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SELECTED CASES OF UNIVERSITY R&D

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Abstract

In the ten selected cases of university R&D, the authors wanted to show the diversity of TUB's innovative profile and the specific features of different university R&D actions. 1. The SGA-7N telecommunication equipment is an example of the so-called "soft instrument concept", which means that a relatively simple general purpose hardware is applied and the actual measurement tasks are realised in software. 2. The correction of colour deficiency is possible with medical glasses developed by TUB professors. 3. The development of two medicines, of which the second one brought international success and profit for Hungary is presented. 4. The new types of modified polyolefins, which were developed in a TUB department, are now used in industry. 5. The new laser brazing technology of aluminium will probably open new perspectives mainly in the market of vehicle industry. 6. The Boron Neutron Capture Therapy (BNCT) is an internationally acknowledged and supported research project in the treatment and research of cancer. 7. Neutron activation analysis can determine the chemical composition of materials, here the origin of archaeological ceramics is the focus. 8. Design guidelines and dimensioning software were developed for thin-walled steel profiles; an innovation for the construction industry. 9. The laboratory of the department of physical chemistry has become internationally recognised for researches on intelligent soft materials. 10. A "classic" innovation closes this issue: modular driver seat family jointly developed by "professors" and company experts.

Keywords: R&D, innovation, engineering, signalling equipment, colour deficiency, pharmaceutical development, polyolefins, aluminium technology, cancer treatment, archaeology, thin-walled construction, intelligent materials, vehicle seat development

1. DESIGN AND REALISATION OF THE SIGNALING MEASUREMENT SYSTEM SGA-7N

1.1. The Research Topic and a Short Introduction of the Department

The SGA (Signal Generator and Analyser) projects are high-tech developments in the field of digital signal processing, resulting in successful applications in the telecommunication industry. An important feature of the projects is the continuous software development since 1992. This is a good example of the so-called 'soft instrument concept', which means that a relatively simple general purpose hardware is applied and the actual measurement tasks are realised in software providing

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features based on frequent consultations with the customers in the course of the whole development cycle.

After the stand alone signaling test instruments SGA-2 and SGA-7w, the signaling measurement system SGA-7N was developed. This has first been deployed at Westel, a Hungarian GSM company. The development was managed by Péter TATAI. The SGA-7N system is used for the monitoring of trunks between mobile switches all over the country. At present it analyses as much as 10 million calls per day. A key element of the success was the efficient and enthusiastic development team. There exist a few other similar systems in the world; e.g. the Hungarian Telecom Company decided to purchase a Danish system.

The department of telecommunications and telematics hosting this research has a more favourable age profile than the University average. It is an internal condition not to employ anybody without a PhD (this degree can be obtained at the age of about 27). The number of employees in positions paid by the State is 29 and a further 14 people work with contract (under the conditions of civil servants) financed from the department's own income.

1.2. Background and Characteristics of the Research

The department (and its predecessor) under the direction of Dr. Géza GORDOS deals with the development of telecommunication test systems since the mid 70's. Dr. Géza GORDOS has always endeavoured to have colleagues at the department with experiences from the industry as well; this was the reason why Péter TATAI joined the department. He had been working for the industry at the Research Institute for Telecommunications for 20 years. He ensured the continuity in the SGA research projects, which can be considered a combination of applied research and experimental development.

In the early 90's telecommunication technology and services were underdeveloped in Hungary. At that time the department contributed to the birth of the Act on Telecommunication by providing expert consulting, and it took active part in the long range (e.g. high-speed networks) and short term R&D. Moreover, the department followed the continuous and often rapid progress in the field of telecommunications, providing a solid technical basis, particularly when special Hungarian knowledge was needed (e.g. in the case of communications between the conventional and the new digital telephone exchanges).

Around the end of the 80's, an excellent team was formed at the department, and a successful test instrument (EP-2) was developed for Elektronika Co. This instrument is being marketed world-wide today, under the PCM-40 name by Wandel and Goltermann Ltd., a leading German telecommunication instrument manufacturer company. As compared with the former conventional testers weighing approximately 25 kilograms, the new instrument was merely 2.5 kg, and it could measure all the important transmission parameters of telephone channels. The instrument was not patented because the new ideas would have been complicated

to protect, and their copying would require a lot of investment by the competitors anyway.

The history of SGA development was published in the [Research News] of TUB. In fact there are much less articles published about this research than on for example automatic speech recognition, another research topic of the department; the latter one is a more fruitful subject for publication. It should be noted that the researchers of the department often publish articles in the journals 'Magyar Távközlés' and 'Híradástechnika'.

The development of the SGA-7N system has only been one step lasting about 2 years during the decade long innovation process. It was based on former systems (the first one was made in 1992), and the development has been continuous since then. The project was started by 3 persons, and at any time, 5–10 people was the maximum number of researchers on this topic.

At the beginning the hardware was assembled at the department. Nowadays the manufacturing is organised by Euro-Triasz Ltd., because the production volume significantly increased. Currently, the R&D work is focused on realising new features and services for the SGA-7N monitoring system. Development of a protocol system has also started.

1.3. Copyrights and Financing

Copyrights of the developed SGA-7N system have not been sold to the customers. The Westel company ordered the system and the department delivered it. Its cost was roughly HUF 71 million (35 million for 2-year software development, 6 million for the Oracle database and 30 million for the initial hardware).[2]

Between 1991–99, the income of the department from contracts on SGA projects was about HUF 73 million. In order to increase research capacity, external software developers have also been employed. Euro-Triasz Ltd., which realises sufficient profit from this project, owns the manufacturing rights and the department obtains royalties from the sales.

1.4. Essential Problems of R&D

Product development can be realised in two ways: (i) establishment of a company for the new ideas; this could have been done for SGA-7N, or (ii) outsourcing the manufacturing of the basic instrument and concentrating on applications. The latter option was chosen by the department.

The following problems have been encountered during the R&D processes:

- At present the amount of works exceeds the department capacities: increasing the number of positions financed by the state has not been allowed since 1995.

[2] HUF 71 million is approximately US$ 230 thousand at the exchange rate in 2000 (the editor).

- The University considers contracts one-by-one, and after the expiration of a contract no money can be reserved for future research. This has also been the case in the SGA projects. In addition, the University does not allow payments in advance even in the case of concluded contracts, although it was allowed some years ago. As a result, the continuous financing within a research topic is hardly possible.
- Income of the department from industrial contracts can be spent only through the public procurement process, even if there are much faster and cheaper possibilities.
- The use of office and laboratory rooms is not optimal. Some 'buffer' space, which could be rented by the working teams of the departments, would be necessary. Such demand emerged during the SGA projects as well.

The importance of establishing strategic rather than conventional industrial relations in R&D should be underlined. In the case of conventional relations, the industrial partner specifies the parameters and the deadline, the department then designs and realises a product and finally the settlement of accounts comes. Of course, such contracts are very important, however, in strategic relations the partners evaluate each other in the long run and such interactions often result in new achievements.

The immediate publications are not typical in R&D. The closer the practical application, the more reluctant the companies become in offering their consent to publication initiatives by the University.

The SGA-7N project can be considered very successful, the industrial customers have been satisfied with the work of the department and they demand further similar applied research and development in the future.

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2. CORRECTION OF COLOUR DEFICIENCY WITH GLASSES

2.1. Birth of the Invention

Colour deficiency, as an inherited genetic disease, had seemed immedicable before. People, who had colour deficiency, could not choose about a hundred professions,

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they could not be architects, carpet-weavers, dental technicians, dentists, designers, photographers, airline captains, house-decorators, hairdressers, etc. They could not (and still cannot) obtain professional driving licence either.

Two professors at the Technical University of Budapest (BUTE), dr. Klára WENZEL and dr. György ÁBRAHÁM (Department of Precision Engineering and Optics at the Faculty for Mechanical Engineering) found the solution after 12 years of research. The invention was unique and original.

According to the new theory, the reason for colour deficiency is not that the sensitivity of one of the receptors decreases, but that the receptor is sensible to another colour range than a receptor with normal colour vision. The professors elaborated the mathematical model of colour deficiency. They constructed glasses with colour filter lenses that can correct colour deficiency. With the use of thin layer technology, the glass lenses are covered with very thin layers of chemicals, which let some ranges of light through the lens, while others are reflected. Number, material and thickness of the layers are determined by the sensitivity of the three colour receptors of the retina. The filter is designed with the help of computer and the glasses are covered with vacuum evaporation technology. The filter can be put on eyeglasses, sunglasses and contact lenses as well.

Certainly, an instrument that can precisely measure the range of colour deficiency also had to be constructed. The instrument designed by the inventors is very precise in measuring colour blindness. Colour deficiency was classified in different categories, similar to dioptry. This way, about 30 different glasses can provide solution for the different colour deficiency problems.

An American-Hungarian optician, János SZAPPANOS jointed the inventors and helped in the manufacture of 50 different glasses that were tried with 600 patients.

The results were rather convincing. Improvement in less serious cases was 100% and the average improvement in vision was about 80%. Even the colour-blind patients reported 50–60% of improvement. The inventors started the procedure of patenting after the promising experimental results.

2.2. Patents

The inventor engineers could find Hungarian supporters very fast – quite differently from the long patent procedures of some other Hungarian inventions. The first support came from the secretary of the Hungarian Patent Office: for the international patenting procedure, which cost HUF 14 million (about US$ 46 000), the inventors received 70% interest free loan, and they had to provide only the missing 30%. Out of the Hungarian patent attorneys, they chose the Gödölle–Mészáros–Kékes–Szabó International Office. The office helped in patenting the invention in the most important countries of the world. The glasses were patented in 1993 in the member countries of PCT, an international patenting committee, whereas the instrument was registered in 1995. There are some important countries, which are not PCT

members, so patenting had to be done separately in some countries. In the USA, Japan and the Newly Industrialised Countries patenting was an individual procedure. Today, the patent is protected in 20 countries, which is quite a few. Certainly, the borrowers, i.e. the patent owners must pay the HUF 14 million (US$ 46 000) loan back, after utilisation.

The university professor patent owners immediately started to look after the possibilities of utilisation. They used every international forum to make their invention known and to find investors for mass production. The international fame was the result of the active role played by the investors at different exhibitions and other displays. Having negotiated with many large international companies, finally an agreement was concluded with the First Hungary Fund.

2.3. The Invention in Production

As early as the experimental stage, the inventors needed manufacturers, which were able to engineer the required colour filters and instruments. Experimental production was not easy, as manufacturing of the colour filter required high technology unavailable at Hungarian companies. Accidentally, the inventors met Mr. SZAPPANOS, who did already help many Hungarian companies by providing different instruments. He arranged the manufacturing of the requested filters in the USA, even before he was aware of the actual purpose. Later, this fact was the reason for involving him as patent owner. After the Hungarian Optical Works (abbreviated as MOM) fell apart, other Hungarian companies with optical profile were commissioned with the manufacture of glasses. Cooperative manufacturing was not really smooth. As machines and instruments were obsolete in these companies, there were many quality problems in manufacturing. As a consequence, only 7 of the mentioned 30 types of the special medical glasses could be manufactured in a substantial amount. The technological backwardness still exists: the waiting time is between 2–8 weeks on the Hungarian market.

The experimental development stage was implemented at the university department. From the very beginning the inventor-researchers wanted to produce for the Hungarian market first, then for the international markets. Thus, the exclusive right to manufacture in Hungary was the non-pecuniary contribution in the establishment of a limited liability company, which was supposed to produce for the local market. Half of the quotas in Coloptic Ltd. is owned by the investors and the other half by a Hungarian investor. In the beginning, manufacturing and sales coordinated by Coloptic Ltd. were very successful. The colour correcting glasses are available at five opticians, who also have the diagnosing instrument. Manufacturing, as we mentioned above, is troublesome and hand-craft-style. Until now, there was no large investment to meet the local demand, the Hungarian investors seem to have no interest. The reason is probably the establishment of the international manufacturing company (see later), which does not pay attention to the small Hungarian market. However, its mere existence seems enough to discourage the

Hungarian investor from further development. We must note that the potential local demand – taking into account that the Central and Eastern European market is not (yet) targeted by the international company – would be enough for the development of manufacturing in Hungary. Nevertheless, the Hungarian network of Coloptic Ltd. does not expand and manufacturing stagnates. Despite the investor's will, there is no adequate supply of the colour correcting glasses for Hungarian patients with colour deficiency.

2.4. Coloryte Co.

The First Hungary Fund was established in 1989 with US$ 76 million primary capital. The Fund obtained information on the colour correcting glasses from the invention list of the National Committee for Technological Development. Subsequently Coloryte Co. was founded, in which the three patent owners (Mr. SZAPPANOS being the third) had 20% of the shares. This share was embodied in the two patents, except for the right to manufacture in Hungary. The company planned to invest US$ 12,4 million in the manufacture of medical glasses and the instrument measuring colour deficiency. The research and development base was operating in Szentendre as of the 6th of June 1999, which enabled the manufacturing of the instrument within Hungary. 50–100 instruments were to be manufactured each year. The manufacture of colour filters and the glasses themselves were planned in the USA (Atlanta) first, then in Western Europe. The speed of EU accession will determine whether the planned European production headquarter will be in Hungary or not. There will also be marketing offices in both Europe and overseas. The American company is being established.

Coloryte Co. and the Hungarian patent owner Coloptic Ltd. came into conflict, which – as we have already mentioned – disturbs the development and supply in Hungary. The essence of the conflict is that apart from the right to manufacture and distributed in Hungary, the inventors put all the patent rights in Coloryte Co. Coloryte made substantial investments and started to prepare everything for the production of the inventions. Thus Coloryte does not understand why – through the inventors – Coloptic Ltd. has the Hungarian rights to produce even if the developments were financed from American capital. This situation is not easy and hard to solve – the Hungarian investor also shares this opinion. Now Coloryte tries to understand and interpret the points stipulated in the different contracts and convince the Hungarian parties. It seems that Coloryte does not want the Hungarian rights for free. Although the Hungarian investor agrees that the situation is 'impossible', certainly he does not want to give up the acquired right. If he does so, the investment and the business line would become meaningless. The investors constitute the point of collision and liaison: they have interest in both companies, and neither Coloryte, nor Coloptic wants to take measures against the investors. Unless there is a compromise agreed, the legal battle is destined to continue for a long time, and the court will decide what the end of the story will be.

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3. RESEARCH OF TECHNOLOGY AND DEVELOPMENT OF ELECTRONIC CONTROL UNITS AT THE DEPARTMENT OF ELECTRONICS TECHNOLOGY

3.1. Historical Background of the Research in the Field of Electronics Technology

The department of electronics technology was founded in 1964. In accordance with its original name the establishing program set the target to teach and research the different subjects of materials science, physical design and manufacturing technology for the benefit of the telecommunication and instrumentation industry. During the first years the efforts in the field of education, i.e. the detailed development of the principles of courses, curricula and main subjects, overshadowed the research activity, therefore it was only in the early seventies when the first research and development projects were launched. The increasing research activity led to the recognition that technology is the branch of knowledge dealing with scientific and industrial methods and their practical use in industry, and, as a consequence, it is needed for the work of every electronics engineer. Since the scope of the Department was also expanded to the entire electronics industry, its name was changed to the present form in 1971.

In the seventies the following topics ruled the R&D activity of the department:

- Precision mechanics and the mechanical construction of electronic instruments.
- Electrochemical processes and the technology of printed wiring boards.
- Thin and thick film technology, the design and realization of hybrid circuits.
- Quality assurance, reliability and electronic noise.

In particular, the design and fabrication of printed wiring boards and hybrid circuits were very efficient, and by the end of the decade the laboratories were equipped by complete fabrication facility in both fields. Many of the fabrication instruments were also developed by the members and prepared in the workshop of the department.

From these roots the following research and development areas of electronics packaging technology have grown out by these days:

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- The design and fabrication of printed wiring boards.
- Design, prototyping and test of laminated, ceramic and deposited multichip modules, i.e. MCM-Ls, MCM-Cs and MCM-Ds.
- Design and assembling fabrication systems, in particular 2,5D or 3D positioning control units, and laser machining systems.
- Basic research and test-sample realization of sensors, in particular with the application of electroactive conducting polymers.
- Information engineering principles of production control and the application of production control systems for fabrication lines of small and medium size series.
- Development of multimedia education tools, in particular the virtualization of laboratory experiments and equipment.

In the following three characteristic types of projects are presented.

3.2. Development of Positioning Control Units and their Application for Laser Machining Systems

The development activity of computerised electronic control units for high precision positioning has more than two decades tradition at the department of electronics technology. This activity was carried out in the course of dozens of smaller projects and resulted in the development of sophisticated fabrication equipment.

- By 1984, as the result of a development project of the department, the obsolete control system of the Digigraph was replaced by a Spectrum Home Computer, and magnetic tape was used for the storage of the control programs.
- By 1987 the Spectrum and the complete control system was replaced by a Personal Computer (PC), even the regulation functions – originally stored by wired memories – were solved using software means. The big power supply was also replaced by the application of a PC power supply unit and a self-developed high power electronic module.
- A similar Digigraph Drawing Machine was equipped with PC control and is in industrial use for the drawing of patterns of the sails of yachts and boats.
- Using the similar principles the complete electronics of a Contraves Drawing Machine was replaced by PC control.
- Using the similar principles the low current electronics of a Plasma Cutting Machine – with positioning range of 3 by 9 meters – was replaced by PC control.
- Parallel to the above listed activity a high precision (0.001 mm) step motor driven X-Y positioning table was developed using a control system built with the application of the first commercially available 4 bit microprocessor. All mechanical parts of the X-Y table as well as the electronics control system were developed and fabricated at the department.

- The high precision step motor driven X-Y table and its control unit were applied to the Thin Film Resistive Network Design and Manufacturing System, whose development was a R&D project of high importance at the department, and which resulted in the doctor theses of a couple of its members.
- Utilizing the gained experiences in developing sophisticated control units, laser machining systems were developed for different applications. The *GRAVILASER* system (*Fig. 1*) can be used for marking and engraving notes and pictures onto surfaces of various materials. The hardware and software parts of the galvanomotor controlled X-Y beam delivery system, as well as the optical parts and the control unit of the laser, the heat exchanger, the Q-switch control, the control software system and the image processing system for camera input were all developed, assembled and realized by the department.
- The *GRAVILASER II.* system was developed and built using the combination of linear and angular beam deflection principles for beam delivery.
- The Thermotrimmer laser system was developed and assembled for the laser engraved adjustment of the resistance of thick film thermistors.
- The Gravimarker laser system was developed and realized for the high precision marking of very small metal parts.
- Computer control system was recently developed for a CO_2 laser machining system. The speciality of this system is the application of microcontroller for the interpolation of inclined and curved lines.
- A 3D multiprocessor position control system is under development for the control of a highly sophisticated laser micromachining system.

3.3. CM2: Cheap MultiChip Modules – an INCO – Copernicus Joint Research Project

The European Commission sponsored INCO Project ‘Establishment of Fast Prototyping Low Cost Multichip Module Technology Facilities in Eastern Europe for the Benefit of European Industry’ (Contract No IC15-CT96-0743) was launched in 1997 and concluded in 2000. The Project was coordinated by the department of electronics technology.
The most important research and development objectives of the Project were:

1. The improvement of the technological capabilities of low cost, high performance electronic circuit modules in some Countries of Central-Eastern Europe (CsCEE), i.e. in Hungary, Romania and Slovenia. Other partners were from highly developed European countries .
2. The increase of functional and interconnection density, preferring the application of integrated interconnection substrates to the extremely expensive on-chip customization, in order to achieve the desired level of performance as cost-effectively as possible.

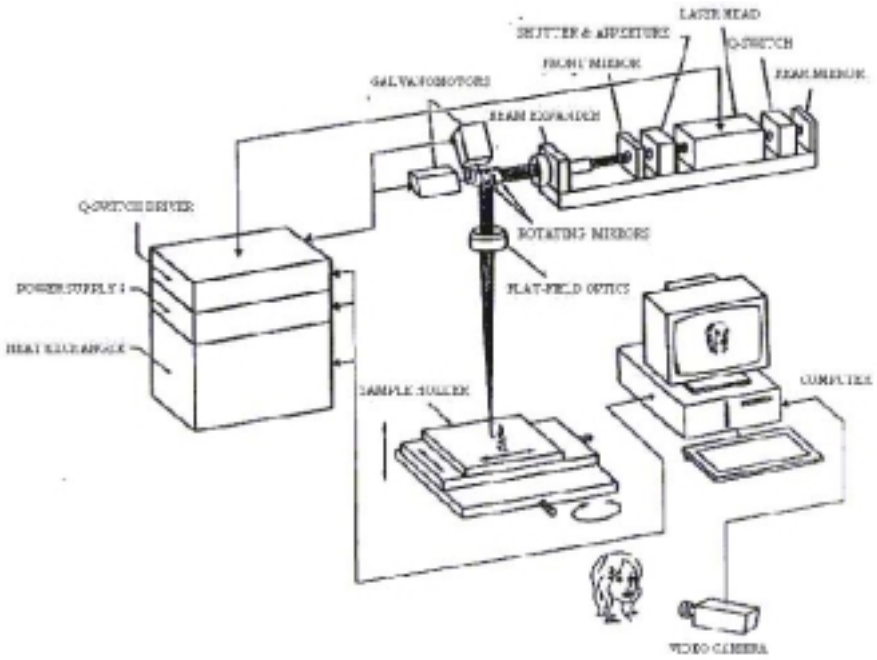

Fig. 1. The GRAVILASER universal laser machining system

Multichip module technology, utilising and/or uniting the advantages of laminating (L) and ceramic (C) techniques, was considered and selected as the promising solution of the requirements. The expected results were higher reliability, increased yield, and reduced use of materials and processing. From the assembling point of view we set the target to apply chip-and-wire technology for small and medium scale integrated circuits, which were of high importance in application specific circuit prototyping. The manufacturing systems were planned to integrate new processing technologies with well-established ones in all development phases, including design, manufacturing, assembling and test. Their application was expected to result in faster prototyping and shorter production period, the prototyping facility had to be able to produce competitive and high quality products.

The functional and interconnection density of electronic modules was increased by the application of integrated interconnection substrates, using new results on the following innovative process technologies:

- Laser induced direct patterning, using the gap cutting process with the combination of tin electroplating and wet chemical etching.
- Diffusion Patterning^{TM} (using DuPont's technology) to fabricate high density thick film multilayer structures for MCM-C prototypes.
- Application of micro BGA (Ball Grid Array) packages for MCM pro-

totypes to achieve higher component density, improved electrical performance and lower cost.

3. Strengthen the relationship between research institutions of Central-Eastern Europe (CEE) and their EU Partners in order to enhance research and technological capacities in some Countries of Central-Eastern Europe (CsCEE). ENPACKED, an Electronic Network for Packaging Education was established to maintain and strengthen the relationship between research institutions of Central-Eastern Europe (CEE) and their EU Partners.
4. Establish links with the newly formed Small and Medium-size Enterprises (SMEs) responsible for product development and distribution.
   In the three Central European partner countries (in HU, RO and SLO) links were established with hundreds of newly formed Small and Medium-size Enterprises (SMEs) responsible for product development and distribution. These enterprises already used the services of the established prototyping facility.
5. Safeguard and stabilize the RTD potential of CsCEE by means of traineeships and seminars for researchers working on the Project.
   The RTD potential of the three countries in the field of packaging technology was safeguarded and stabilized by the project. Among other results it has been proved by the large number of publications, which are placed onto the ENPACKED web site. The development and the use of Virtual Laboratory (see in the next chapter) are also the results of these efforts.

3.4. Virtual Laboratory Support for Electronics Packaging Education – an IEEE/NSF Sponsored Project

The rapid development of packaging technology is accompanied by the dramatic change in the knowledge required from engineers, researchers and scientists working in this field. Microelectronics packaging education for both undergraduate students and working engineers has increasing importance. It is, however, at a much lower level than electronics and microelectronics education in general. A possible reason for this is the high cost that is necessary to carry out hands-on experiments.

An interactive virtual microelectronics packaging laboratory environment can provide a new tool in practical education both for students and instructors. Interactive multimedia web-based training programs gain greater effectiveness from this medium. This way of learning allows the user to enter into a world that attempts to imitate situations of real life, providing immediate, real-time responses to the user's input. The use of graphics, animations, sounds make the virtual environment more realistic and the training more effective and enjoyable.

The main reason that the department has begun developing the Virtual Laboratory was to be able to support the existing microelectronic packaging education. The targeted audience includes the large group of students of the Electrical Engineering Branch, who attend the lectures of Electronics Technology. It also involves

those who take part in any of the degree programs of the department, a smaller group of undergraduate students and Ph.D. scholars who would like to perform research in the real laboratories and have to determine the processing parameters prior to the real experiments. But the Virtual Laboratory is open for everybody who wants to take part in distance learning courses on packaging technology, thus students from other universities are welcome, just as are practicing engineers.

The language of the Virtual Laboratory is English. This is acceptable for the Hungarian students as well, since they have to take a technical foreign language examination parallel to their engineering study before the end of the fifth semester. 90–95% of the students chooses English as foreign language.

Fig. 2. a. Opening virtual laboratory doors, *Fig.2. b.* The layout of a laboratory

The Virtual Laboratory can be accessed from the homepage of the department of electronics technology: http://www.ett.bme.hu/vlab. When you visit this web site, there you will find the six doors of the laboratories of the department of electronics technology at BME (*Fig. 2a*). When a door is opening, by clicking on it, you can go in, and can find the layout of the laboratory (*Fig.2b*). You can click on any of the equipment and then its specification appears, and it is also possible to study the equipment and their operation.

The Virtual Laboratory is accessible through the Internet. It fulfills the principal main purposes; students and engineers can improve their knowledge of microelectronics packaging by studying manufacturing equipment, processes and products. It also provides an excellent possibility for students to make preparations for their hands-on experiments.

4. THE EMETIN – CAVINTON PROJECT
Synthesis and preparation of compounds for the mass production of medicines

The common characteristics of the research and development of the two medicines are that the basis of both original active agents is a plant (herb). In both cases the

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natural agents were synthetised by the research team of the Department of Organic Chemistry.

Chronologically Emetin was the first research project. It started about thirty years ago. The plant Ipecacuanha (South America) contains the alcaloid Emetin as the biologically most activa agent. The production of the madeicine was realised by the Hungarian pharmaceutical firm called Chinoin Gyógyszer és Vegyészeti Termékek Gyára Rt. From the viewpoint of scientific research Emetin was considered as a significant result for the department, but for the producer it did not bring considerable economic result. The product appeared in the medicine market relatively late, it was followed soon by more modern products. After a few years the production had to be ceased. The research part of the project was based on previous reference works of the department.

The research and development project was completely financed by the producer firm. The firm became the owner of patent rights, the researchers were mentioned among the patentees, but they had only marginal financial benefit from the sales of the product. In those days the aspects of marketing and return were not the most important ones in the decision making process, maybe that was one of the reasons of limited sales success of the Emetin. From scientific and development point of view the project was very efficient, it became an important reference for later contracts, like the Cavinton project.

The research and development work of the *Cavinton* started years later. The medicine was an international success from the viewpoint of marketing and profitability as well. The product is still on sale in Hungary and abroad.

The active agent of the plant Vinca minor are some alkaloids, most importantly the base called Vincamine. When the medical effect of the plant was discovered, the potential producer tried to develop plantations. Very soon it became known, the plant is unsuitable for plantation. The effective agent, the Vicamin had to be produced by synthesis.

Professor SZÁNTAY made an offer to the potential producer, Richter Gedeon Vegyészeti Gyár Rt. His offer was based on the very good references and previous successful research and development activities in similar fields. They contracted for taking part in the total synthesis of the effective agent and the preparation of the product for mass production. The synthesis of the active agent was successful. Numerous derivatives of the Vincamine were prepared by the researchers of the Rrichter company. The very best was named Cavinton.

About 40–50 people took part in the realisation of industrial patent, including medical doctors, pharmacists, technologists. The researchers played a significant role in the preparation and organisation of mass production.

The utilisation of the research and development project was fruitful in this case. The new medicine produced on the basis of the original patent achieved significant international success. The patent and all the other rights became the property of Richter Gedeon Vegyészeti Gyár Rt. The form of researchers' cooperation was based on contractual relations, they did not receive share from the return on sales. Their research and development activity was an excellent reference for further assignments.

Cavinton brought significant international business achievements for the original producer. The biggest return was achieved in Japan, where according to the contract with the Takeda Company, the Japanese partner makes the package from the imported Hungarian basic material and the product is traded under the name of Calan. In the pharmaceutical industry it is usual to commercialise identical products under different names. It is absolute natural in the case of generic medicines.

The results of the research activity could be published – not completely – only after the appearance the patent. According to professor SZÁNTAY about 90 percent of the results was published. The results were utilised in the university education as well. Technics used during the research work are part of the curriculum at several courses.

The research work was totally financed by the producer firm, the university applied only the usual deprivations.

Nowadays the research and development activities in the pharmaceutical industry are originally very time – consuming, risky and costly. The cost of research and development represents about 15 percent of the return on sales and this proportion is still growing. The costs have to be reimbursed mostly while the patent subsists. This effort leads to constant strive after the increase of the price and market shares.

Therefore large producers try to outsource a growing part of their research and development activity, or order it from small firms, where new ideas, approaches are expected.

The smaller firms (specialised in research and development activity) and university laboratories are able to produce new molecules and simulate their mechanism of effect. But they are not able to finance the extremely expensive and capital intensive laboratory and hospital tests and controls. Today there is no university department capable of financing even the necessary preliminary research in order to get the references for further contracts.

The most capital intensive phases of research and development can only be executed in the biggest producer firms, this is why there are efforts even among competitor firms to cooperate. The giant companies try to give orders to university departments, laboratories and small private firms for carrying out the first, most risky phases of research and development activity. They prefer to stick themselves to the subsequent phases which can be planned better and usually produce bigger and calculable incomes. This procedure was followed in the case of Cavinton as well.

In the pharmaceutical industry the tendency is that around the biggest producers a phenomenon of ‘ring around the moon’ appears, which consists of small firms, departments of universities and research institutions. The role of this ring will be different from those in the processing industry. The subcontractors produce results of research and development, new molecules, methods, survey data, inventions, ideas instead of spare parts, fixtures and fittings.

There is competition between potential subcontractors. They can get new orders if they have good references, adequate infrastructure, professional background, existing and systematically promoted international connections. For a productive

international cooperation many previous financial and intellectual investment is needed.

To build up a prosperous research team with adequate references takes decades. Nowadays, the documented professional results are not enough, the team has to be managed financially as well, because research and development can only be carried out on business basis. A lot of producer companies insist on establishing joint ventures with external research institutions, departments, laboratories for the purpose of sharing the risks. Under the existing financial practice in Hungary, it is difficult and almost impossible for university departments to provide the necessary capital for the foundation.

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5. DEVELOPMENT OF HIGH PERFORMANCE POLYOLEFIN PRODUCTS

5.1. Results of the Research

The research was aimed at the development of polypropylene-based, modified products, whose features make them suitable for substituting high performance, high cost engineering plastic products. The results have great industrial importance. Due to the technology of modification, it is possible to widen the range of use of polypropylene products and to meet the latest demands of users.

5.2. Stages of the Innovation Process

The scientific preliminaries date back to the 70s. In a cooperation with TVK, our department started some basic research, which resulted in the development of a product family called Modylene.

By using cheap fillers, the prices of polymers can be reduced; however, some of their properties change for disadvantageously. Our new technology uses additives, which can reduce the unfavourable properties and can even increase some parameters of the base polymer.

[1]The author of this case study is Ildikó PETRUSKAHead of research: György MAROSI, György BERTALAN (Department of Organic Chemical Technology)

This new development was considered to be original even internationally, and became patented in 30 countries throughout the world. Widening the range of choice of modified polyolefins and developing special new types of them became possible by the 90s.

Subsequently, in the framework of an OMFB project we developed our high performance products. The project was based on results of previous basic research, and it deepened and sped up the process of innovation already in progress. It was carried out in cooperation with TVK Co.; the ambitions of the researchers met the interests of the business policy of the manufacturing company. The problems emerged during the process of innovation induced further research. As a result of this, we received two more patents:

- A new technology to make halogen free flame retardant polyolefin products
- Interface modification in filled and flame retarded polyolefin products

As a result of some further development of the polyolefin modification, our research concentrated on the development and the use of halogen free flame-retardant polyolefin products. Since 1999 the department coordinates an EUs project in this field.

5.3. The Utilisation of Research Results

Every stage of the innovation process closely connected to education. The initiated industrial problems introduced new tasks to laboratory practice, and the experiments were made with the help of postgraduate students. The process of innovation – combining the aspects of basic and applied research – was accompanied by many publications.

As a result of the research, a new family of products was introduced into the market. Later on they were supplemented by further product types. The two patented techniques founded on the basic patent served the purpose of supplementing the high cost polymer products with new high performance polyolefin types. The production was carried out on a new compounding line, with an economic technology. While working on the development of the new family of products, we considered the following factors:

- increased strength and stiffness
- excellent chemical resistance
- high level of stability
- recyclability
- good price/performance ratio

The development of the new family of products for TVK Co. served two purposes: (i) getting a share on the market of composites of a high technical level (thus improving image of the company) and (ii) creating a set of new properties of products which meets the demands of users. Moreover, polypropylene composites have a higher value of use and more profitable than basic polymers.

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6. DEVELOPMENT OF LASER BRAZING FOR ALUMINIUM

6.1. General Features of the Project

The project in question was carried out at the department of vehicle manufacturing and repairing at the Faculty of Transportation, with the support of a foreign industrial partner. The research – which can be classified as applied research – was aimed at increasing the absorption coefficient of aluminium on the wave-length of the carbon-dioxide laser.

The subject of the research is very typical because the use of laser technology in connection with several materials has spread all over the world and in the past few years this process sped up in Hungary, too.

6.2. The History and the Result of the Research

In the case of aluminium the main problem about the use of laser is the fact that its reflexion is very high. However, if you want the energy in the laser beam to be absorbed, you have to make sure that the material has the necessary absorption capability.

As a result of some former researches at our department, in the case of steel we managed to decrease its reflexion with a graphite coat. The further investigation was based on the researchers' intuition, which suggested them that it might be possible to do this also in the case of aluminium, with a silicon coat.

Fortunately, the researchers' interest met the plans of Solvay Fluor and Derivate GmbH to expand the market regarding the spreading of the technology of soldering aluminium with flux.

The research result can be summarised in the fact that flux is used not only as an auxiliary product to brazing but it is also put on the radiation-absorbing surface. As a result of this, its absorption capability grows from 2–3% to 50% and it becomes possible to solder 1 mm aluminium plates with a 300–400 W laser.

Brazing aluminium with a carbon-dioxide laser instead of welding it with a NdYAG laser is preferable from two points of view:

- carbon-dioxide laser is cheaper than NdYAG laser

[1]The author of this case study: Ildikó PETRUSKA
Head of research: János TAKÁCS (Department of Vehicle Manufacturing and Repairing)

- in the case of thin plates it often happens that the whole plate is burnt through and smelted, which causes an aesthetic flaw on the surface. For brazing, however, it is not necessary to smelt the material in full; it is enough to smelt the surface layer.

In the course of the applied research we exercised real time process control and thermovision measurements. Our preliminary experiments and measurements proved that the absorption capability of the flux changes along with the change of temperature. These measurements may be regarded unique because there are no international data regarding the temperature-related changes of the emitting capacity of different materials on the wavelength of carbon dioxide.

With the progress of the process of our research Solvay Fluor Derivate GmbH got an increasingly clear view of the prospects of applying the results in practice. Thus, the original direction of the research underwent some change, and the aspects of practical utilisation got more and more emphasis: our research included not only aluminium but also aluminium-magnesium alloys, and we examined not only the brazing of plates but also that of other things, e.g. pipes. These new directions of research made it necessary to solve other technological problem to.

6.3. Utilisation of our Research Results

The results of our research have become embedded in education; moreover, they have helped the students to learn a new attitude towards approaching problems. In the process of education the methodology of research has also become the methodology of thinking. By influencing our postgraduate students in their choices of subject, the results of our research have become directly embedded in the education of postgraduate students.

The research was aimed at developing a new technology, which makes it possible to use the materials in a new way; the economical returns of this are yet to be estimated. The new technology will probably open new perspectives mainly in the market of vehicle industry.

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7. BORON NEUTRON CAPTURE THERAPY (BNCT) FOR CANCER [1]

7.1. Research Summary

The Boron Neutron Capture Therapy (BNCT) is an internationally acknowledged and supported research project in the treatment and research of cancer. The Boron Neutron Capture Therapy serves for selective treatment of malignant tumour. During the traditional X ray or neutron therapy the radiation injures also the healthy tissues around the tumour. The advantage of the new therapy is that it saves the surrounding healthy cells while kills the tumour. This method has an essential advantage in the treatment of brain tumour, considering the effect of the blood-brain barrier. This barrier ensures the selectivity of the therapy, i.e. killing the tumour cells, with negligible damage in the healthy tissues.

In Hungary this research began with the support of OTKA[2] at the end of the 80s. Chemists, immunologists, physicists working at the Budapest University of Technology and Economics (TUB) and Eötvös Loránd University of Sciences (abbreviated as ELTE in Hungarian), furthermore physicians and biologists of the National Institute of Oncology worked as members of the team that began to comprehensively research this field in Hungary. The Institute of Nuclear Techniques (INT) contributed with a reactor, and the researchers developed the special irradiation field for the therapy.

At INT Éva ZSOLNAY, leader of the research project works together with 1–2 researchers. Two technicians, and further 5–6 people assure the reactor operation supporting their work. (At the National Institute of Oncology there are one biologist and 2-3 assistants who take part in this stage of the work.)

From 1993-94 the European Union intended to accelerate BNCT coordinating the research work done in different countries in the frame of a special program concentrating on this field.

BNCT is a comprehensive research that needs the contribution of specialists in different sciences, so there is need for physicians, physicists, chemists, immunologists, and biologists. In the work of the European consortium established for BNCT 9-10 research centres take part.

By the end of the 90s the national research centres (due to the cooperation of TUB, ELTE and the National Institute of Oncology) – based on their results – gained a membership in the European Consortium on BNCT. In this research the main task of the specialists of TUB was to develop the final irradiation field with optimal parameters to the therapy and execute biological investigations on the effectiveness of BNCT.

As a result of the comprehensive work now the main task of the researches is the clinical implementation of the therapy.

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[1] The author of this case study: Éva PÁLINKÓ
Head of research: Éva ZSOLNAY (Institute of Nuclear Techniques)

[2] National Scientific Research Fund or OTKA as abbreviated in Hungarian

7.2. Projects in Progress

The BNCT project started in frame of the 4th European Framework Programme in 1999, with the participation of 12 laboratories of 9 countries (among them the Institute of Nuclear Techniques). In the frame of the 5th European Framework Programme on Research and Technological Development a consortium of 10 different countries submitted an application, which is under judgement now.

At the end of the 80s when this research began, OTKA financed this project.

As several projects are connected to this research, it is difficult to ascertain the order of the resources, but the biggest financier is the European Union, while the Institute of Nuclear Techniques is supported by OMFB (National Committee for Technological Development), too. For the period from 1999 to 2001 HUF 7,5 million is available from the 4th Framework Programme, at the same time OMFB gives another HUF 7,6 million. The BNCT research is at the stage of solving the problems of clinical application.

Among the countries participating in the research in the Netherlands by the EU reactor (EURATOM), in Sweden, in Finland, in England at reactor and accelerator centres the application of the therapy is in progress. In the Netherlands the radiation of 10 voluntary patients was undertaken in 1999 while in 2000 there will be further 10 patients treated with this therapy.

The participation in the EU project is important not only for the acknowledgement of national research (at TUB), but also for the treatment of the Hungarian patients in the future. Researchers hope that the patients from the countries taking part in the research will have preference after the launch of this therapy to clinics.

Project leader Éva ZSOLNAY says that recently there were negative tendencies in the Hungarian education and research at universities. While 30% of the tutors were fired, the number of the students has been continuously growing and in addition to educational work fewer tutors are able to spend their time on research.

The changes in the financial system of the university effected disadvantageously the departments having experimental laboratories. While e.g. an economist delivers a lecture to 50–100 students in one hall, at the Institute of Nuclear Techniques – where the students work with radioactive materials – 2–3 students need a tutor, a laboratory assistant, and the staff of 5–6 persons operating the reactor, this way the per capita support tends to zero.

The institution is underfinanced, so covering the daily costs is basically gained from external resources. To execute all the research tasks – after the use of resources from competitions for the maintenance of the institution – the amount available is not enough, so researchers undertake overtime work, e.g. they themselves make the material to be purchased (and list it as costs).

The researcher says that due to the change in the financing of education and research and the growth of educational tasks of the tutors, the researcher, who intends to engage in research work besides education, is extremely overloaded. Here one person does three times more work than employees in a West-European research centre.

8. PROVENANCE STUDY OF ARCHAEOLOGICAL CERAMICS [1]

8.1. Research Summary

One of the fields of radiochemistry is the neutron activation analysis, with the help of which the chemical composition of materials can be determined:

- in the case of archaeological samples the composition of materials helps to determine its origin and other archaeological features can be revealed.
- in the case of geological samples, if the elemental composition is determined by the method in question one can determine e.g. from what kind of volcanic activity the rock originated.

The main point of this method is that reactor neutrons cause changes in the nucleus of elements, producing their radioactive isotopes. The emitted radiation of these radioisotopes can be detected and used for qualitative and quantitative determinations, as a result of which we can determine the elements and their concentration in the investigated material. For this method a research reactor and a nuclear measurement system is necessary.

The reactor at the Budapest University of Technology and Economics was built in 1971. Since then one of the main research fields has been neutron activation analysis. There are two directions followed by the researchers of the department:

- on one hand, they go on applied research e.g. in the fields of archaeology, geology, medical science,
- on the other, hand they work on the development of methods, e.g. to adopt it for the determination of elements not investigated before.

At the department in the frame of research on activation analysis, investigation of the provenance of archaeological ceramics is the only project ordered and financed by clients. The project leader says that the main problem with this research is that it is on the border of chemical and social sciences, so it is quite difficult to gain money in a competition focused either on natural or on social sciences. Usually the national financing is provided by OTKA.[2] For tenders, applications are submitted together with archaeological institutions and museums.

At the moment research work is in progress in the frame of two Israeli projects:

- In cooperation with the Hebrew University in Jerusalem the investigation of the storage pots of the Dead Sea Scrolls is going on. By determining the place of manufacturing for these jars one can probably reveal the place where the scrolls were written. This research is not supported by any external source. If the Israeli partner gains money from competitions, the Hungarian research centre will get financial support.

[1] The author of this case study: Éva PÁLINKÓ
Head of research: Márta BALLA (Institute of Nuclear Techniques)

[2] National Scientific Research Fund or OTKA as abbreviated in Hungarian

- The other research began upon the request of the Israel Antiquity Authority. This project focuses on the analysis of anthropomorphic and zoomorphic pottery assemblage of a sanctuary in an early Iron Age Israeli fortress. The aim is to find the ancient workshop of these pieces, to have better understanding of religious practices of the settlers of the site.

The financial resources connected to the analysis of this material depend on the number of samples taken, namely 60 US$ per ceramic sample to be analysed.

8.2. The Use of External Resources

The money gained from competitions and commissions cover the expenses for repairs of the equipment used in the research.

The leader of the project will be able to cover the costs of her travels to conferences held abroad.

The wage-like payments serve to maintain the interest of the staff operating the reactor.

Application of the activation analysis in archaeology enables the use of research results from natural sciences in the field of social sciences. In the case of provenance study of pottery – in addition to typology, decorative form, colour and fabric; all with quite a lot subjective elements in the judgements – the chemical composition can give objective, measurable evidences on the possible workshop(s), delivery routes and other archaeological relations of the finds.

The principal Hungarian researcher, Márta BALLA, is an internationally well-known, respected person, who works together with many Hungarian and international archaeological institutions, museums in several projects. The researchers participating in the work introduce their results on international conferences and write publications in cooperation. The researcher's successful work is recognised, which is proved by the fact that recently the Discovery Channel shot a film, for which the research reactor of the Technical University was chosen as place for shooting. The film is about the research methods of natural sciences, e.g. the role of neutron activation analysis in the investigation of the Dead Sea Scrolls.

The benefits of the research cannot be measured in money, they are applied to social sciences, where results cannot always be given as financial profits.

9. DEVELOPMENT OF LINDAB HALL SYSTEM FROM THIN-WALLED PROFILES[1]

9.1. Results, Utilisation of Research

Lindab is one of the market makers regarding thin-walled steel profiles, it produces steel frame structures and cladding elements of halls. The company established a manufacturing base in Hungary with green field investment in the industrial zone of Biatorbágy. However, statical dimensioning background for Hungarian application of Lindab products did not exist. From 1996 László DUNAI, associate professor at the department of steel structures (TUB) was asked to work out statical design procedures. Under the commissions, design guidelines and dimensioning software were developed.

Following this commission, the relationship with Lindab went on extended with new fields. In the second phase, research-development tasks were carried out. There were attempts to find application fields for thin-walled steel products coming from the Lindab factory in Hungary. The second phase resulted in multifunctional small span hall system built from thin-walled profiles.

The research-development cooperation led to a structural system based on new thin-walled Lindab products for small span halls relying on theoretical studies and experimental tests. As a result of one and a half year research-development work, the hall system appeared as a market product and it offers a new application field for Lindab.

Following this successful cooperation, Lindab has been pursuing intensive negotiations with the researchers of the department on extending the relationship to new fields.

9.2. Technical-Professional Part of Research

Lindab produces and markets cold-formed profiles of lightweight hall structures traditionally as a system or additional components. In the case of small span halls (below 10 meters), classical steel halls are generally non-competitive with traditional (e.g. masonry, timber) structures. This research-development project worked out a new steel structure system built form thin-walled (1–3 mm wall thickness) cold-formed sections.

9.3. Finances for Research

Finances for regular experimental research in the field of steel structures are insufficient even if tenders are won. Industrial commissions provide possibilities for

[1]The author of this case study: Márta SZABÓ
Head of research: László DUNAI (Department of Structural Engineering)

experimental research but the costs of experiments in university laboratories are relatively high. In the case of experimental test of Lindab profiles, financing for laboratory tests – in addition to high overhead costs – were primarily sufficient for the payment of the direct associates.

Due to the costs of experimental research and strengthening computer background, the methods of research have shifted to numerical simulation, which means virtual structural model experiments. Large scale experimental development programs entail high costs and cannot be carried out at universities. The goal of real experimental research is the establishment and verification of virtual experiments.

Eminent theoretical basis greatly contributes to future results. Great knowledge can result in significant product development and new products. Foreign contacts are vital elements to knowledge improvement and new inspirations. During research-development, the young generation (PhD students) proved to be the best partner. University researchers' ideas can give new inspiration for industrial companies and the possibilities in this field are under-utilised.

10. INTELLIGENT SOFT MATERIALS

10.1. Essence of Research

A conference held in Japan, which earmarked the new direction of research on intelligent materials, gave new motivation to Miklós ZRÍNYI.

The new quality for intelligent materials is not attributed to one material but to an arrangement, the coexistence of the material and its environment. 'Multifunctional materials, which perceive one or several characteristics of the physical or chemical conditions of their direct environment, process these signals and respond quickly and clearly by significant changes of their conditions, are called intelligent materials. Perception in most of the cases is possible as a result of balance between the given material and its environment.' (ZRÍNYI, 1999/a p. 699.) Miklós ZRÍNYI has gained credit for research and development of magnetic gels. 'The gel can be extended, bent, rotated, contracted with suitably chosen magnetic field. The shape of the gel in the dynamically changing magnetic field changes periodically. In this way gel-machines without component exposed to friction can be constructed.' (ZRÍNYI, 1999/b p. 687). This may have significant role in the development of robot technology, pistons, cylinders and valves.

The lack of a well-equipped laboratory made it possible for Miklós ZRÍNYI to think freer, to develop new procedures for the research of intelligent materials and to develop magnetic gels. The previous methods were cost- and instrument-intensive and did not lead to fast results. Gel research in magnetic field could be performed even with simpler laboratory background.

[1]The author of this case study: Márta SZABÓ
Head of research: Miklós ZRÍNYI (Department of Physical Chemistry)

10.2. Utilisation of Research Results

Research of intelligent materials at the department of physical chemistry (TUB) is one of the new development possibilities of chemical industry. In addition to chemistry, this research requires other disciplines like mechanics, magnetic fields, thermodynamics.

Miklós ZRÍNYI's research in the field of intelligent soft materials has achieved outstanding results even internationally. As a result of his research, the laboratory of the department of physical chemistry has been internationally acclaimed.

Only a few laboratories in the world have great results in this field, one or two laboratories in the USA, among them the laboratory of MIT, some laboratories in Japan and in Italy, Europe. The results are indeed significant on international level but our laboratory employing several researchers is poorly equipped. The results are due to unique intellectual capacity, particularly the creativity of Miklós ZRÍNYI.

Practical application of results from basic research, development of new products and procedures, however, require good instruments, qualified researchers. Applied research on the other hand is pursued in well-equipped industrial laboratories. Research engineers of Ford for example develop products based on the researches of Miklós ZRÍNYI.

10.3. Lack of Capital?

Regarding the research of intelligent materials the Department has won a great number of significant tenders, both Hungarian and foreign. NATO commissions for research, participation in the European Union INCO-COPERNICUS program are significant foreign funds, Canon and Bridgestone are also among the sponsors.

According to the calculation of Miklós ZRÍNYI, commissions of HUF 20 million from companies could not be undertaken because of inadequate staff and instruments although professional capacity exists.

The results so far have come from great ideas, which can be cheaply realised. Through basic research, new application areas could open up but there is a long way between basic research and experimental realisation that requires cost-intensive research. At university level, more efficient R&D can be ensured by preferential support for research that is outstanding even on international level.

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11. DESIGN OF MODULAR DRIVER SEAT FAMILY FOR COMMERCIAL VEHICLES

For about 20 years, the staff of the department of automobiles, part of the Transportation Engineering Faculty, is involved in studies of vibration theory, collision, ergonomics and physiology, as well as in design activities. As a consequence of a successful former cooperation, in 1997 IMAG (IKARUS Spare Parts Manufacturer–Mór) offered the department of automobiles to take part in the applied R&D project, called: 'Development and Production Process Design of Modular Driver Seat Family for Road, Railroad, Agricultural and Industrial Commercial Vehicles'. They applied for and obtained the financial support of the National Committee for Technological Development (OMFB), whose goal is to facilitate the cooperation of companies and universities, in order to develop competitive new products for the market.

The duration of the project is three years. The project comprises all the activities of the innovation chain, starting from design, through production and concluding with the distribution of the products.

The main activity of IMAG is the manufacturing of the self-designed passenger seats for buses and railway carriages. Proving the quality of design and production, IMAG is the exclusive supplier of seats and upholstery for SUZUKI and, as a subcontractor of ITT, is the manufacturer of AUDI seat adjusting mechanisms. The quality management is ISO 9001 compliant and also QS 9000 compliant, which is a stricter standard, specific for the car industry.

For some time the company also develops driver seats. Earlier the seats, built in the vehicles manufactured for export, were produced abroad: in Germany, Great Britain, Slovenia. According to marketing results, on the East European and German market, modern driver seats are again a topic of interest among the commercial vehicle manufacturers. The target customers of the Hungarian market are IKARUS Co., agriculture related customers, rail-guided, tram and subway carriage manufacturing and repairing companies.

Three stages of research and development of the project can be identified:

- Defining the set of requirements and the testing system
- Development of the new product family structure
- Development and design of the production process

The Department of Automobiles had fulfilled the following tasks:

- Modelling the driver seat from the point of view of vibration theory and kinematics
- Adapting the hydro-pulsator to the vibration tests, designing and constructing the measurement instruments and devices, carrying out the measurements

[1]The author of this case study: Mária VÁGÁSI
Head of research: Lehel KÁDÁR (Department of Automobiles)

- Physiological modelling of the driver and the seat connection, developing the algorithms, effectuating and evaluating the measurements
- Mechanical engineering design for the development of the driver seat frame
- Assembling system parts in the production process
- Study and modelling of the driver seat's lifetime and developing the algorithms
- Design of devices for quality and production related measurements

In the project's frame, two basic conditions were set in order to obtain a competitive product: (i) The new product has to be of the latest standard according to the international level, (ii) but it has to be cheaper. The main advantage of the new product is the technically new solution: modularity. This means that the same components can be used to build driver seats for different types of vehicles. The product is competitive with respect to foreign products in what regards the technical parameters. Advantages can be shown even in the case of individual components. The ergonomic properties are considered outstanding.

The most relevant problems that occurred during the project were related to the changes suppliers. The use of air- and mechanical springs made in Hungary was considered an important advantage for the driver seat family superstructure. Their advantageous price contributed to achieve a competitive price for the whole seat. But meanwhile, the potential supplier companies (Taurus – Nyíregyháza, Berva Precision-mechanics Works – Eger) were acquired by foreign companies and changed their production profile. The planned purchases failed, so the developers had to find new technical solutions in order to have the foreseen low-cost new the product.

Until now four solutions were found, which are under consideration to be patented.

In order to establish the financial effectiveness of the project, the company took into consideration the technical and economical advantages brought to the user by the new product and the actual conditions of the market. Between 2001 and 2003 15.000 seats are planned to be produced and sold with the expected profit. For the university partner the project represents an opportunity to maintain high-level R&D activity, to support education and enhance it with new tools and equipments.

APPENDIX

The 41 edited case studies are the following (one is not available out of the 42):

Case study title and author	*Principal researcher, project leader*
Faculty of Architecture	
Energy Saving Lighting Systems (Dr. Márta SZABÓ)	Dr. András MAJOROS – Department of Building Energetics and Service System
Faculty of Civil Engineering	
Development of LINDAB Hall System from Thin-Walled Profiles (Dr. Márta SZABÓ)	Dr. László DUNAI – Department of Steel Construction
Development of Concrete Technologies (Dr. Márta SZABÓ)	Prof. emeritus György BALÁZS, Erika CSÁNYI, Dr. István ZSIGOVITS – Department of Construction Materials and Engineering Geology
Extraction of Fluorine from the Sewage Water of GE Tungsram (Nagykanizsa) (Dr. Márta SZABÓ)	Dr. László SOMLYÓDI, Dr. István LICSKÓ – Department of Hydraulic and Water Resources Engineering
Faculty of Economic and Social Sciences	
TQM Programme of TUB-SUNY (Dr. József TOPÁR)	Dr. Gábor Csaba SZABÓ, Dr. János KÖVESI, Dr. József TOPÁR – Department of Industrial Management and Business Economics
Organisation Development (Dr. András KRÉMER)	Dr. András KRÉMER, Dr. Sándor MÁTYÁSI – Department of Sociology and Social History
Faculty of Mechanical Engineering	
Medical Glasses for Correcting Colour Deficiency (Dr. Katalin DÉVAI)	Dr. Klára WENZEL, Dr. György ÁBRAHÁM – Department of Precision Engineering and Optics
Analysis of Complex Systems – Analysis of Friction Inset for Clutch (Dr. Márta SZABÓ)	Dr. Sándor TÓTH – Institute of Machine Design
Development of gas turbines (Hajnalka HORVÁTH)	Dr. Attila MEGGYES – Department of Heat Engines
Analysis of Polymers and Composite Structures – Theory and Methodology for Measurement (Hajnalka HORVÁTH)	Dr. János MAROSFALVI – Institute of Machine Design

COMMET Information Systems Supporting Design of Environmentally Friendly Products. Genetic algorithms in machinery design (Hajnalka HORVÁTH)	Dr. Tibor BERCSEY – Department of Product Design and Agricultural Machinery

Faculty of Transportation Engineering

Modular Driver Seat Family for Commercial Vehicles (Dr. Mária VÁGÁSI)	Lehel KÁDÁR – Department of Automobiles
Interlocking and Compatibility in Railroad Safety Technology (Dr. Ildikó PETRUSKA)	Dr. Géza TARNAI – Department of Transport Automation
Methods of Safety Testing at Nuclear Power Plants (Dr. Ildikó PETRUSKA)	Dr. József BOKOR – Department of Transport Automation
Development of Hydraulic Gear (Dr. Ildikó PETRUSKA)	Dr. Sándor HŐGYE – Department of Transport Automation
INNOFINANCE Method for Financial Feasibility (Dr. Éva PÁLINKÓ)	Dr. Lászlóné TÁNCZOS – Department of Transport Economics
Development of Simulator for Vehicle Motion Dynamics (Dr. Ildikó PETRUSKA)	Dr. István ZOBORY – Department of Railway Vehicles
Wear Analysis of Metallic Rolling Contacts (Dr. Ildikó PETRUSKA)	Dr. István ZOBORY – Department of Railway Vehicles
Endurance Testing of Bogie Frames to Estimate Operation Lifelength (Dr. Ildikó PETRUSKA)	Dr. István ZOBORY – Department of Railway Vehicles
Diagnostics for Thermic State of Stress of Railroads (Dr. Ildikó PETRUSKA)	Dr. János TAKÁCS – Department of Manufacturing and Repair of Vehicles
Development of Laser Brazing for Aluminium (Dr. Ildikó PETRUSKA)	Dr. János TAKÁCS – Department of Manufacturing and Repair of Vehicles

Faculty of Natural Sciences

Development of Short-Distance Infrared Spectrograph – industrial application and new products (Dr. Katalin KEREPESI)	Dr. János GIBER, Dr. Péter RICHTER – Department of Nuclear Physics
R&D for the Development of Chemical Sensors with a Microphysical Approach (Dr. Katalin KEREPESI)	Dr. János GIBER – Department of Atomic Physics
Development and Application of Simulations for Nuclear Power Plants (Dr. Éva PÁLINKÓ)	Dr. Attila ASZÓDI – Institute of Nuclear Techniques
Provenance Study of Archaeological Ceramics (Dr. Éva PÁLINKÓ)	Dr. Márta BALLA – Institute of Nuclear Techniques
Control for Failure in Nuclear Fuel (Dr. Éva PÁLINKÓ)	Dr. Nóra VAJDA – Institute of Nuclear Techniques

Boron Neutron Capture Therapy for Cancer (Dr. Éva PÁLINKÓ)	Dr. Éva ZSOLNAY – Institute of Nuclear Techniques

Faculty of Chemical Engineering

From Basic Research to Industrial Application – with Special Attention to Technologies in Agriculture and the Food Industry (Dr. Mária VÁGÁSI)	Dr. Sándor GÁL, Dr. Béla KOCZKA – Department of General and Analytical Chemistry
Research on Intelligent Soft Materials (Dr. Márta SZABÓ)	Dr. Miklós ZRÍNYI – Department of Physical Chemistry
Development of Polyethylene Granules with Medium and High Density (Dr. Mária VÁGÁSI)	Dr. Béla PUKÁNSZKY, Gábor NAGY (TVK Co.) – Department of Plastics and Rubber Technology
Synthesising Basic Compounds of Medicines Termed Emertin and Cavinton and Preparation for Mass Production (Dr. Katalin KEREPESI)	Dr. Csaba SZÁNTAY – Department of Organic Chemical Technology
Development of High Performance Polyolefin Products (Dr. Ildikó PETRUSKA)	Dr. György MAROSI, Dr. György BERTALAN – Department of Organic Chemical Technology
Extraction of Molecules from Plants and Use for Medical, Food Production and Cosmetic Purposes (Dr. Mária VÁGÁSI)	Dr. Béla SIMÁNDI – Department of Chemical Engineering

Faculty of Electrical Engineering and Informatics

Research on the Technology for Electronic Driver Modules (Balázs BORSI)	Dr. Zsolt ILLYEFALVY VITÉZ – Department of Electronics Technology
Application of ATM in Information Networks – Copernicus Research (Balázs BORSI)	Dr. László JEREB – Department of Telecommunications
R&D Activity of the Companies and the Interuniversity Centre for Telecommunication and Informatics (Balázs BORSI)	Dr. László PAP – Department of Telecommunications Dr. Géza GORDOS – Department of Telecommunications and Telematics
Development of Compact Bulb – Construction and Production Technology (Balázs BORSI)	Dr. László VAJTA – Department of Control Engineering and Information Theory
Design and Implementation of the SGA-7N Signalling Equipment Network (Balázs BORSI)	Dr. Géza GORDOS, Dr. Péter TATAI – Department of Telecommunications and Telematics
R&D in the HSN Lab (Balázs BORSI)	Dr. Tamás HENK – Department of Telecommunications and Telematics
Research on High-Temperature Superconductor Materials (Balázs BORSI)	Dr. István VAJDA – Department of Electric Machines and Drives