interact with each other by sharing information about their lives, interests, relationships, etc.

The Semantic Web is an extension of the traditional Web with the aim to share data among websites as well as applications. In contrast to the traditional Web where the relationships between different resources are only human readable, Semantic Web provides a framework to describe data and their annotations so that the data becomes also machine readable. The fundamental characteristic of the Semantic Web is the description of various content or information with metadata.

Due to these characteristics, the use of Semantic Web technologies brings several advantages to the end user. This special way to describe resources facilitates also the precise search for information by different criteria.

THE NEW CHALLENGES IN ENGINEERING EDUCATION

The work of IGIP is related to engineering education. But what is engineering?

"Engineering is the discipline, art and profession of acquiring and applying scientific, mathematical, economic, social, and practical knowledge to design and build structures, machines, devices, systems, materials and
processes that safely realize a solution to the needs of society." [4]

Short definition of engineering: **Exploiting basic principles of science to develop useful tools and objects for the society.**

This means, engineering is the link between the sciences and the society, the real life of the people. The concept of engineering has existed since ancient times as humans devised fundamental inventions such as the lever, wheel and pulley. But actual two new tendencies are visible:

**Firstly** we can observe a big (and accelerated) growth of the area of engineering.

Besides the traditional fields of civil engineering, construction engineering, electrical engineering, etc. new engineering disciplines occur:

- Software Engineering
- Data engineering
- Medical Engineering
- Neuro Engineering
- Gen Engineering
- Social Requirement Engineering, etc.

And there are also new tasks within traditional engineering disciplines:

- Online Engineering
- Remote Engineering
- Virtual Engineering
- Reverse Engineering

**On the other side** we can observe a terrific acceleration of the life time cycles of technical (or engineering) products (and processes or technologies too!).

How many years does it take to reach a market audience of 50 Million?

- Radio 38 years
- TV 13 years
- Internet 4 years
- iPod 3 years
- Facebook 2 years

Never the speed of the development in engineering was so high as today.

Both tendencies require powerful new efforts in engineering education - or in other words: **The importance of pedagogy - is growing enormous.**

**NEW QUESTIONS OF TODAY’S AND FUTURE ENGINEERING EDUCATION**

There are especially serious changes in the social position of learning:

- According to some estimates, more than 80% of all learning occurs on the job rather than in tertiary and post-tertiary education!

Learning in the future has to be an integrated part of the job! More over: learners on the workplace are not only consumer of learning resources, but have often also developer or provider role. They participate in the development of content and often in its delivery as well. This brings new challenges to the integration of learning and work. [5]

- Data from Australian and Portuguese surveys show: Engineers tend to spend the majority of their working week (around 60%) engaged in activities which involve interaction with others (meetings, supervision, writing reports etc) and only around 40% is devoted to technical engineering activity.

- There are also new organizational aspects in engineering education [6]:

  On one hand, engineering issues, either in industrial products or in engineering projects, become very complicated and most of them are cross disciplinary ones.

  On the other hand, the working environment is getting more and more internationalized due to the globalization of the world economy. Products are fabricated by worldwide cooperation and manufacturing resources are linked by international supply chains. Nowadays engineers have to know how to work in multi cultural environment with people from different countries.

  This means the next generation of engineers will need to possess the ability to work seamlessly across cultures, have outstanding communication skills and be familiar with the principles of project management, logistics, and systems integration.

- To face current challenges from the real world, higher engineering education has to find new ways in order to quickly response to the new needs of engineering education at low costs.

  This means it is necessary to improve the agility of engineering education in the future. One of the approaches in this direction is the creation of virtual educational units.

All this trends result in new questions and needs to Pedagogy and especially Engineering Pedagogy.

- What learning approaches have to be used to give an effective response to these changes?
- What are the pedagogies that enable 21st Century learning in engineering?
What learning skills in engineering education need to be developed and in what ways have been shown to be successful in achieving them?

What pedagogical approaches have been found to support the different phases of the life-long learning continuum or is there also a pedagogical continuum?

What are the learning approaches that enable competence in leadership skills in a multi-cultural working environment to be delivered?

Ambient technology is becoming a reality - what does ambient learning in Engineering Education look like? How can it be designed, delivered and assessed?

These are some of the reasons, why the importance and the heaviness of engineering pedagogy is so enormous growing.

**IGIP’s International Engineering Educator Title**

As shown in this paper, there are dramatically changes necessary in engineering education. These changes strongly request new didactic and pedagogic concepts.

The IGIP offers such a concept. Interested engineers can complete an additional education in accordance with the IGIP Curriculum. IGIP has worldwide already 46 approved educational centers and more than 1100 approved “International Engineering Educators” (Ing.Paed.IGIP) registred.

The IGIP model's point of departure is that the individual engineering lecturers initiate and are responsible for the teaching and learning concepts for the training of engineers and technicians. The quality and success of the engineering studies are decisively influenced by the teachers' personalities and how they are trained.

Engineering educators expand their typical engineering subject competence by acquiring teaching and learning skills in theoretical and practical coursework corresponding to the objectives of the Ing.Paed.IGIP model.

The students taking engineering education training should acquire the necessary professional skills which technical teachers must have to be able to exercise their profession effectively and creatively.

The proven IGIP engineering education curriculum is based on the knowledge of traditional pedagogy in philosophy and the liberal arts but respects the particular character of the technician and the analytical-methodological approach in the fields of engineering science.

After many years of experience in industry or research, engineers who are appointed as teachers at a technical school or university are influenced by their professional careers. Their way of thinking is determined by the precision of the technology, by their work with quantifiable, measurable events and objects. The influence of their discipline, the “language” of engineers, must be taken into account in their engineering pedagogy education; it must penetrate the engineering education curriculum.

The IGIP Recommendations for Engineering Pedagogy Studies (in short IGIP Curriculum) are described in detail in [7].

Interested institutions and engineers, teachers, students are welcome to contact one of the 23 IGIP National Monitoring Committees or the IGIP headquarters in Austria.

**REFERENCES**

Use the following as the guide for references:

[2] Toru Iiyoshi & M.S. Vijay Kumar, MIT

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