

Lecture Notes on Data Engineering
and Communications Technologies 151

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The International Society For Engineering Pedagogy

1972–2022

IGIP International Society of Engineering Pedagogy
Internationale Gesellschaft für Ingenieurpädagogik
Международное общество по инженерной педагогике



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*In fond memory of Adolf Melezinek the
founder of IGIP and its President for 30 years*

Foreword

Fifty Years is a Long Time—However You Count Them—But Impact Counts More....

Over the past fifty years, from 1972 to 2022, the world has witnessed amazing advances in engineering innovation, technology, practice, and—perhaps less recognized but absolutely true—engineering education.

Think back to a few 1972 “breakthroughs”. In 1972 the first scientific hand-held calculator is introduced. The programming language FORTRAN 66 is created. “Pong” was released as the first commercial video game. The first full-scale humanoid intelligent robot was completed, to name but a few.

These moments in time were remarkable, and even more remarkable is to see the evolution and legacy of these engineering efforts.

In joining with you to celebrate the 50th Anniversary of IGIP, I cannot help but reflect on not only the milestones of success this organization has achieved over these many years. But also, on the $50 \times 50 \times 50$ individuals who have contributed to that success. And, most important, to the cumulative and collaborative impact IGIP has had on so many educators, teachers, and students around the globe. I am proud to have been a part of this amazing journey, and I remain so very proud to commend the IGIP community on all it has achieved, its impact, and on the lively contribution it will make to engineering education and practice going forward from today in different regions of the world.

Today, rather than looking backward, IGIP continues to look forward in its efforts to bring together engineering, pedagogy, and practice—engineering, the theory of and education, and the practice of teaching—to benefit the engineering students and the world’s citizens of tomorrow. IGIP’s full circle of members, working groups, training centers, and partners join together for impact, and its network continues to expand globally. The IGIP curriculum, certification, accreditation, and training initiatives are shared through the IGIP network by its publications and conferences. As accredited by UNESCO, IGIP’s mission principles of work are grounded in the

goal of creating a world informed by history, energized today, and innovated for the future through world-class engineering.

George Mason, USA

Dr. Hans Jürgen Hoyer
Secretary
General International Federation of Engineering
Education Societies (IFEES)
Executive Secretary
Global Engineering Deans Council (GEDC)

Preface

Engineering is a key driver of human development. At present, when the society is dealing with digital transformation, artificial intellect, and various innovative technologies connected with the fourth industrial revolution, the role of engineers in the technological progress is even more significant than ever before. Engineers must have a great variety of competences from the ability to solve technical problems to the ability to work in a team, to forecast ecological and ethical consequences of innovations for moving towards the fifth industrial revolution. One cannot underestimate the professional training of engineers carried out by technical universities and colleges. The capacity of the future engineer to solve challenging problems may have a direct effect on what the future generations will inherit.

No wonder there are a lot of Engineering Education societies and organizations. Among them, IGIP, International Society for Engineering Pedagogy, has earned a high reputation thanks to its fruitful history and unique activities. Its mission is focused on pedagogical training of technical lecturers. Despite a great choice of innovative educational technologies, it is still the lecturer who remains the central figure of the teaching process.

At present, there are a lot of technical universities that train future engineers. But we realize that in many cases, their lecturers do not have any pedagogical education. Some become brilliant teachers; others go the long way of trial and error.

For 50 years IGIP has been developing and promoting the ideas of Engineering Pedagogy as a branch of professional pedagogy. In IGIP there is a tradition to now and then sum up and analyze the results. IGIP has already done it three times: in 1997, in 2001, and in 2015. These results are published in the books “Who is Who” and in the monograph “IGIP. International Society for Engineering Pedagogy. The Past, Present and Future”.

Now on the eve of the 50th anniversary of IGIP, it is also just the time to look back into the past, to show the present, and to try to foresee the future of the Society. Its authors used various sources: the above-mentioned publications, numerous papers published in IGIP Symposia Proceeding, the official journal “Report”, the IGIP Newsletter, the materials sent by IGIP members, recollections of the significant events by their participants, the authors’ own experience, and other sources of information.

The book contains a lot of photos thanks to Yu. Shkitskiy, Istvan Simonics, and other IGIP members and conference participants.

The book encompasses the historical span up from 1972 up to 2022 and is addressed to IGIP members, technical teachers, students, postgraduates and administrators of educational institutions, administrators of national and regional state bodies of education, members of other societies, recruiting agencies, and all of those who are interested in Engineering Pedagogy.

We hope this book will attract new supporters of Engineering Pedagogy and help its new members realize its specificity. We hope the late achievements of the young teaching generation will contribute to the further prosperity of IGIP, increase efficacy, and improve Engineering Education, and maybe sometimes it will be used for preparing the next IGIP book.

The authors would like to extend sincere gratitude to IGIP President Hanno Hortsch; IGIP Past President Teresa Restivo; IGIP First Vice President Axel Zafoschnig; Executive Committee members Pavel Andres, Uriel Cukierman, Eleonore Lickl, Wolfgang Pachatz, Istvan Simonics, Matthias Utesch; former President of the International Monitoring Committee Dana Dobrovska; former Director of Scientific Research Ralph Dreher; former General Secretary Hartmut Weidner; IGIP members Ivana Simonova and Alexander Soloviev for submitting valuable information.

For further information about IGIP—<http://www.igip.org>.

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Chapter 1

The History of IGIP



1.1 A Glance at the History of Engineering Education

It is a well-known fact that the word “engineer” originates from Latin “*ingenium*” meaning “abilities”. Two-three centuries ago it was borrowed by many European languages from Old French “*engigneor*” that at the beginning of the twelfth century denoted “architect, creator of military devices” [1].

Engineering activity differs greatly from that of a scientist. Scientists study laws of nature, and engineers apply knowledge to create practical things that do not exist in nature and which people can use. They are devices, gadgets, materials, methods, and technologies, including computing programs, innovative experiments, new solutions to a problem, or any other improvements in our lives. Every product or construction used by modern society has been touched by an engineer’s hand.

The construction of Egyptian pyramids, the Roman aqueducts or Via Apia, the Great Wall of China, the Hanging Gardens of Babylon would not have been possible without the knowledge and practical skills of ancient civil engineers.

Archeologists have evidence of a very high level of human knowledge embodied in amazing mechanisms centuries ago. One of such artefacts was found not far from a Greek island of Antikythera at the beginning of the twentieth century and is known as “Antikythera mechanism” [2]. It dates back to 50-70 BC. It is a complex of gears that was designed to predict position of the planets and solar and lunar eclipses. The mechanism is considered to be an ancient analog computer. The scientists suppose that the inventor of this device was Archimedes, a mathematician, and an engineer.



Accumulation and transfer of knowledge about the surrounding world are known to have played the key role in the creation and development of our civilization. At the beginning of our civilization valuable technical information was passed over from one generation to the next one. In ancient times a person possessing unique knowledge and practical skills passed it to his pupil (Raffaiele Santi: “The School of Athens” [3]. Aristotle and Alexander the Great are one of the examples. In ancient Greece such an instructor was known as “paidagogos”, or “pedagogue”.

At that time there appeared philosophical schools of Socrates, Aristotle, and Plato. [4]. Thus, in ancient times theoretical studies, practical applications, and teaching were concentrated in one person.

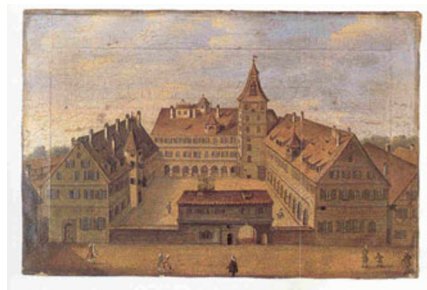
In the Middle Ages, Europe established universities as a scientific and educational institution. Education focused on law, medicine, and theology, the latter being most important and prestigious. By the eleventh century, medieval educators developed scholasticism, a method of research, scholarship, and teaching. But nevertheless, teaching was based on the classical model of the ancients with a master passing on his knowledge to one pupil. Later professors began instructing a larger number of scholars.

At that time there was no opposition between art and technology. For example, waterworks did not only encompass decoration of fountains but also creation of pumping stations to supply water. And an artist had to master the technology of construction. [5]. Leonardo da Vinci being an artist and an engineer at the same time may be the best symbol of this unity. He is more famous for his paintings, but he also

had a vast number of inventions, including hydraulic pumps, a helicopter, a steam cannon, and a parachute.



In the 16th and the seventeenth centuries the first universities incorporated courses for engineers. Among them, the University of Altdorf (*Universität Altdorf*) [6] in Germany and Leyden University (*Universiteit Leiden*) [7] in the Netherlands.



The University of Altdorf was a university located in a small town Nürnberg outside Nuremberg. It was founded in 1578 and received university privileges in 1622.

Leyden University was situated in the city of Leiden. It was founded by Prince William in 1575 as the first Dutch university in the Northern Netherlands. The University educated its students for religious purposes, but it also gave the country and its government educated men in other fields.

In the Middle Ages the universities concentrated on theory, in particular, surveying and fortifications. Practical aspects of technology were passed on to craftsmen.

By mid-seventeenth century, artillery and fortifications had become so complex that armies of different countries began training officers in mathematics and mechanics. In its turn military engineering stimulated the development of civil engineering. In 1775, King Louis XV of France authorized Jean Perronet [8] to set up School of Bridges and Roads (“Ecole des ponts et chaussées”). This institution offered a three-year program for engineers.



In Austria in 1717, Prince Eugene founded a school for military engineers in Vienna which became the Academy of Engineering under Maria Theresia [9] in 1747.

Even civilians were allowed to attend classes alongside military men. One of its most famous civilian graduates was Balthasar Neumann, an engineer and constructor of waterworks—best known for building the palace at Wurzburg (Würzburg Residenz) in Germany [5].

In Russia in 1701, Peter the Great by his Decree founded “The School of mathematics and navigation” [9] («Школа математических и навигацких наук») in Moscow. This event was followed by the opening of the Engineering

School in Moscow (1709), the Engineering School (1713), and the Mining School (1715) in St. Petersburg.

The engineering schools of that time were focused on the development of fundamental theories whereas practical knowledge was always passed on during apprenticeships to the trades.



The inventions of a steam engine with a piston by Thomas Newcomen in 1712 and a steam machine by James Watt in 1781 were among the factors that initiated the Industrial Revolution. The development of specialized steam machines in the eighteenth century led to mass production of goods and demanded mechanical engineers who were able not only design and manufacture machines but could also operate and maintain them.

No wonder industrialization demanded training a great number of specialists. But neither secondary school graduates nor craftsmen were suitable, which resulted in setting up engineering schools in Europe.

In 1794 in France Napoleon Bonaparte replaced Perronet's school with the "Ecole Polytechnique" that hosted the greatest mathematicians and theoretical mechanics of that age, for example Fourier.



The foundation of the "Ecole Polytechnique" in 1794 is usually stated as the birth of formal engineering training. For the first time, students, or cadets, received a high-standard general qualification before continuing with their professional training at specialized institutions of higher education. Those were considered to make a fundamental contribution to industrialization.

Polytechnic Institutes in Prague and Vienna followed in 1806 and 1815, respectively, as well as several engineering schools in other German-speaking countries in the first third of the nineteenth century [5]. It is necessary to mention that the concept and model of teaching in these educational institutions were different from those in the French engineering schools.

In Russia, the nineteenth century is the time of beginning and developing the Engineering Education. The starting point was the foundation of St. Petersburg Institute of Corps of Transportation Engineers (Санкт-Петербургский институт корпуса инженеров путей сообщения) in 1809. It was followed by the opening of Technological Institute in St. Petersburg [10] (1828), Technical School (Техническое училище) in Moscow (1868), Technological Institutes in Kharkov and Tomsk (1868), and Imperial Moscow Engineering School (Императорское Московское инженерное училище) (1896).



In America, as early as 1795, a crude form of military engineering was taught in the town of West Point even before the military academy was set up there. In 1819, West Point began modeling itself on the Polytechnic School (Ecole Polytechnique) of Paris. Rensselaer Polytechnic Institute offered a course of civil engineering by 1828 and the University of Virginia [11] by 1833. Norwich University appeared even earlier. According to L.E.Grayson, all these institutions looked to France for guidance [12].



The polytechnic schools struggled for recognition, and it was necessary for them to emphasize theory and research even more in order to be “scientific” enough in comparison with long-established classical universities. It was, after all, also a question of engineers being allowed to obtain doctorate degrees. And the first PhD in engineering (to be more precise, *applied science and engineering*) was awarded in the United States at Yale University in 1863. By the way, it was the second PhD awarded in Sciences in the USA [13].



As a result, research and theory were becoming more and more important in technical schools which placed them at the forefront of the polytechnic schools. Teaching receded into the background, and a vacuum arose in association with teaching and practical work.

In order to overcome the gap between theoretical and practical training of the engineers, in the second half of the nineteenth century in Europe a new breed of construction and engineering schools were founded that later developed into engineering colleges (Höhere Technische Lehranstalten) and further down the road into universities of applied sciences (Fachhochschulen).

“Fachhochschule” is a University of Applied Sciences in Austria, Germany, Liechtenstein, and Switzerland. In contrast to classical universities historically it was mainly oriented to training specialists possessing practical skills. An educational institution of this type has always related to a certain professional area (e.g. technology or business).

Universities of applied sciences offered a shorter course of studies. Their obvious advantage was that the educational programs involved compulsory practice at the place of future employment. Practical approach at the basis of education prepared students for immediate employment in industry even though the course of studies was shorter.

Educational programs at engineering universities were longer and aimed at training engineers, researchers, and top managers. Importantly, the mastering of basic sciences was stipulated from the start of education.

The higher Engineering Education system in many countries in Europe was modelled on the German system, in which there is a clear difference between vocational and academic higher education.

Nevertheless, even universities of applied sciences also were interested in research and development just like classical academies [5]. Even when introducing new

models of teaching the issues of instruction methods were somewhere in the background. At the beginning of the new millennium, describing this situation Albert Haug wrote [5]:

As in the 19th century, today's university professors view themselves as researchers and often hold teaching in low regard. Excellent researchers are geniuses who are often eminently capable of passing on their knowledge. Professors who dedicate most of their time to teaching are not regarded as proper professors. Even though research and teaching are always mentioned as a common goal, teaching always remains second class. It is not surprising that instruments have been developed to reward the reputation of research, from the Scientific Citation Index to the Nobel Prize. Meanwhile, teaching often vegetates, like an unassuming wallflower. Minor "teaching awards" at regional level do not help much either; they just conceal the true state of affairs.

This brief glance at the history of Engineering Education shows that technical changes in the world forced classical universities to expand and include technology. Europe developed its first Universities 4–5 centuries ago and its first Engineering Schools around the middle of the eighteenth century, thus laying groundwork for an old and deep-rooted tradition.

But in the wake of Engineering Education technical schools drifted mainly towards theory and academic study neglecting to some extent the necessity of excellent and up-to-date teaching.

1.2 The Significance of Technical Teacher Training in Europe in the Second Part of the Twentieth Century

The second part of the twentieth century is characterized by scientific and technological changes in the world: space flights, the use of nuclear energy and new synthetic materials, the creation of computers, introduction of the first microprocessors, etc. These innovations caused intensive growth of scientific and technical information and as a result a great demand for new engineers and technologists. Many new technical educational institutions have been established, such as 1828 Technische Bildungsanstalt Dresden, Germany (today TU Dresden).



Naturally, it led to the increase of the number of students in engineering universities all over the world. For example, in 1985 in the USSR the number of students reached 5.1 million and approximately 40% of them were students of engineering universities [13]. Victor Schutz, past IEEE President described the situation in America of that period in the following way [14]:

The students increased dramatically in numbers and the professors typically «weeded out» 50% or more from the entering class. We offered courses, which were disjointed and separated without any correlation between them. Worse, we told our first and second-year students in the basic, often abstract courses, something like «Trust me...You will need all this eventually....the good stuff comes later...

Unprecedented technological development had a great impact on the system of Engineering Education worldwide and made educators reconsider the value of teaching technical subjects. Technical knowledge had to be transferred to the younger generation most effectively. The level of teaching had to correspond to the level of technology and social development of that period. On the one hand, the mastering of discipline knowledge should be based on relevant scientific knowledge in this discipline, and, on the other hand, the teacher needed to translate this information for students in the most effective manner. Besides the progress in technology gave a variety of tools which could be used in the classrooms.

At last, as never before, the attention was drawn to the process of teaching. The second part of the twentieth century saw the birth of higher education pedagogy [15]. Pedagogy is the study of teaching methods, including the aims of education and the ways in which such goals may be achieved. The field relies heavily on educational psychology, or theories about the way in which learning takes place [16].

But pedagogical works were too far from thousands of engineers who taught technical subjects at engineering universities all over the world. An engineering educator should not only own scientific information, but also should know the best way to lead a student to its assimilation. To develop a proper system and methods of teaching it is necessary to conduct relevant research. However, because of the daily teaching load the teachers of technical subjects had no time for such research.

The concept of pedagogy for engineers had been around for quite a while, but very little had been done with it. The first attempts are considered to have been undertaken in the second part of the twentieth century.



In one of his articles Adolf Melezinek (1932–2015) writes that in the 1950s in Europe there were three centers dealing with pedagogical education of engineers which were worth mentioning [17]. They were Dresden Engineering Pedagogical School, Prague Engineering Pedagogical School and Klagenfurt School of Engineering Pedagogy (die Klagenfurter Ingenieurpädagogische Schule) [18].

The creation of Dresden Engineering Pedagogical School coincides with the foundation of the Institute of Engineering Pedagogy in the Technical University in Dresden (Technischen Universität Dresden) in November 1951 [19]. Professor Hans Lohman was the first Director of the Institute. Later in 1963, Prof. Lichtenecker was appointed to this position.

The development of Prague Engineering Pedagogical School dates back to the 1960s. It was represented by the Institutes in Prague, Brno, Olomouc, Bratislava, and Kosice. The birth of the Prague School is connected with the opening of Engineering Pedagogy School in 1961. The coordination of pedagogical studies in engineering universities of Czechoslovakia was carried out by associate professor Jiri Mericka who was the Head of the Institute of Engineering Studies of the Technical University of Prague. In 1991 this institute was incorporated in Masaryk Institute. The head of this institute was associate professor Dana Dobrovska. Professor Driensky and later associate professor Roman Hrmo represent the school of Engineering Pedagogy being developed in Technological University of Bratislava.

Klagenfurt School of Engineering Pedagogy relates to the University of Klagenfurt (Alpen-Adria-Universität Klagenfurt, AAU). In the 1960s teachers and the process of training were in the center of heated discussions. Many specialists hoped that technical tools of teaching especially the so-called “teaching machines” could improve the situation. Educational institutions were planned to be opened in Paderborn, Wiesbaden, Klagenfurt, and Aarau.

The only educational institution at the university level was founded in Klagenfurt. The goal of the the Department of Educational Technology that was established at the University of Klagenfurt in 1970, was to train teachers for secondary schools, technical colleges, Universities of Applied Sciences (Fachhochschulen) and Universities. At the same time, the Department of Educational Technology was supposed to provide a home for pedagogical research. It was an excellent idea, and it really was the answer to the situation at the time.



In 1971, Adolf Melezinek was appointed the Head of the Educational Technology Department of the University of Klagenfurt. It was not possible to make a better choice. By that time A. Melezinek had gained important professional experience and combined competences of an engineer and an educator and was devoted to the theory of education.

As Dipl.-Ing. Hartmut Weidner, IGIP Secretary General from the time of IGIP foundation in 1972 until his retirement in 2003, said in his speech at the Award Ceremony at the 41st Conference in Villach,

Adolf Melezinek had a very exciting life. He was born in Vienna in 1932, and when he was 12 his family moved to Prague. There, he started an apprenticeship as a radio mechanic, but soon he moved to Higher Technical College for Telecommunications and later continued his studies at the Technical University in Prague. There he completed the course in Electrical Engineering and was awarded the degree of Graduate Engineer (Diplomingenieur). In his next career step, which, no doubt, has decisively shaped his life, he studied pedagogy and psychology and completed his study program with the degree of PhD in this field.



During those studies, Melezinek regularly dealt with the methodology of teaching technology and of engineering, and he consequently wrote his doctoral thesis “The theory and teaching methods of communication engineering” (“Strukturtheorie und Lehre der Nachrichtentechnik”) about newly developed area of engineering education theory.

In his academic career, Adolf Melezinek has always pursued a very varied pathway. He has worked as a research assistant, as a teacher at a vocational school, as a professor at a Technical College, as a university assistant. In 1970 he was invited to lecture on Engineering Pedagogy at the Karlsruhe Institute of Technology (KIT- Karlsruher Institut für Technologie) and spent a year there.

As the Head of Educational Technologies at Klagenfurt University, Adolf Melezinek formed a creative team of interdisciplinary experts. He was instrumental in providing the young university with advanced equipment and introduced new contemporary technologies of teaching. The faculty work was held in high regard by their peers. Klagenfurt University thus became a pilot project and a demonstration object that drew a lot of international attention because of its teaching equipment. He managed to combine the development of theory and practice of teaching.

As he saw it, the theory of Engineering Pedagogy was developing taking in account various trends. By his own account, the Klagenfurt School of Engineering Pedagogy approach developed by A. Melezinek is based on the “philosophic-humanistic approach” but also incorporates the “cybernetic approach” based on the information theory, which allows for quantitative measurements and the system of controlled feedback under the special conditions of teaching technical subjects [20].

In concurrence with the ideas of the Klagenfurt School, Engineering Pedagogy is viewed as both “a science and an art”. It tries to connect the science of education with the art of teaching. The educational process should be scientific—a sensible algorithm should be created for the activity of teaching—but we should not lose sight of the person and their art, which inspire teaching and give it creative impulses. The art of teaching should be brought to bear the foundations of a science on the effects of learning processes [21].

A. Melezinek defined the subject of Engineering Pedagogy as scientific investigation and practical realization of the objectives and contents of technical subjects as well as the process in which the subject matter is transformed into knowledge for the addressees with the help of certain media and instructional methods within a sociocultural environment [20].

Establishing the fundamentals of Engineering Pedagogy was a step forward at that time, as engineering and pedagogy had never been linked before on a scientific level. As Albert Haug recollects [5],

The various disciplines of educational sciences, such as pedagogy, sociology and curriculum theory were enriched by a new and unusual subject, namely educational technology, and new media, influenced by the idea of teaching machines. A qualified communications engineer who had become involved in teaching and training quite by chance was one of its founding professors.

He was given quite a breathtaking laboratory at the time, and he invited engineers to work with him. The professor was called Melezinek and one of his engineers, another communications engineer, Weidner. Whenever something new is set up, it often relies on a small number of enthusiasts to see the idea through.

But Melezinek was a true engineer and had enough experience teaching technology to exploit such an auspicious situation. Teaching technology was very important to him. He knew and felt that this had to be done by insiders, by engineers who were familiar with the technology and who had mastered its language. At the same time, this group had to adopt the principles of pedagogical disciplines and apply them to technological subjects on the one hand and to encourage the use of new technical teaching aids and make these available to pedagogy on the other.

