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ROLE OF THE TECHNICAL UNIVERSITY'S R&D IN HUNGARIAN INNOVATION

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Abstract

In 1999, the Budapest University of Technology and Economics (TUB)[1] started a research project to explore the properties of R&D undertaken at the BME research institutes. In this article we would like to present the most important results of the research, which was based on 42 case studies. After the general properties of TUB's R&D, the authors present the factors that influence knowledge flow at the university research units. Then the most important management problems pertaining to innovative performance are summarised. Finally, the use of R&D results and the most important obstacles to more efficient innovations are discussed. Throughout the article, the TUB innovations are put in the focus of analysis.

Keywords: higher education, research and development, innovation.

1. Introduction

In the developed countries the research and development of higher education of technology significantly contributes to innovations, at the same time the R&D results have decisive influence on certain fields of education as well. Therefore, we thought it was very important to study the R&D activities of the leading Hungarian technical university, the Budapest University of Technology and Economics (TUB) and to

[1]Previously, the university had been termed Budapesti Műszaki Egyetem (Technical University of Budapest) or BME (TUB). Despite the new name, the old abbreviations are still in use.

scrutinise the University's relations with the Hungarian and international industry. The Ministry of Education (State Secretariat for Research and Development) gave significant support for our research. Our research concepts were based on the known OECD recommendations.[2] We could also make use of the methodological experiences of an OMFB[3] research[4] in the subject.

First, each University faculty recommended an R&D project to study. A list with 59 projects was the result and out of the recommended projects, 42 were processed as case studies, following detailed guidelines.[5] In our opinion, the 42 cases reflect the current innovation activities and R&D profiles of the University. It is also characteristic that the innovations pertaining to companies are mostly in conjunction with the R&D activity of large companies. The departments are often strongly bound to certain industries; on the one hand, they are in close relationship with the dominant companies of their scientific field. On the other hand, however, many TUB departments build their relations with laying too much emphasis on the traditional (large) industry.

By definition, novelty is the keyword for the innovation concept and each examined case had this feature. Applied research and experimental development dominated the studied cases, in our opinion it is also characteristic for technological universities. Nevertheless, it might be true for our University as well that making difference between basic and applied research is often difficult. Moreover, a substantial number of researches pertaining to traditional industries is service in its essence, such as the provision of technological expertise, analysis of materials, structures, measurement, etc.

Only 3 of the examined cases did not classify as R&D, however, they were significant innovations as technology transfer. One of them – the adoption of TQM training – even has importance for the whole national economy.

Table 1. The studied innovations by type – number of projects

<table>
<tr><th rowspan="2"></th><th colspan="3">Development of a</th><th rowspan="2">Other</th><th rowspan="2">Total</th><th rowspan="2">In percent of the 42 cases</th></tr>
<tr><th>new product</th><th>new technology</th><th>software</th></tr>
<tr><td>Basic research</td><td colspan="3">7</td><td></td><td>7</td><td>17</td></tr>
<tr><td>Applied research</td><td>2</td><td>11</td><td>1</td><td>2</td><td>16</td><td>38</td></tr>
<tr><td>Experimental development</td><td>7</td><td>3</td><td>2</td><td>4</td><td>16</td><td>38</td></tr>
<tr><td>Technology transfer</td><td colspan="3">3</td><td></td><td>3</td><td>7</td></tr>
</table>

[2] See [12], and [13], [17].

[3] National Committee for Technological Development, the old name of the State Secretariat for Research and Development. NTDC's corresponding Hungarian abbreviation was OMFB, and is still often referred to as that.

[4] [18]

[5] See the list of the studied projects in the Appendix.

Many research projects in our sample reached the experimental development stage (extraction of fluorine from sewage water, modular driver's seat family, safety testing of nuclear power plants, hydraulic gear, infrared spectrograph, development of medicine, design of SGA 7N telecommunication measurement equipment, etc.). Most of the laboratories, which had been well equipped before, are not able to develop their equipment so that the experimental development stage of R&D can remain at the University. This role is more and more often overtaken by the client or other research units, subcontractors, which have modern labs. It is exceptional that the University's research activity reaches the phase of using the R&D results in practice.

In 22 examined cases, the time between starting and closing the projects was less than 5 years, the most frequent number was 3–4 years. It seems that Hungarian innovation is not yet interested neither in following the globally accelerated trends of R&D, nor in longer researches that yield returns only in long run.

Undoubtedly, there were examples of researches that had been going on for more than 10 years. However, these were usually basic researches or series of applied researches assigned to one research topic, which the researchers tried to keep alive with substantial effort from grants and research contracts from the industry. The easiest way to be contracted for research is if there is an urgent, gripping technical problem. The client is interested in short-term return, and he does not even respond to the questions arising for the research on the further problems. It is very difficult to be contracted for longer term and expensive research.

According to our information, the cases in our sample differ from the University's R&D as far as the time span of researches is concerned. The 'average' university R&D projects are short run, there are many 'measurements' done on a contractual base – of which many should be considered as borrowing the university capacities and not traditional R&D.

2. Knowledge Flow and Influential Factors

The most important motive for university R&D is the accumulated knowledge of the department and its recognition. Almost each interviewed project leader denoted the department's knowledge as the most fundamental source of information for the birth of the innovation:

One of the most important supportive factors of innovative knowledge flow is the intensive researcher mobility. Unfortunately, in most of our cases mobility was one-way: from the university to abroad and the business sphere. Brain drain within the Hungarian borders and to abroad is a very significant problem. Although we found example of a researcher coming to the university (e.g. the SGA 7N research, see its case summary later), we have not heard that the University managed to employ foreign researcher or lecturer as department staff for a longer period of time.

Table 2. Sources of information for university R&D*

	Fundamental	Important	Regular	Hungarian	Foreign
Department's knowledge	79	14	7	14	12
Relevant literature	5	52	33	40	50
Conference	7	24	24	29	33
Personal relationship	21	36	40	33	36
Company	17	24	31	36	19
Bridging institution	–	14	–	–	–
Other	–	12	–	–	–

*frequency of mentioning (%)

Participation in foreign and Hungarian conferences and publishing in Hungarian and foreign journals help mostly the establishment of new relationships and acquiring new contracts. Many case studies also referred to the importance of inter-university cooperation. The grant system, the supplementary professional knowledge and the available laboratory are important in the cooperation with Hungarian higher education institutions. In joint researches with foreign partner universities the membership in professional association can also be an initiation to innovation (department of electronics technology). However, beside personal relationship, the necessity to apply for tenders and grants is the basic motivation for joint researches, for which there were many examples among the studied cases as well.

It is a unique and general tendency that the interviewed project leaders consider the R&D contracts as an essential source for keeping the departments, labs, and researchers. Without acquiring business R&D contracts, most faculties could not even provide the equipment needed for education and the material for laboratory work. As far as the keeping of researchers is concerned, the problem of one-sided mobility rises again: the departments think that bringing up and keeping the researcher is important and not the encouragement of mobility of 'quality' researchers, which would guarantee more intensive knowledge flow.

The importance of laboratories is special. Today, the researchers share the opinion that most of the labs are not suitable for the measurement of high-tech products and technologies. Certainly, the new labs established recently by some large foreign companies are the exceptions (the HSN lab was founded by Ericsson for instance). Only two of our cases mentioned that departments had been cooperating in the utilisation of a laboratory.

Very few cases mentioned that a so-called bridging institution played role in the R&D project. Nonetheless, the role of OMFB grants was often praised. Most researchers thought that the facility, in which OMFB gave loan for R&D to the companies, was efficient (the university's part did not have to be paid). This financing structure resulted in some new R&D contracts for the University. However, some researchers mentioned that this credit facility did not make the companies – especially the small ones – be interested in research, and that this construction reached only those companies, where R&D was thought to be important.

3. Management-type Problems in University Innovation

In the case of TUB, competitive R&D activity undertaken for industrial clients is of strategic importance. The new style of applied researches also confirms this: the departments are researching in topics, the problem solving of which is important for the companies. The researches are definitely more and more interdisciplinary and industry oriented. This phenomenon is still very spontaneous, however, it is worth supporting it along strategic directions. As our case studies have shown, successful researches that focus on industrial problems have significant carry-over effects.

Obviously, the different regularly published R&D booklets or the so-called Newsletters (by the Scientific Directorate of TUB) make substantial difference compared to the earlier approach to innovation. Nevertheless, in our opinion the University still does not collect that essential information on R&D, which could be analysed for the future. Thus, the University does not have aggregate statistics that could make the profitability of R&D results visible.[6]

Despite the above mentioned, our case studies also justified that there is no uniform university approach to innovation. Only a few times could the faculties observe the actual activity of inner organisations that potentially help R&D.

Table 3. Projects that could make use of the organisations helping R&D

	Basic research	Applied research	Experimental development	Technology transfer	Total	In percent of the 42 cases
University organisation	2	2	–	1	5	12
Business intermediation	–	–	2	–	2	5
Hungarian Patent Office	–	–	1	–	1	2
(Contractor) company	2	3	2	–	7	17
Other	–	2	–	–	2	5

Another sad experience of *Table 3* is that the Patent Office cannot be seen on the horizon of university R&D, and even TUB organisations fail to provide efficient help for research and development (we must bear in mind that our cases were especially successful!).

Altogether, the issue of inventions and patents is the most critical one as far as university innovation is concerned. Among the R&D activities explored by our case studies, there were 10 patents, in one case the patent procedure is in progress

[6] We should mention that there was a report on this issue in 1999, and the departments, which could realise the highest contracted R&D revenue per capita, were given financial support.

(as a result of the research on medical glasses for colour deficiency, there were two patents submitted). This is a very high proportion, but it is not true in general.

Table 4. Protection of intellectual property in the cases

	Basic research	Applied research	Experimental development	Technology transfer	Total	In percent of the 42 cases
No protection	1	4	5	1	11	26
Confidentiality agreement	2	6	4	2	14	33
Patent	3	3	6	–	12	29
Other	1	6	1	–	8	19
Mentioned the costs of protection	–	–	1	–	1	2

In the majority of our cases the researchers could not gather the significant own part needed for patenting. In the University, the number of patents and invention applications sharply dropped in recent years, usually the patent became property of the industrial client including all the financial matters.

We could draw an unfavourable picture of the role played by the innovative research unit or researcher as far as business use is concerned. Direct business share from the increased revenues induced by the introduction of new product or technology was very rare. Beside the remuneration stipulated in the research contract and scientific recognition (publications), the researcher may only have hope for future contracts. We could not find the way through which the University can take share from the profits of innovations that started from the university and achieved considerable market success.[7]

In addition to the above mentioned, these unquestionably successful innovation cases revealed further management types of problems:

- The departments are often not able to conclude good contracts, they do not use their opportunities. Occasionally, even multinational companies try to abuse this situation.
- Since there is a market gap, 'bridging' is sometimes undertaken by 'department-related' enterprises for their own interest. This way, the corporate and university behaviour patterns often contradict. Moreover, attraction from the business sphere is sometimes very strong, against which the strategic relationship (alliance) of the company and the department can protect. There were very few examples of such relationship.

[7] Our research could not undertake the mapping of solutions for the problem. International experience can probably help, however, the efficiently operating entrepreneurial university is obviously a long-term target.

- University researchers feel that too much work and investment should be made in advance before actually concluding a significant research contract.
- There is no legal way of accumulating liquid reserves at the departments. Therefore, the researchers must turn to tricks and there is significant cross-financing between the research projects. In the long run, it is rather unfavourable.
- Changes in the University's financial system put especially huge burden on departments that use experimental labs. There is no positive discrimination in favour of those departments, which have need for large laboratory capacities for their material intensive researches. The central administration deserves cuts in unit costs, which – at these departments – is only possible by cutting the labs' costs. In these departments industrial contracts are often the only sources for daily research expenditures; it means extra work, extra burdens, though – positively – the students can also take part in research work.

All these point to that there are still many management factors that hinder the autonomous actors of university R&D, at the same time there are no strategic structures that could minimise the opportunity cost. Thus the establishment of a University Support Department that helps the researchers is an urgent task at TUB.[8]

4. Utilisation of University Innovations

A significant proportion (2/3) of the elaborated case studies provided information on the starting motives and initiations of the industrial user or client.

Among the important aims, efforts to improve quality are surprising. Obviously, it is a favourable trend even if in the enterprise surveys[9] more and more Hungarian companies say that their products are competitive on international markets. The share of efforts to open new markets or increase market share is also promising. The share of innovations targeting adjustment to standards and rules, or the ease of environmental burdens is in fact low, with special attention to the most sensitive areas of Hungary's EU accession. Other figures of important innovation targets are definitely low. It seems that the Hungarian innovation system does not assign proper weight to the important aspects of competitiveness denoted in the above table.

One of our cases related to Paks (site of the only Hungarian nuclear power plant) also showed that 'the industry' does not finance researches on environmental

[8] Our research team knows that the cases' feedback to university organisations and environment has not yet been revealed in this research on university innovations. In the studied cases there was no reference to the organisations established by the university to support R&D (e.g. Enterprise Office, Innotech, etc.). The role played by such organisations is the subject for future researches.

[9] See the latest of GKI Co.'s traditional enterprise survey: 'As enterprises see 2000', March 2000.

Table 5. Distribution of innovations by the purpose of users (%)

Purpose	It was: not targeted	It was: more or less important	It was: very important	No response
Replacing old products	38	12	17	33
Improvement of product quality	10	10	48	33
Increasing product range	17	24	29	31
Open new markets, increase market share	19	10	43	29
Application of standards and rules	24	17	31	29
Improving production flexibility	40	19	7	33
Decreasing labour costs	43	24	0	33
Decreasing material use	29	29	12	31
Decreasing energy consumption	38	10	19	33
Easing environmental damages	26	17	26	31

protection with pleasure. According to the traditional explanation, the business sector tries to avoid researches and modernisation efforts that aim at the internalisation of externities.

The above statements are also supported by the missing aims. Replacement of old products is not targeted despite that in the international flow of products and production factors the international product/technology life cycle is a well-known phenomenon, and on Hungarian markets the modern products and technologies are not necessarily marketable, even if it would be welcome from the aspect of Hungary's competitiveness. Nonetheless, we also found examples of narrowing technology gap (relative lagging behind); marking new technological directions and being present in the mainstream.

The fact that our cases did not aim at reducing energy consumption also contradicts international (OECD) trends. Efforts to decrease labour costs are also poor. Although the future competitiveness of the Hungarian economy will not necessarily depend on cheap labour force, it seems hardly reasonable that none of the cases mentioned the reduction of labour costs among the very important aims.

Importance of the studied innovations is underlined if we consider that 18 nation-wide important cases could reveal that the R&D result was sold in Hungary, and in more than half of the projects the R&D result was sold abroad. In more than 25% of the cases a new product was developed, which proved to be successful both on Hungarian and international markets.

Our cases also gave information on how the profits of innovation could be measured. The research plan solicited the gathering of figures on direct economic

Table 6. 'Industrial' use of R&D results in the cases

Use	Importance for the national economy		Total
	High	Smaller	
R&D result sold in Hungary	43	12	55
R&D result sold abroad	26	24	50
Sale of new product on Hungarian markets	19	17	36
New Hungarian product exported	10	17	26
Technology introduced in Hungarian production	26	17	43

NB: in some cases the research project had not been finished or the university researcher had not always had the opportunity to see the 'industrial' result of his/her research. This is generally true for individual (sole) contracts, sometimes for software development, and for almost all basic researches.

benefits. Certainly, the project leaders often tried to call the attention of case study authors to other special aspects. New medical treatment of a disease, new archaeological technology, consumer satisfaction, environmental issues, development of infrastructure, etc. were among the other benefits.

Table 7. Benefits of innovations

	Basic research	Applied research	Experimental development	Technology transfer	Total	In percent of the 42 cases
Sales revenue	2	5	8	2	17	40
Cost efficiency	–	6	3	2	11	26
Sale of intellectual property	–	4	5	–	9	21
Increase of efficiency	1	3	5	2	11	26
Increasing safety	–	2	4	1	7	17
Other	5	9	5	1	20	48

In non-profit use, the importance of publications – which is a typical attribute of higher education – is outstanding. In our opinion publications have a determining role in obtaining research contracts, in successful participation on grants and tenders, and in bringing fame to the researchers. Moreover, publication is a driving force: the teaching hours, department career, scientific qualification etc. often depend on publications.

Table 8. Non-profit use of innovations in the cases

	Basic research	Applied research	Experimental development	Technology transfer	Total	In percent of the 42 cases
The result was published	4	12	11	2	24	57
Appears in education as well	5	9	9	1	29	69

Education is one of the most important recipients of the innovations we examined.[10] Results of R&D activity appear in education almost immediately according to the interviewed project leaders. In gradual education mainly the novelties of basic researches appear. Almost each case study mentioned the involvement of PhD students in the researches. Due to the R&D activity, the departments can suggest the students different topics for final papers (theses) and PhD dissertation for the solution of problems that emerge in industry. The new research results achieved in industry are directly built in the education process with no delay, and they improve the quality of education. This is true for every studied research project, but in strategic relationships (such as the Ericsson relation in the sample of the Faculty of Electrical Engineering and Informatics) this is one of the most important and declared objectives.

For Ericson, the value of the university team does not depend on whether the university staff is able to develop a new product or not. To do that Ericson has its own Product Units all over the world. Ericson is in need of high quality labour force, which may later constitute the company's top scientific researchers. Financing is also based on the PhD students. Most of the 'financed' PhD students work on topics that are of interest for Ericson, but this is not a strict criterion. What they require is that the PhD students should have 2–4 final year students who help, and possibly some 2–3 more from lower classes. The team is therefore pyramid-like.

Based on the cases, we summed up the factors that hamper innovation. Our collected empirical information showed that not insufficient demand is the most important obstacle to TUB innovations. However, we were sceptic about the opinion regarding the lack of information since we saw that though each researcher has rather excellent expertise on his/her scientific field they are frequently lost in the legal issues pertaining to innovation. This also justifies that the allocation of information regarding the 'best practice' of R&D organisation is not efficient at the University. There are attempts to make up for this deficiency. In the near future a free legal course will be launched. Interest and the expected number of participants, however, remain questionable.

[10] An earlier GKI Co. research, which processed 17 case studies, also called attention to the high share of innovations that appear in education [18].

Table 9. Obstacles to innovation

	Basic research	Applied research	Experimental development	Technology transfer	Total	In percent of the 42 cases
Insufficient demand	–	1	1	1	3	7
Lack of information	–	1	–	1	2	5
Inadequate R&D capacities	3	3	3	1	10	24
Inadequate financing	3	9	9	1	22	52
Poor chance of return	–	2	–	–	2	5
Other	3	5	5	–	13	31

Poor chance of return to innovation was not often denoted. One of explanations may be the sample of successful cases, the other is the lack of information since the enterprise surveys showed the poor chance of return as a very important obstacle to innovative activity.[11]

Finally, one of the most important conclusions regarding the university researches was that after the traditional complaint of inadequate financing, the inadequate R&D capacities ranked as the most important obstacle of innovative activity. Inadequate capacity does not concern the labs only, but almost every researcher agreed that layoffs and mass education increased the burdens of education over to an extent, above which they do not have time for research-development, experiments, measurements.

A specific aspect of inadequate capacities is that the evolved grant and tender system, and especially its frequent modification put substantial burdens on the overloaded professors. Elaboration of a tender documentation is very time consuming, and out of 10 applications approximately 3–4 may win. The lack of 'own part' needed for the preparation of research and bidding is often missing; a further aspect of inadequate capacities. The opinions converge that without own investment, there is no chance to win tenders. Other sources of information confirmed that from 2000 the University would help the departments by paying 1/3 of the own part for OMFB grants that aim at the purchase of expensive equipment.

In spite of the mentioned problems, as a summary we can say that after the years of recession the Budapest University of Technology and Economics is again in organic relationship with certain actors of Hungarian and international industry. In some cases this relation means top high-tech research. In other segments – though internationally competitive knowledge of the department cannot be questioned – the critical amount of world-wide significant R&D results is still awaited.

[11] See the latest of GKI Co.'s traditional enterprise surveys: 'As enterprises see 2000', March 2000.

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