ibw-research brief

issue No. 05 | November 2003

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An outlook on the basis of a survey among companies and the situation on the labour market

On behalf of the Federation of Austrian Industry ('IV'), the Austrian Economic Chamber ('WKÖ'), the Austrian Trade Unions ('ÖGB'), the Chamber of Employees ('AK'), the Federal Ministry of Education, Science, and Culture, and the Federal Ministry of Economical Affairs and Labour, the ibw conducted a written survey among companies that engage in research and innovation. In the course of this, people were polled both on trends in the demand of qualification regarding operational fields and specific subjects, and on how they assess the chances for university graduates and companies that are related to technology. Moreover, official statistics concerning the numbers of university freshmen and graduates were analysed, and the ibw also closely examined employment of engineering graduates and graduates of natural sciences in a long-term perspective and in a subject-specific way[1].

I. The results of polling the companies

At the end of the year 2002, or at the beginning of 2003 respectively, companies that engage in R&D (research and development) were polled all across Austria, especially those belonging to the secondary economic sector. 23 per cent out of a total of 650 questionnaires found their way back, and 149 of these could be analysed. The results were weighted and projected.

The companies polled employ a calculated number of approximately 310,000 people. Out of these, 7.1 per cent have a university degree in engineering or in science; 0.8 per cent come from specialised tertiary colleges of higher education ("Fachhochschulen"), and another 8.5 per cent are graduates from advanced secondary technical colleges or comparable vocational institutions. Among the employees with a doctorate degree in natural sciences or engineering, 49 per cent were mostly engaged in R&D. Of all university graduates with a master diploma, 39 per cent worked in R&D, and 24 per cent of all graduates from secondary colleges did so, too.

Regarding their being apt for positions in research and development, company representatives that were interviewed give by far the most credit to graduates from technical studies at universities (74 per cent gave the optimum grade '1'); staff that have a degree in natural sciences from a university received a '1' from 44 per cent, and 33 per cent awarded the representatives of tertiary technical college graduates the 'very good'. In the operational area of 'marketing, sales, and customer care', graduates from specialised tertiary colleges did almost as well as university graduates in engineering (approximately 20 per cent were given a '1'). Staff who come from advanced secondary technical colleges were regarded as being best in the field of 'production (including preparation)', with 48 per cent of the interviewees awarding them a '1' – a rate no other group comes near, except for graduates from specialised tertiary colleges (42 per cent).

Development of qualification: looking back and ahead

Nearly 16 per cent of the companies refer to the number of employees that are engineering graduates from university as having been "going up sharply" in the last three years, and another 36 per cent report that their number is "increasing rather than falling". As regards engineering qualifications in general, almost half of the companies polled report no significant change in the course of the last three years; with natural sciences, three quarters see no change in figures.

In the last few years, the companies have met difficulties finding suitable members of staff with engineering or science degrees from universities: finding apt MSCs in engineering ('Diplomingenieure') have caused more problems than science graduates.

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[1] Arthur Schneeberger / Alexander Petanovitsch: "Innovation and university education: opportunities and challenges of a new qualification offensive for Austria in technical and natural science". *ibw*, July 2003, Vienna.

Approximately 50 per cent of the companies consider the chances of employment for graduates from universities and advanced tertiary colleges as "going up slightly". As regards natural sciences, more than 70 per cent of the interviewees expect primarily a need for substitutes. A "slightly rising" need for personnel is expected mainly in the fields of research and development (64 per cent) and marketing, sales, and customer care (54 per cent).

The interviewees that expect an increase until 2005, see employment spread fastest in the conventional and classical areas of engineering: Machine Construction and Electrical Engineering/Electronics. As it was expected, also Computer Science and Mechatronics/ Automation Science achieved best results.

What were the reasons for the increase of employment of engineering and natural science graduates over the last few years? Most prominent among the reasons listed were "new technical problems/tasks" (63 per cent), as well as "additional investments in R&D" (59 per cent). Moreover, nearly one in five of the companies surveyed witnessed an increase of jobs in the aforementioned field of employment, which they see as a result of their participation in European programmes.

How the general development of demand is seen according to fields of specialisation

The enterprises were asked how they assessed the long-term demand for engineering or science graduates according to specialised fields. The question was aimed at a "general assessment of employment possibilities also outside one's own company". The results mainly show *three large groups* of specialised fields:

- Specified subjects where an "increase rather than a decrease" in demand is expected on the labour market in the long run.
- The classical and conventional areas of engineering; company representatives mostly expect there to be a constantly high demand for substitutes in the long run (see also the above paragraph). Yet, around 40 per cent of the interviewees expect the demand to be "going up slightly in the long run". Among these are Electrical Engineering, Machine Construction, Chemical Engineering and Process Engineering.
- Thirdly, those branch of studies for which the demand on the general labour market is expected to stay the same in the long run. They include Technical Physics, Timber Engineering, Building and Construction Engineering, and Engineering in the Coal and Steel industry, including Mining.

Cooperation with universities and specialised tertiary colleges: striking differences

If one looks at cooperation in the field of innovation, the dominant position of the universities becomes apparent, as does the international dimension. 33 per cent of the companies which are actively involved in this area cooperate with universities very frequently, while in the case of advanced tertiary colleges it is (so far) only 6 per cent that do so. The way that the companies which cooperate with the new advanced tertiary colleges in R&D matters are embedded in institutional or personal innovative networks is fundamentally different in nature to those cooperating with universities: it is merely the advanced secondary technical colleges that prove to be a further common partner in cooperation.

The educational cooperation that is most frequent in the technical field of the companies polled mainly consists of providing work practice for those educational studies where the former is mandatory: most commonly, companies provide workplaces for AST college students, but also for students of advanced tertiary colleges. The companies which engage in R&D and fund dissertations and theses of university students, very often employ students, too.

Chances of innovation: present areas of strength and future fields of hope

The field of technology that is seen as being by far the most promising and thus having chances on the market already short-term is 'motor vehicles, engines and supply'. Three other fields, which are to do with information and environment technology, come second, all three of them having been listed almost equally often.

Further evaluation puts short-term chances in relation to medium- and long-term prospects that are to do with fields of technology: as to relating time patterns, those fields of technology take a top position, for which by far more of the decision makers surveyed see medium- or long term chances on the market rather than short-term prospects. This sequence which has been differentiated according to time patterns is essentially a list of *areas of hope* – in contrast to already *identified areas of strength* (or established R&D clusters). 'Research-intensive' fields of engineering (high spending on R&D in the respective industries) head the list of areas of hope that are related to technology fields. Among these are Micro System Engineering, Chemistry and Pharmaceutics, as well as Aviation and Space Technology including its supplying industry.

The importance of promoting incentives

The survey that was conducted towards the end of 2002 and at the beginning of 2003 also polled the companies as to how far the political commitment to increased funding of innovations had had an effect on their R&D activities to that day. For nearly 45 per cent of the companies engaged in R&D, the research policy was a relevant clue and incentive. 25 per cent mentioned that the R&D aims of the Government had already exerted influence, and a further just under 20 per cent were expecting its influence for the years to come.

II. A long-term analysis of the labour market and an outlook

The number of graduates from engineering and science studies in jobs rose from just under 21,400 in the year 1971 to nearly 34,600 in 1981 and 49,100 in the year 1991. At present, there are around 66,000 with the above-mentioned qualification working. This means that these qualifications increased their presence from 0.9 to 1.0 per cent between 1871 and 1981, to 1.3 per cent by 1991 and finally reached 1.7 per cent of all those in work in 2002.

If one draws an international comparison, there can still be seen a deficit in R&D spending as well as in the employment of science and engineering graduates. For the aim of the Government (raising the R&D percentage to 3.0 by 2010) to be reached, engineering and science graduates from either universities or tertiary colleges would have to make up approximately 2.6 per cent.

Figure 2:
Engineering and science graduates from universities and colleges, as well as R&D spending

Relation	*trend*				*projection*	
	1971	1981	1991	2002	2006	2010
Engineering and science graduates	21,352	34,561	49,117	66,300	85,000	102,000
In % of people in work	0.7	1.0	1.3	1.7	2.2	2.6
Research ratio in % of the GDP	0.61	1.13	1.47	1.95	2.50	3.00

Sources: Austria Statistics, census, our own calculations

A balanced effect on the labour market when doing forward projection

If one projects forward the demand for substitution and additional need for engineering and science graduates, one can (without looking at the respective fields of specialisation) expect the new demand and supply to be well-balanced. Yet, this would involve replacing 25 per cent of all university graduates in these subjects by tertiary technical college graduates.

Depending on the degree to which the political aim of innovation (raising spending on research) is put into practice, there can be expected shortages in human resources

Corresponding to how much the Government's aims of innovation will be actually put into practice, one can expect growing tension on the labour market of engineering and science graduates. Even though one can hypothetically assume that around 50 per cent of university graduates in the aforementioned subjects could be replaced by tertiary technical college graduates, there would still be a yearly gap of much more than 800 new graduates. The huge leap from1.9 to 3.0 per cent in R&D spending would not only require a relative growth of more than 50 per cent in terms of financing, but also mean that organisation and personnel management would be *taken to new levels*. As a consequence, new approaches would have to be made as to expanding possibilities of university education and career, institutional cooperation (universities, advanced tertiary colleges, other research institutions and companies), as well as national and international recruitment.

But to what extent can the growing number of tertiary technical college graduates *substitute* the decline in engineering graduates from universities? There exist formal limits to substitution, for example in the technical and scientific teaching professions at schools and universities. Differences in prior education also have an effect on the working fields of people in the private sector. The survey of 2002/2003 backs up the assumption that when it comes to substitution, there is a lot more leeway in 'marketing, sales, and customer care' than there is in the field of ' research and development'.

In the course of putting into practice the political aims of innovation, the question how to prepare students of advanced tertiary colleges for R&D jobs would become pressing, and with it the need to equip these technical studies with the necessary facilities. What is more, questions would crop up more and more frequently of how to optimise structural conditions of international recruitment of R&D personnel in the company and university sector.

A lack of qualification in the classical engineering sciences

The general estimations of supply and demand do not sufficiently account for the disparities that exist between the respective fields of specialisation. Due to the development of freshmen numbers on the one hand, and the statements made by company representatives on problems with recruiting staff in the last three years, as well as on expectations for the next three years on the other hand, there begins to emerge a clear imbalance between the demand for qualification and its supply.

The decreasing numbers of graduates from the classical university studies in engineering, and the positive medium- and long-term expectations of the companies point to a lack of workforce in this section of the labour market. The phenomenon of falling numbers of beginners of engineering studies can be put down to a) a demographic drop in the respective age groups, b) the tertiary colleges attracting the masses, and c) the rocketing numbers of

Figure 2:
Diplomas in science and engineering according to university types, as well as the percentage of the comparable age groups 1985/86 – 2000/01, and a prognosis based on freshmen numbers; Austrian citizens and foreigners.

year of birth	universities				advanced tertiary colleges		in total	in % of all 25 to 29-year-olds	average of the 25-29-year-olds
	science	engi-nee-ring	mining	agricul-ture and forestry	tech-nical	media			
1985/86	450	1,078	63	230	-	-	1,821	1.5	117,953
1990/91	640	1,397	103	324	-	-	2,464	1.8	136,938
1991/92	671	1,542	103	320	-	-	2,636	1.9	140,179
1996/97	995	2,414	151	442	84	0	4,086	3.0	136,949
1997/98	1.070	2,212	151	**471**	253	0	4,157	3.1	132,460
1998/99	1.051	1,928	212	388	542	0	4,121	3.3	126,342
1999/00	924	2,140	151	425	709	144	4,493	3.7	120,095
2000/01	1,030	2,269	166	440	834	187	**4,926**	4.3	114,663
2001/02	960	1,993	152	401	1,140	227	4,873	4.5	109,520

Sources: Austria Statistics; Federal Ministry of Education, Science, and Art; our own calculations

tracting the masses, and c) the rocketing numbers of new students of 'Information and Communication Technology' since the fall of 1999/2000.

In the *classical engineering studies* – despite the fact that companies have been signalling high and sometimes even increasing demand – one can expect *a significant drop in university diplomas* in four to five years: minus 22 per cent in Mechatronics, minus 32 per cent in Machine Construction, minus 34 per cent in Electrical Engineering, minus 26 per cent in Mining and the Heavy Industry (excluding Synthetics and Plastic Engineering), and minus 48 percent in Synthetics and Plastic Engineering.

The sector of advanced tertiary colleges boasts growing graduate numbers in the fields of automation science and electronics. Yet, it remains to be seen whether the sharp drop in graduate numbers can be substituted by tertiary college graduates immediately and *in all working areas* of the companies. This question is especially prominent in the field of R&D. Medium-term, here could be about to emerge a need for further courses for tertiary college graduates.

Technical Chemistry and Synthetics and Plastic Engineering: all relevant studies see decreasing graduate numbers. Yet, the companies' expectations regarding future demand are all but negative.

Technical Physics: falling numbers of graduates stand in contrast to a relatively positive outlook on employment numbers on the part of the companies.

Building and Construction Engineering: graduate numbers are going *down* slightly (in architecture, they drop sharply), except for 'Economical Engineering and Construction'. Job prospects for graduates look quite good. Tertiary colleges are bringing new technical work specialisations into the sector of building and construction.

Unlike the classical engineering studies, *Biology and Biotechnology* are scoring growing graduate numbers. Companies, however, still report problems finding suitable personnel over the last three years. The university output of biology are only partly suitable for engineering matters on the labour market; relatively unfavourable labour market data underlines this observation, too. There exist two studies that are quite new, and they will be of importance in terms of technology and industry. These are *Microbiology* (at the university), and *Bio- and Environmental Engineering* (tertiary college).

The studies that have been profiting most from the dropping numbers in the classical engineering studies are the subtypes of Information and Communication Technology at both universities and tertiary colleges. Computer Science alone is going to see an increase in yearly graduate numbers of 90 per cent in one or two years, due to an increased influx of students since the late 1990s. What is more, tertiary college graduates of Information and Communication Technology are going to boost workforce offers in this sector to a level that is going to be five times higher than it is at present.

Various approaches to promoting the potential in engineering and science

The following pressing questions will have to be discussed in the future:

- How should the specialised tertiary colleges be positioned in the field of research?
- How could the interface between secondary technical colleges and universities be improved, according to the international, triple-segmented standards of graduation?
- What about the need for study offers for people in jobs (bachelor – master degrees),
- And, last but not least, the importance of setting up attractive 'promotion' and 'post-doc' institutions to foster a positive outcome of 'brain-drain' and 'brain-gain'.

This research brief is a short version of the study under the same title *Education and Economy No. 29*
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