CONNECTION BETWEEN EDUCATION AND INDUSTRY

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Men of Vas County created the highest level of technical culture more than 110 years ago. They managed to do this by the mastery of theoretical and practical knowledge. The hydroelectric power plant in Ikervár could not have been established at that time and at that place if there had not been teachers such as Dr. Adolf Kunc and Dr. Sebő Edelmann, and students such as the Gothard brothers. Examining the teacher-student relationship we can see that Adolf Kunc was Dr. Ányos Jedlik's student. The next significant starting point could be the Benedictine Secondary Grammar School in Győr where Jedlik and Edelmann studied. The dissertation will present how the intellectual and empirical knowledge that accumulated through generations appears in a certain region and in practical life, and how it becomes cultural and intellectual wealth. Also nowadays, introducing new and highly developed technologies could be successful only if there is adequate receptivity and we can add more values to this. If we realize that true values can be created only this way than we can exploit our human resources more effectively.

Preamble

It was 1896 when the hydro-electric power plant was put into operation in Hungary – and it still produces electricity. The construction started in autumn 1895, but the elaboration of the concepts and the plans had to be started much earlier than that. Such a power plant was one of the first in its kind in Europe, but it was the very first technical scheme of this kind in Greater Hungary. At the end of the 19^{th} Century a pressing question was how craftsmen working in small and medium-sized industry might obtain power sources necessary for their work. One of the possible solutions was employing manpower but, as this was becoming more and more expensive, it was not an appropriate source of power in the manufacturing of competitive, cheaper goods. Steam-powered machinery, which still flourished in this period, could only be used economically when high outputs were in prospect. And combustion engines were not mature enough technically to operate safely, steadily and economically. It is plain to see that electricity appeared to be appropriate to eliminate the above-mentioned problems as a secondary energy carrier in industry. This is reinforced by the following quotation, from proceedings at the 26^{th} Ambulatory Conference of Doctors and Nature Observers in Brasow. "*In the major cities, the main reason for the unfortunate struggle of small and medium-enterprise craftsmen is the very fact that they employ an expensive work force – manpower – and thus they are unable to keep up with large factories which apply steam-driven machines."* (*EDELMANN*, 1892).

In spite of that, local districts intended to use electricity mostly for public and private lighting. Candles, paraffin and gas that had been used for both public and private lighting involved several basic problems. Mainly in enclosed spaces, the smoke, grime and other exhaust materials emitted by paraffin and gas lighting equipment polluted the air of the room, and blackened the walls, the paintings and the furniture. Not least, electric lighting was preferable to the above-mentioned fuels from the point of view of fire safety. Kovács Pál began his report on a journey to Italy in the Bulletin of the Hungarian Engineers' and Architects' Association as follows. "*During my journey I found that nowhere else on the Continent is electric lighting as widespread as in Italy.*" Let us consider the reason for that. Italy did not possess any coking coal so they bought the fossil coal required for producing gas from England; but this import increased the cost of gas production. The waste material that had remained from gas production was not marketable. Apart from the economically relevant factor, there were others such as the nocturnal lifestyle typical of the southern areas, and also the heat that came from other means of lighting, which made staying in enclosed spaces virtually impossible in the summer months.

Of course, every new technology from which society benefits and which satisfies real needs must be recognized and, even more importantly, it must be accepted by members of the society. This recognition and acceptance has never been straightforward, and may not be even today; it seems generally hard – sometimes too hard – for societies to accept a new technology and its practical use. This reaction tends to be greater in those societies where the technical culture is at its most basic.

The plight of electrification in Hungary at the turn of century

In the period under review, those settlements engaged in electrification insisted on having their own, so-called communal power stations built, or at least an electric power-house built and operated by an entrepreneur within the settlement; then the settlement paid a certain yearly fee for public lighting. These generator plants were set up within smaller consumer districts, and their networks only generated and supplied the amount of electricity needed in each particular district. This stage can be called the first period of development. The second stage in Hungary started around the mid-twenties, when the task of a generator plant was not merely to supply a single settlement but also the surrounding towns and villages by means of span-wires. The third stage, that is, the construction of the so-called high-voltage networks, started in the thirties. This third stage has been going on still today, facilitating the economical provision of electricity to those parts of the country where no other primary energy sources are available locally. Thus, the construction and implementation of the power plant and the electric supply-main of Ikervár was nearly thirty years ahead of the national average.

Electricity supply in Hungary, in 1925, was in transition: halfway between the first and the second stages. In that year, out of the 211 operating generator plants in common and partly common use there were 26 plants that approached the characteristics of trunk-plants, which were capable of supplying a larger area than just one town or village (*STRAUB,* 1925).

Of their nature, rural power-plants mostly do not have management proper to a commercial enterprise; their relative operating costs are higher than those of larger plants and their useful production is significantly lower.

Regarding ownership, we can state that in the first period, and mainly at its beginning, there were almost exclusively communal plants. At the beginning of the second period, shareholding companies were given a leading role. The communal plants generated direct current while the shareholding companies and the power-plants owned by institutions supplied firstly alternating current and later three-phase current.

The power plant and the electricity supply-main of Ikervár were ahead of their time in regard to their form of ownership, as the founders established themselves as the Vasvármegyei Elektromos Művek Részvénytársaság (Electric Works of Vas County Shareholding Company). The necessity of forming a shareholding company is partly due to the high cost price, which was 1,600,000 Austrian Forints. Since investors were only willing to buy shares if they could see their investments return, the plans had to be drawn up in such a manner that the scheme was profitable for the investors and economical for the consumers.

The reason why the Ikervár power-plant generated direct current ten years after the transformer was invented is very simple: there was not enough domestic capital for the construction of the power-plant and power transmission, so foreign capital was needed as well. The Swiss financial group (Kauffmann Banking House Basel, Cheneviere Banking House Geneva, Galopin Banking House Geneva, Davel Banking House Geneva, Georgeo Ormand Banking House Geneva) agreed to support the shareholding company only on condition that the mechanical and electrical equipment of the power-plant were ordered from the "Cie de l'Industrie Electrique et Mécanique Geneve" (Thury) factory and the "Escher Wyss" factory in Zurich, Switzerland (*VaML CT* 198). Consequently, the domestic industry had to be excluded and this mainly concerned the Ganz factory.

The constructors of the electrical works

It has been mentioned that, in those early days, ordinary people were slow to understand that it was not necessary to build a power-house within the administrative boundaries of the settlement. This misapprehension was perfectly exemplified by the town-council and inhabitants of Kőszeg when they were offered the opportunity to connect the town to the electricity network by extending the Szombathely main line. It reads in the weekly paper named *Kőszeg és Vidéke* (Kőszeg and Its Surroundings) in its issue of 21 October 1894, in the article entitled *Electric Lighting*. "*…the offer requires at least 15 thousand Forints for 1000 glowing flames at 15 Forints each, for the planned introduction of electric lighting. And what else can we see? We can see that apart from this huge yearly cost, we will have to face the great distance of the Ikervár hydro-electric plant, which is not under our control any more, and the long distance wire connected to it, which we will probably have to share with many others*." In Kőszeg, electric lighting only started on 13 July 1907, that is, after more than ten years. When we consider the industrial development of Kőszeg, these ten years were really significant, because the industrial facilities established in the county were located in other towns and villages, such as Szentgotthárd, Körmend and Szombathely. Thus, the inhabitants' acceptance, and their cultural and social understanding, have a decisive influence on the economy and standard of living in a particular region and settlement.

Let us see who those people were, and what they did, who took the first steps to counteract the backwardness of Hungarian society at that time.

Among the pioneers we find Dr. Edelmann Sebő, high school senior master, and Gothard Jenő, Mechanical Engineer, physicist, astronomer, and correspondent member of MTA (the Hungarian Academy of Science). In the organisational tasks, Gothard Jenő's brother, Sándor played an important part as well: he lent his knowledge of law and economics to the furtherance of the project. These three people were the ones who really believed that the project was feasible and who knew whom to commission to do the specific planning and implementation jobs.

In the summer of 1880, Szombathely became the centre of scientific interest in the country. Between 21 and 28 August, the period's most outstanding Hungarian natural scientists attended the 21st Assembly of the Association of Hungarian Doctors and Nature Researchers. *Figure 1.* Within the framework of this assembly, Foucault's pendulum experiment was repeated. Kunc Adolf and the Gothard brothers performed the experiment in a way that "*their great proficiency, keenness and expenditures brought complete success*" (*SZABÓ*, 1891). Also at this assembly, Kunc and Gothard demonstrated a telephone conversation between Szombathely and Herény (*BERTALANFFY*, 1880). These experiments were seen among others by Jedlik Ányos, who gave a presentation at the Assembly on the importance of educational aids in the teaching of natural sciences (*JEDLIK*, 1880).

This brief introduction was necessary to an examination of the link between education and industry, since Jedlik, Kunc, Edelmann and the Gothard brothers make up a three-generation chain not only on the basis of their ages but also of the evolution of their scientific knowledge.

Jedlik Ányos was born in Szímő on 11 January 1800 and was baptized István. In 1819 he completed the first year of the philosophy course, called *Logica*, in the local Lyceum of the Benedictine order in Győr, and in 1820 he completed the second year called *Physica* (*JEDLIK*, 1885). He listed the names of his tutors in his autobiographical pieces. For Jedlik, perhaps Czinár Mór meant the most. He taught him physics and he might have inspired him to become a physicist himself. Czinár began a thorough development of the stock-room of educational aids. Presumably, Jedlik helped with the stock-room jobs. In 1823 in Győr, in the third year of high-school training, he was employed as a teacher. Between 1826 and 1831 in the local Lyceum of the Benedictine order in Győr, he taught the order's students the subjects: Nature, Nature Studies, and Field Farming. His favourite subject was Physics, which is proved by the fact that he continued developing the stock-room. In the inventory that he compiled in 1831, he listed the devices that he had bought and made for the teaching of electro-technology, but he also made good the shortage in other areas. Whenever possible, he retained the services of local craftsmen. He had always been devoted to experimental teaching and he clearly saw that it was impossible to teach effectively about items of which the learners had no experience. In 1829 he collected the reports of his experiments in a notebook, where he also recorded a summary of his lectures. Even at that time, his exceptional technical and engineering talents showed. His discovery of constant electrical spinning and the electric motor date back to this period.

Returning to the planners of the hydro-electric plant, we must review some phases of Edelmann Sebő's life, which are relevant to the subject.

Edelmann Sebő was born in Győr, on 21 July 1851. He completed the first seven years of high school in the former school of Jedlik and Czuczor, that is, the Benedictine High School in Győr. The stock-room for natural studies was probably well-equipped at the time, which is perhaps the reason why he attached such importance to the development of such a stock-room in Szombathely, where he was a teacher. So, the first common point is the Benedictine High School in Győr, where Jedlik and Edelmann gained enough inspiration for a lifetime, in which natural sciences played a significant role.

Jedlik was appointed to membership of the Physics Department within the Faculty of Arts at the University of Pest on 2 November 1839, where he worked from 1 March 1840 to 1878. There, at the university, was the second common point. Kunc Adolf was born on 18 December 1841 in the village of Sál in Vas County. He completed the lower secondary-school classes in Keszthely, and the upper ones in Szombathely. He started his teaching career in Szombathely, in the Premonstratensian High School in the 1863/64 academic year, as a substitute teacher. His superior sent him to the University of Pest to obtain a teacher's degree and Master of Arts degree. Kunc spent one year at the Faculty of Arts. Among his teachers was Jedlik Ányos, Professor of Physics at the University, who taught him chemical studies and electricity (*HORVÁTH-MOLNÁR*, 2002). Kunc is likely to have been one of Jedlik's favourite students: this is shown by the words he wrote by his own hand in Kunc Adolf's assessment: "*He has made his studies with excellent diligence and progress; he has been most diligent in the completion of the training*." This is considered a remarkable mention from Jedlik Ányos, a professor whose demands were rather strict (*TURÁN*, é.n.).

Kunc's teaching activity took place during the technical and industrial boom in Hungary. In his scientific work, Kunc applied the methods of "experimentation", the "right perception of facts" and the "reflection" on these facts, and these are what he had passed on to his learners and followers. Here is what he said about this approach: "*When following the path beaten by the geniuses of the past, reflection combined with experimentation will surely answer our questions*." (*EDELMANN*, 1871). From the year 1874 until 1884 he was the Headmaster of the Royal Main High School of Szombathely. It was during this period that Edelmann entered the High School as a Premonstratensian Priest. In the academic year 1881/82, he attended Eötvös Loránd university lectures at the Hungarian Royal University in Pest and, as a special student, he attended the lectures of König Gyula and his collaborators at the József Technical University in the same period. From our point of view it is important to mention that he was an active participant on Szombathely's examining board for stokers and operators. He fulfilled this commission until his retirement in 1907 and took it so seriously that he even wrote a manual for examinees (*KOVÁCS*, 2002). This work of his shows that practical knowledge, that is, the education of those working in industry, was important for him and he was ready to do something for this cause.

The Gothard brothers attended the High School in this period as well. Jenő was born on 31 May 1857, and Sándor on 6 February 1859, in Herény. Their grandfather, Ferenc, was engaged in trying physical and electro-technical experiments between 1780 and 1831, and he also prepared physical devices himself. There is evidence of the family-related inspiration in the following recollection: "…*Jenő's father: Gothard István spoke a lot about these old experiments to his eldest son, thus arousing his interest in* *physics at a young age…*" (*HARKÁNYI*, 1909). Gothard Jenő himself mentioned such a device: "*As a curiosity, I must mention the very first piece of the collection that we started the physical experiments with 12 years ago, which is a 100-year-old cylinder electric-charging machine…*" (*GOTHARD*, 1882).

This family-based inspiration was complemented by the attitude of the Premonstratensian High that the brothers attended, where Kunc Adolf was a teacher of theirs. Kunc's personality had a great effect on both boys. After his school-leaving examinations in 1875, Jenő continued his studies at the Technical College of Vienna, and Sándor, who took his school-leaving exams a year later, went on first to the University of Law in Budapest and then in Vienna – despite his interest in natural science.

Having finished their higher learning, the boys returned to Herény, where they set up an experimental laboratory and precision-mechanical workshop named "Herényi Műcsarnok" (Herény's Gallery). Their first success was manifest at the National Industrial Exhibition in Székesfehérvár, which was organized in May-June 1879. It was there that they met Konkoly Thege Miklós. (*TÓTH*, 1993.)

Teachers and learners

In 1877, the High School "*was given the greatest scientific invention of the 19th century, the telephone*". The experiments were executed by Dr. Kunc Adolf, the High School's director, Edelmann Sebő, Premonstratensian teacher and two students, Gothárd Jenő and Sándor (*MESTERHÁZY*, 1983.). The first practical successes came at the beginning of the 1880s. On 18 April 1880, they succeeded in making a telephone connection between Szombathely and Kőszeg. At the Szombathely end of the line were Kunc Adolf and Gothard Jenő, while in Kőszeg there were Edelmann Sebő and Gothard Sándor (*VASMEGYEI KÖZLÖNY*, 1880).

After the successful experiment, Kunc and Gothard established a permanent telephone connection between the High School and Herény's Gallery. Next, they tried to establish a long-distance connection, which they managed to do in the summer of 1881, between Herény and Ógyalla. The approximately 175 km distance was no obstacle to their success.

In 1884, there was a vacancy in the provost's position in Csorna, and Dr. Kunc Adolf was nominated by the members of the order for the post of superior. From that moment, Kunc and the Gothard brothers could keep in touch by telephone as well.

After the favourable results of light-current electro-technical experiments the trio stayed in Szombathely and turned to heavy-current electro-technology; however, astronomy remained the priority. During the next almost one and a half decades, Gothard Jenő did internationally recognized work in the fields of astrophysics and astronomical apparatus-technology.

In the observatory in Herény, there had been electric lighting since 1889, for which he had designed its own small steam power plant and a hydro-electric plant on the river Gyöngyös, thus providing the castle, the observatory and the farm with electricity. He made use of the local generator in combination with a battery-system. The battery-system consisted of 28 Schenek-Farbaky-type accumulators, with a capacity of 150Ah (*ETZ*, 1892). This local power-plant might later have played an important part in the construction of the large one, as it was functioning as kind of a model, providing the experience that was necessary to prepare the county's effective leaders and end-users for the acceptance of the new technology.

From the '90s onwards, electricity played a role at a number of events; it was almost always there to add to the solemnity, just as it did at the Coronation Jubilee in 1892. "*Kámoni Street was a marvellous sight right from Széchenyi Square. The street side of the Hagel-house and the building of the Seminarium were illuminated, commanding our attention. The building of the Lyceum was electrically illuminated by teacher Dr. Edelmann Sebő. In one window of the Lyceum there was an electric reflector, casting its rays of light far away and lighting up parts of Széchenyi Square just as if it had been daytime*." (*VASMEGYEI LAPOK*, 1892).

Observations

Many times we think that the introduction of a new technology or the formation of a new branch of industry is almost a series of coincidences, or at least the consequence of spontaneous processes. With the above-mentioned example, I wish to demonstrate that the introduction of a new technology at a given location requires both a theoretical preparedness dating back several generations, and practical experience as well – as well as very hard work.

The plans of the power-plant that has been referred to were prepared by 1895, but that is also the year when Jedlik died. Jedlik had nothing directly to do with this power-plant, but indirectly he had a lot to do with it. And a similarly important factor was the schools, starting with the Benedictine High School of Győr, where Mr. Czinár, a teacher, began the deliberate expansion of the natural sciences stock-room, which activity was continued by Jedlik, Kunc and Edelmann. This expansion was complete in the period of the third generation, and it culminated in the construction of the power-plant.

Though Jedlik was a physicist, he enriched electro-technology with so many of his inventions that we can deservedly call him an electro-technologist; what is more, the first Hungarian electro-technologist. His theoretical preparedness was outstanding, and he had a very good technical and engineering talent in addition. It is unfortunate that he never published the theoretical descriptions of his two greatest inventions, the electric motor and the dynamo, so according to the global history of technology these two instruments are not considered to be his inventions, even though it was the dynamo-machine that made the further exploitation of electricity possible, both in the field of electrical power and lighting. Consequently, light-current electro-technology started to develop first and applications were designed like the telegraph and the telephone, because these were relatively easy to supply with the batteries existing at the time. The first really spectacular application of the electric motor was the vehicular tramway car. The first miniature electric engine was introduced by Siemens at the Industrial Exhibition in Berlin in 1879.

The teaching activity of his student, Kunc Adolf, coincided with a period marked by a new technical environment. Electro-technology, stepping out of experimental laboratories and workshops, received a more and more practical attention because, with the existence of electric motors and dynamos, the first industrial applications were made possible.

In the era of the third generation – the period of Edelmann and the Gothard brothers – electro-technology was perfected, but this perfection had to be recognized. The mosaic pieces written down in the form of laws by natural sciences had to be put together, the ways of their practical realization had to be discovered, in order to build the technology that would raise the quality of life of each person in society. Like monks who had taken vows, the teachers Jedlik, Kunc and Edelmann also contributed a human-centered approach to their technical creations. They never tried to push technology and science beyond the limits of human spirituality and moral responsibility.

Today's societies are living in an accelerated world where – as we think – we can implement anything, anywhere immediately. But we must see that, in order to create something permanent and valuable, the common efforts of several generations are required, because no activity – including industrial work or even the introduction of a new major in an educational institution – can be built without a foundation. No new technology can be implemented as a so-called "green-field" investment in an area where the appropriate intellectual background and the right working culture have not been formed.

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