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Biomedical Engineering as a Career Resource: Survey from Tampere University of Technology*

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This paper presents the results of the survey concerning graduates with a Master of Science in Engineering (hereafter engineers), who have studied Biomedical Engineering (BME) in the Ragnar Granit Institute (RGI) at Tampere University of Technology (TUT), Tampere, Finland. The material of the survey consisted of 267 persons who had included BME as a professional subject in their degree program between 1976 and the spring of 1997. The survey was conducted during the summer of 1997 as a postal questionnaire study (respondence rate was 77%). According to the study, 90% of the respondents had found their first job in less than three months. The type of their first employment for 95% of respondents was full-time. The job description of every second respondent was related to BME. Of those who had submitted their Master's thesis to RGI, first job descriptions were clearly related to BME more often than in the cases of other respondents. The first job corresponded very well with the type of education, and this correspondence has even improved in recent years. When comparing the ability provided by their education with the importance of areas of expertise actually required at work, the respondents said deficiencies lay in the areas of project and teamwork, oral communication skills, and negotiation skills. Education in RGI was perceived as a good, interesting, and respected basis for a career.

INTRODUCTION

TO OUR KNOWLEDGE, no other comprehensive study on the success of BME education programs has been published. Certainly there exist several questionnaires made for students who have not yet completed their studies. However, we feel that such questionnaires give information mainly on the opinions of students regarding teachers' skills rather than the value of the program for their placement in working life and the value of the program for their future success.

Concerning the value of the program for placement in working life and for future success, which is the real crux in education programs, information is obtainable only with questionnaires composed for persons who have already served several years in working life.

Furthermore, evaluation of an education program is only qualitative if we cannot compare results with those of similar studies carried out on other biomedical engineering programs and/or programs in related areas like electronics, computer science, etc.

Therefore, in publishing this article we wish to increase our colleagues' interest in performing similar studies on their own programs in order to find out where the 'baseline' for the results is and to be able to form quantitative conclusions regarding the success of different programs.

Another motivation for publishing this study is to help our colleagues to plan such studies. We now have experience of how this kind of study should be performed and how a questionnaire should be formulated, and from our own mistakes we have learned how such a study may be further improved.

We hope that this article will motivate our colleagues who are directing BME and other programs to perform similar studies with persons who have completed their programs and to publish their results so that they are available to all interested. In this way we can create a very important information source for evaluating and improving existing engineering education programs and creating new ones.

Biomedical engineering industry in Finland

The biomedical engineering industry in Finland (population 5.1 million) manufactures high-technology products and the export rate of the industry is extremely high, exceeding 95% with the largest companies. Biomedical engineering companies invest in research and development, and the high-technology products of the field are indeed among the most technology-intensive category, in which the R&D-intensiveness exceeds 8.5%. Personnel growth in the field has been rapid and, according to the 1997 statistics, there were at that time almost 150 biomedical engineering companies employing approximately 5,000 persons. The total turnover of these companies amounted to approximately €700,000,000. The industry is primarily located in the proximity of

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university hospitals and universities of technology. However, the biggest biomedical engineering companies are located in the Helsinki area (capital of Finland). The field of biomedical engineering is continuously expanding. Due to more advanced methods and equipment and increasing medical knowledge, the growth rate is likely to accelerate.

Biomedical engineering education in Finland

In Finland, BME education was launched by Tampere University of Technology (TUT). In keeping with the growth in the field, the need for education in BME has increased in recent years. Consequently, curricula including BME have been set up at many universities. In addition to TUT, education in BME is at present provided by Helsinki University of Technology and the Universities of Kuopio, Oulu, and Turku.

Objectives

The objective of this study was to obtain a full picture regarding the graduation and placement in working life of BME engineers educated by RGI. Thus we carried out a detailed examination of the TUT student register and a questionnaire study among the engineers who had studied BME at TUT [1].

From the point of view of RGI, the objective of the study is to provide feedback, so that the education provided by the Institute can be further developed.

MATERIAL AND METHODS

Between the academic year 1976–77 and the end of the academic year 1996–97, 272 TUT students had included BME in their Master of Science (M.Sc.) in Engineering degree program as a major or minor professional subject. With regard to them, a detailed investigation was carried out concerning the starting date of the Master's degree program, graduation date, and professional subjects included in the degree program, on the basis of the TUT student register and archives. The sample included six international students who had attended the International Graduate School of RGI and been awarded the basic degree of Bachelor of Science (B.Sc.) in Engineering.

For the postal questionnaire study, current addresses were checked through the national address information telephone of the Population Register Centre. The addresses could be retrieved for 267 persons, who comprised the sample of the postal questionnaire study.

The objective set for the survey included obtaining answers to the following questions:

- How soon after their graduation did engineers acquire a job?
- Where did they find a placement and with what type of job description?
- How did their job description correspond with their education at TUT?
- Did their job description involve BME?

In the analysis phase, in addition to analysing the entire material, the results of the questionnaire study were examined separately with regard to those who had graduated in the 1980s and 1990s. Furthermore, some statistics were prepared separately for men and women.

BACKGROUND OF STUDENTS

Number of students

The number of students who have included BME in their M.Sc. degree by graduation year are presented in Fig. 1 (first column). Of the 272 engineers, 86% were male and 14% female. A Master's thesis had been written in RGI by 137 persons (Figure 1, second column), of whom 120 were males and 17 females. Of the Masters of Science in BME, four had graduated from the International Graduate School of RGI. Additionally, 18 Licentiates of Technology and 8 Doctors of Technology had graduated from RGI by the end of the academic year 1996–97.

The popularity of BME has varied considerably over the years. However, since 1990 a distinct increase can be detected in the number of students who have included BME studies in their Master's degree program: by 1990 105 persons (39%), rising during the 1990s to 167 (61%). In the 1990s BME has gained in significance as a minor professional subject. As recently as at the end of the 1980s, 72% of the students had completed BME as a major professional subject and written their Master's thesis on BME. By the spring of 1997, 64% of the engineers who had graduated in the 1990s had included BME in their degree as a minor professional subject.

Professional subjects combined with biomedical engineering

In addition to BME, a large proportion of the engineers had selected their other professional subjects from the Department of Electrical Engineering or the Department of Information Technology. Table 1 presents a list of the most popular professional subjects (selected by more than 10 majoring students). The engineers at TUT can have one to four professional subjects, thus the total of professional subjects in Table 1 differs from the number of the population in the study. The professional subjects referred to in the table were included by 90% of the study participants in their Master's degree program, together with BME. The most popular minor subject supplementing BME was Electronics, included in their degree program by 47% of those who have written their Master's thesis on BME (24% of all the study participants). Electronics was also the most popular major subject when BME was a minor

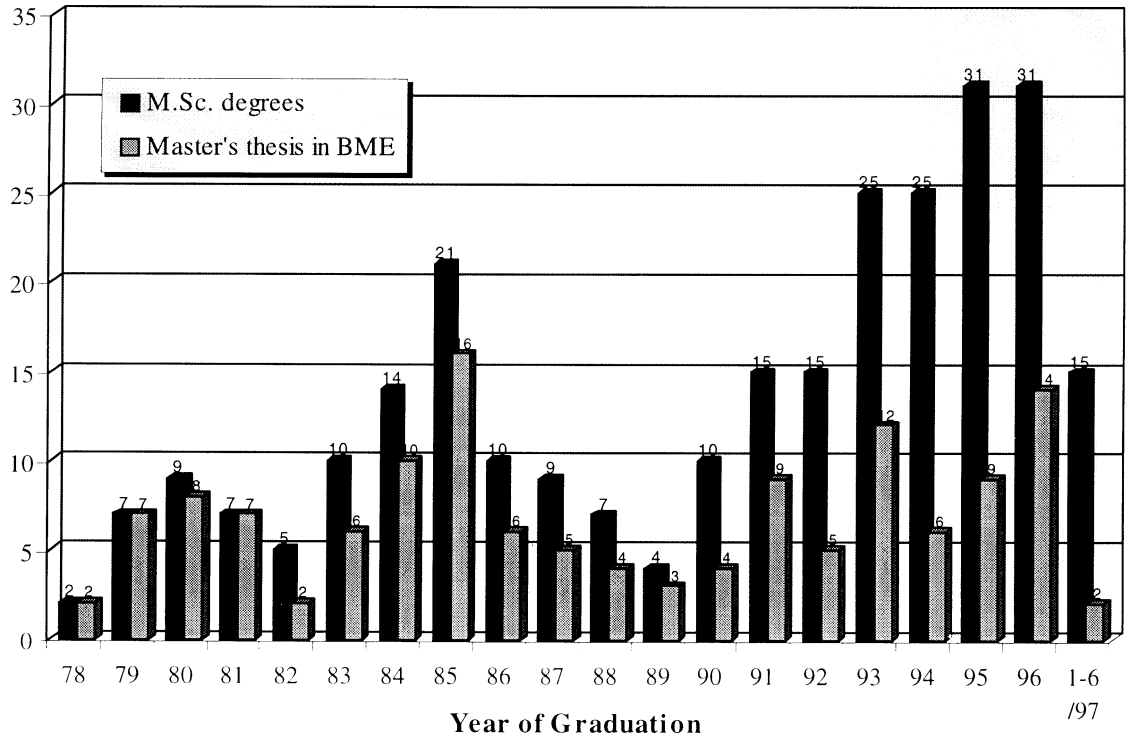

Fig. 1. Number of students who have included BME in their M.Sc. degree (total 272) and who have written their Master's thesis in BME (total 137) by graduation year.

subject. This was followed by Digital and Computer Systems, Measurement Technology, and Physics. These four professional subjects had been included in their degree program by 65% of the participants, together with BME. In addition to the professional subjects included in the table, students have over the years combined BME studies with a number of professional subjects not mentioned in the table (such as Mathematics, Chemistry, and Occupational Safety Engineering).

Duration of studies and age at graduation

No precise number of attendance months could be specified on the basis of the archives and student register. However, the average time spent from enrollment at the University to the completion of the M.Sc. degree in the entire research population was 6 years and 8 months (average in TUT in 1997 was 6.5 years). Figure 2 presents the graduate volumes distributed in accordance with the total length of studies. At the fastest, the Master's degree had been completed in 2 years and 4 months, whereas the longest period taken for graduation was 19 years and 6 months since enrollment at the University. All those who graduated in less than two years came from the International Graduate School and already had a B.Sc. as a basic degree. They were not included in the calculation. Their average graduation time was 1 year and 3 months.

The average graduation times for those who graduated in the 1980s and 1990s were similar (in the 1990s graduation time was 2 months shorter). It was noteworthy that at the beginning of the 1990s (1991–1993), during the economic recession years in Finland, the average time taken to graduate was six months shorter than the average of the entire research population. Females had graduated on average in a period 9 months shorter than males.

RESPONSE TO SURVEY

The questionnaire was returned by 206 persons, corresponding to 77% of the sample for the postal questionnaire study. A total of 135 questionnaires (66%) were returned with names, whereas the figure for anonymous responses was 71 (34%). Of the respondents, 84% were males and 16% were females, corresponding to the 74% and 84% respondence rate for men and women, respectively. Those who graduated in the 1990s accounted for 65% of the respondents. Apart from the fact that the number of graduates from the 1990s was larger

Table 1. The most popular professional subjects combined with BME when BME was the major subject (the other subject being a minor) or a minor subject (the other subject being the major).

Other professional subject	BME major	BME minor
Electronics	64	21
Digital and Computer Systems	52	5
Measurement Technology	45	3
Physics	37	6
Signal and Image Processing	20	14
Software Systems	16	15
Industrial Management	15	9

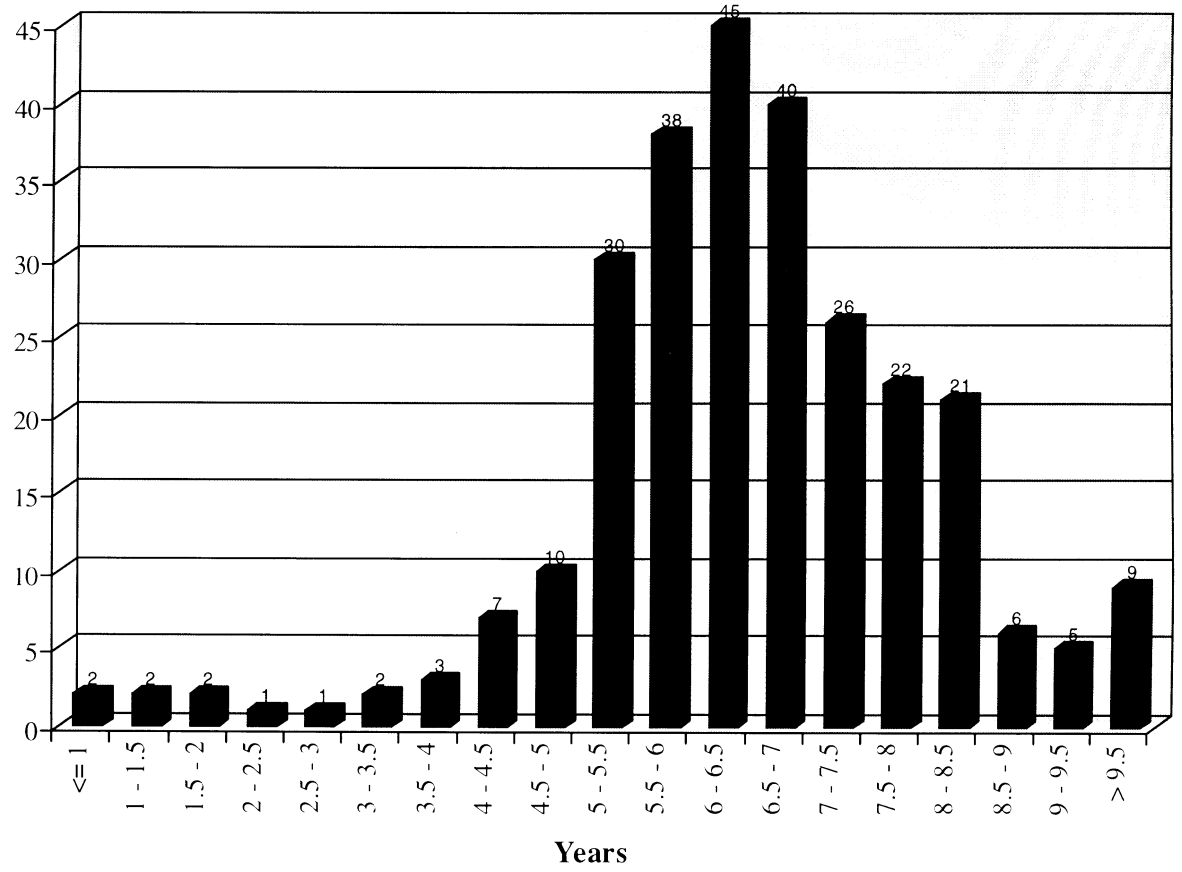

Fig. 2. Number of students who had included BME in their M.Sc. degree by time taken to graduate (total 272). The time taken to graduate was calculated as the difference between the graduation date and enrollment at the University. All those who graduated in less than two years were from the International Graduate School and had a B.Sc. degree from their home university.

than from the 1980s, the respondence rate of those who had graduated in the 1990s (79%) was also higher than with those who had graduated before 1990 (68%).

PLACEMENT IN WORKING LIFE

Location where Master's thesis was written

The location where the engineering work and the Master's thesis were done was asked in the questionnaire using a very coarse classification. The majority of the theses had been written either at TUT (44%) or in the industrial sector (38%). The proportion of theses done at the University has decreased over the years, whereas that done in industry has increased. As recently as in the 1980s 33% of the respondents had completed their thesis for industry, whereas the corresponding proportion for the 1990s was already more than 40%. In the last three years, the proportion of theses completed for industry has further increased up to 49%.

Employment situation after graduation

The engineers who have studied BME have found a placement in working life extremely quickly after their graduation (Fig. 3). Of the 203 respondents, 95% had acquired a job within six months after graduation. For eight persons, finding the first job had taken more than six months after their graduation. The effects of the economic recession in Finland at the beginning of the 1990s were generally discernible in job placement, since more than 70% of all the respondents who had not immediately found employment had graduated between 1990 and 1995.

The type of the first employment for the

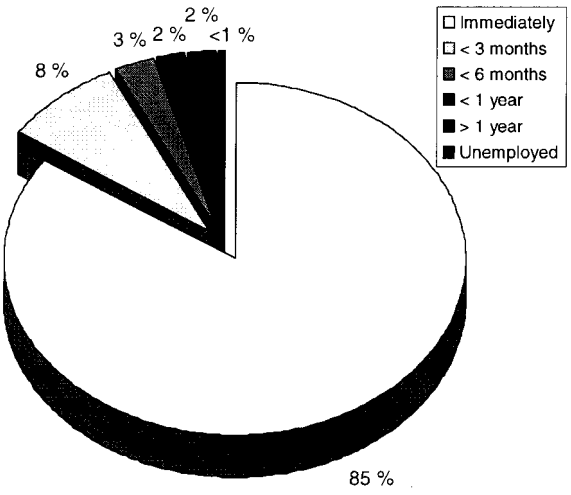

Fig. 3. Placement in working life after graduation.

majority of the respondents (95%) was full-time. Only 11 persons worked in a part-time job as their first employment. Conversely, the difference between permanent (57%) and fixed-term (43%) employment was not equally clear-cut. The economic recession years of the 1990s were clearly manifest in the type of employment. Whereas in the 1980s only one third (31%) of first employment contracts were fixed-term, at the beginning of the 1990s this type of employment already accounted for nearly two thirds (63%). Since 1995 the situation has recovered to the level of the 1980s.

The majority of graduates (57%) found their first job in the Tampere area. The intake of graduates by the Helsinki and Turku areas accounted for 22% and 10%, respectively.

Correspondence between the first job and education

The respondents had done extremely well in acquiring work corresponding with their education in their first job. The majority of the respondents (68%) stated that the tasks of the first job corresponded to a large extent with the education provided by TUT and 26% estimated that their first job corresponded with their education to some extent. Only 13 persons (6%) felt that the first job corresponded with the acquired education only a little or not at all. The differences between those who graduated in the 1980s and 1990s were small. However, an increase in the correspondence between the education provided by TUT and the first job could be detected for the last few years. Of the 63 engineers who had graduated in the last three years, 75% stated that their first job had corresponded with the education obtained from TUT to a large extent.

When asked about the significance of the received BME education in finding their first job, 39% of respondents estimated it to be at least quite significant, 19% somewhat significant and 42% stated that it had no significance in acquiring their first job. The study showed that BME had played a more significant role in acquiring the first job in the 1980s than in the 1990s. In the 1980s two out of three (65%) respondents regarded the received BME education to be at least quite as significant in applying for the first job, but in the 1990s only one third (33%) were of this opinion. Naturally, the situation is influenced by the fact that in the 1990s more students had selected BME as a minor professional subject. This change can undoubtedly also be attributed to the significant growth in telecommunications technology and the good employment situation in the field, particularly in the Tampere area.

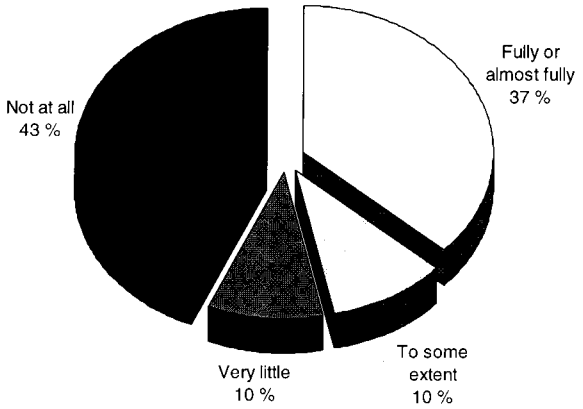

Fig. 4. Relation of job description to BME in first job.

When explaining the relation between the job description of the first placement and BME, respondents were divided almost into two halves (Fig. 4). Almost one half of the respondents (47%) stated that BME was connected with the job description in their first placement at least to some extent, while for a little more than one half (53%) the job description was related to BME either very little or not at all.

A total of 15% (31 persons) of the respondents had worked abroad after graduation for periods varying from two months to 5.5 years (average was 16 months). The most popular country had been the USA (8 persons), followed by Sweden (4) and France (3).

Employment situation at the time of the questionnaire

The type of current employment divided between permanent full-time, fixed-term full-time, and fixed-term part-time was 81%, 13%, and 3%, respectively at the time of answering. Of the persons working in fixed-term full-time jobs, 85% had graduated after 1991, and of those working in fixed-term part-time jobs, all had graduated after 1994. The type of employment was also examined in respect of the type of employer, which showed that of those working in fixed-term full-time jobs and part-time jobs, 85% worked in state institutions. If those respondents working in state institutions were ignored, the proportion of those employed in permanent full-time jobs increased to 95%.

The majority of respondents had been employed in expert positions (62%) in their current organisation. Of the respondents, 32% were employed in managerial positions (manager or director), whereas 5% worked in teaching or salaried positions. Of the persons in managerial positions, 67% had been in working life since the 1980s. Conversely, the majority of those employed in expert positions (81%) had graduated in the 1990s. Of those who graduated prior to 1990, 32% worked in managerial positions and 61% in expert positions. The corresponding figures for those who graduated in the 1990s were 16% in managerial positions and 74% in expert positions. Of the respondents, 11 persons (5%) stated that they had established an enterprise.

The jobs of respondents at the time of conducting the study corresponded to a large extent, some extent, a little, and not at all with the

education obtained from TUT for 50%, 32%, 15%, and 3% of the respondents, respectively. Of the respondents, 30% estimated that BME education was at least quite significant for acquiring their current job. Conversely, 52% perceived that BME education had no significance in finding their current job. BME was fully or almost fully, to some extent, very little, and not at all related to the job description in the current placement for 26%, 10%, 16%, and 48% of the respondents, respectively. The connection of BME with their current job was slightly less for those respondents who had graduated in the 1990s.

The majority of the respondents (47%) had only worked for one employer and 24% had been employed by more than two employers. Of those who graduated prior to the year 1990, only 19% were still working for their first employer, whereas the corresponding proportion for those who graduated in the 1990s was 61%. In this sample, the 'half-life' (the time when at least 50% of the respondents who graduated in a certain year had already worked for more than one employer) was four years: consequently, at the time of conducting the study one half of those who graduated in 1993 were still working for their first employer.

Half of the respondents were still working in the Tampere area. Those who had found their current employment in the Helsinki and Turku areas accounted for 29% and 8% of respondents, respectively. All in all, migration between different locations had been relatively modest; 74% of the respondents were currently still working in the region of their first job.

Area of assignments and responsibilities

Table 2 presents a list of all the respondents' assignment and responsibility areas according to their job descriptions at the time of answering. The proportions in Table 2 indicate the percentages of respondents who had that assignment and responsibility area in their job description. The most common assignment and responsibility areas were product development and design, project assignments, and research. Of the respondents, 79% stated that at least one of these belonged to their assignment and responsibility areas. Product development and design was more frequently represented by those who graduated in the 1990s (62%) than by those who graduated in the 1980s (44%). Conversely, general/business management was distinctly more often related to the jobs of those who graduated in the 1980s (25%) than of those who graduated in the 1990s (2%).

EDUCATION AND INSTRUCTION

Abilities provided by the M.Sc. education for the areas of expertise

The questionnaire study participants were asked about the expertise they needed in their current jobs, giving 16 different areas of expertise (Fig. 5, upper bar). They were asked to estimate the significance of these areas of expertise on a scale of one to five (1—no significance, 5—very significant). The most significant areas of expertise in the respondents' current work were invariably related to language skills, project work and teamwork, use of data processing systems, and written and oral communication skills. A comparison between those who graduated in the 1980s and 1990s showed that the differences in the average significance of the areas of expertise were relatively small in the majority of areas. Distinct exceptions were personnel administration, financial administration, sales and marketing, ergonomics and occupational safety, and industrial design, whose average significance in the current job was considerably greater for those who graduated in the 1980s when compared with those who graduated in the 1990s (the difference between averages was

Table 2. Assignment and responsibility areas in the current job. Answers given by a total of 202 different persons who have chosen a total of 474 areas. The proportions have been determined in relation to the number of respondents.

	Total (202)	Men (172)	Women (30)
Product development and design	55% (112)	57% (98)	47% (14)
Project assignments	33% (67)	33% (57)	33% (10)
Research	32% (64)	34% (58)	20% (6)
Sales and marketing	15% (30)	13% (23)	23% (7)
Data processing	14% (29)	13% (23)	20% (6)
Teaching and training	14% (28)	14% (24)	13% (4)
Technical and general design	10% (20)	11% (19)	3% (1)
General/business management	10% (20)	12% (20)	—
International trade assignments	9% (19)	10% (17)	7% (2)
Consulting	9% (18)	9% (15)	10% (3)
Quality-related assignments	9% (18)	8% (14)	13% (4)
Operation and maintenance	7% (15)	9% (15)	—
Personnel administration	4% (8)	4% (7)	3% (1)
Financial administration	3% (6)	2% (4)	7% (2)
Purchasing and materials assignments	3% (6)	3% (6)	—
Patenting assignments	3% (6)	3% (6)	—
Production planning and management	2% (5)	3% (5)	—
Other	1% (3)	2% (3)	—

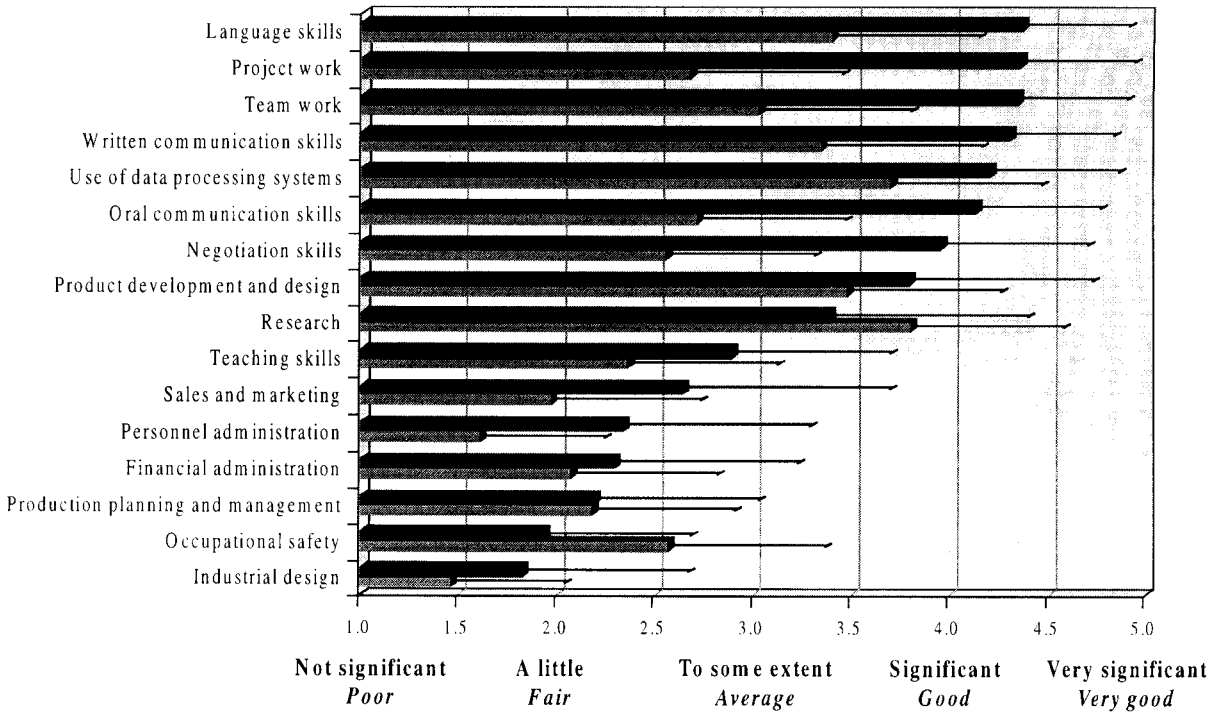

Fig. 5. Significance of areas of expertise required in job (upper bar) and abilities imparted by M.Sc. education (lower bar), presented as averages and standard deviations.

more than 1.5 units). Such a large difference can probably be attributed to the fact that the respondents who have been engaged in working life for a longer period are probably employed in administrative, managerial, or marketing positions to a larger extent. The only area of expertise that was regarded as slightly more significant by those who graduated in the 1990s was production planning and management.

The questionnaire also enquired as to the abilities provided by the M.Sc. education for the areas of expertise (Fig. 5, lower bar). For this question the evaluation scale was extended by one more alternative, 6—don't know (has not been included in the calculation of averages), enabling the respondents to ignore such areas of expertise for which they did not have experience or knowledge in respect of M.Sc. education. According to the respondents, the education had succeeded best in providing abilities for the areas of expertise concerning research, use of data processing systems, product development and design, language skills, and written communication skills. When comparing the abilities imparted by the education from the viewpoint of those who graduated in the 1980s and 1990s, the latter had generally evaluated the abilities provided by the education better than had the former. A noticeable difference could be detected in project work, teamwork, production planning and management, sales and marketing, and financial administration, for which the average of answers of those who graduated in the 1990s was more than half a unit better.

When comparing the correspondence between the education and the significance of the areas of expertise required at work, the most considerable deficiencies appeared to occur in project and teamwork, as well as in oral communication and negotiation skills. Of the abilities in the areas of expertise provided by the M.Sc. education, only research and ergonomics and occupational safety were slightly oversized in respect of their current job.

The respondents were asked to name three languages which were the most important for their work. English was among the three most important languages for all the respondents who had answered the question. Also German (mentioned by 46% of the respondents) and Swedish (40%) stood out in significance from the other languages (French, Russian, Chinese, Japanese, Italian, and Flemish).

Fields of science and technology required at work

In addition to the areas of expertise, the respondents estimated the significance and necessity of various fields of science and technology for their current jobs using the scale of one to five (Fig. 6). The fields of science and technology included in the questionnaire had primarily been selected on the basis of the professional subjects included by the respondents in their Master's degree program. On average, the most significant fields of science and technology were Digital and Computer Technology, Software Engineering, Telecommunication Technology, Electronics, Signal Processing, and Measurement and Information Technology. On the basis of the result, it can be stated that on average the respondents had already in their student years succeeded extremely well in choosing appropriate studies for their future jobs, since the

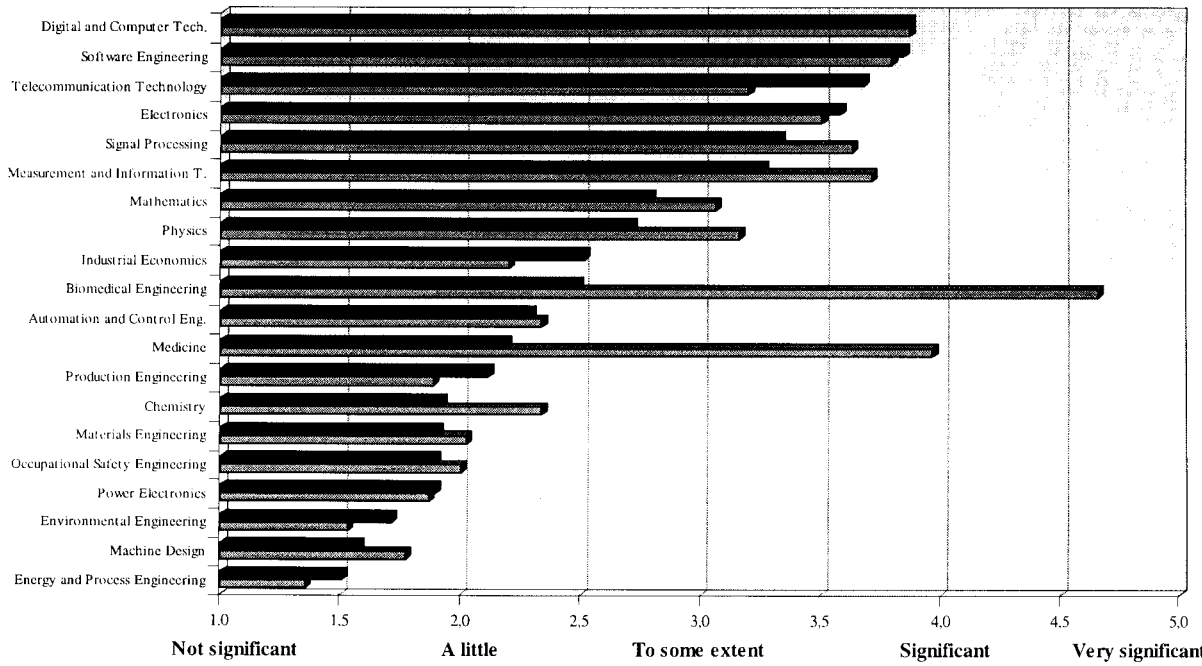

Fig. 6. Significance of various fields of science and technology required in current job for all respondents (upper bar) and for those respondents whose job description at time of answering was fully or almost fully related to BME (lower bar), presented as averages.

above-mentioned fields of technology had also been the most popular major and minor professional subjects (Table 1).

The significance of various fields of science and technology in their current jobs was examined with regard to those respondents who had chosen the alternative 'fully' or 'almost fully' when asked about the relation of their job descriptions in their current jobs to BME. Naturally, the significance of BME was clearly emphasised in this group and almost all of these respondents had estimated it as very significant. The field of science and technology that stood out as particularly significant here was Medicine. In this group, the significance of Measurement and Information Technology, Physics, and Chemistry in their current jobs increased distinctly when compared with the entire research population.

VERBAL FEEDBACK

At the end of the questionnaire there was a free-form section requesting the respondents' opinions on the usefulness of the education provided by RGI and of BME education in general. Moreover, the respondents were provided with the possibility to give comments, criticism, and other feedback to the Institute in the free comments section. Verbal feedback was provided by 84% of the respondents.

The education provided by RGI was perceived by the respondents as an interesting, good, and respected basis also applicable in fields other than BME. Furthermore, the education was regarded as providing a very good general knowledge base and good abilities for conducting and leading interdisciplinary projects. Theoretical instruction was regarded as extremely laudable. The Institute's international character, its English-language instruction, and its accustoming students to using the English language in their reports and presentations were generally regarded positively.

Too modest investment in projectwork and teamwork in both M.Sc. and BME education was regarded as a deficiency. In the opinion of the respondents the planning of the courses of study as well as the degree programs and the counselling of students should place more emphasis on expertise in marketing, project management and planning, together with results evaluation. More medical courses were considered desirable or the possibility to attend more freely and easily courses provided by the Faculty of Medicine at the University of Tampere. Although the Institute's theoretical instruction was praised, a more practical approach in the instruction was also called for.

Contacts with the companies in the field and better consideration of the labour needs of industry operating in the field were regarded as essential. Increasing the number of research and cooperation projects with hospitals and technology centres was deemed to be of utmost importance, but on the other hand cooperation within TUT was also considered important.

As a whole, BME education was perceived as necessary both for the industrial sector and for the development of medicine. The provision of education was regarded as reasonably extensive and of considerably high quality. All in all, BME was perceived as an extremely interesting and inspiring field.

CONCLUSIONS

The survey indicated that the employment situation for M.Sc. graduates, who have studied BME was very good. The education imparted good abilities also for fields other than BME. Thus there is reason to increase the number of students in BME education. Further support for this conclusion was the good correspondence between the first job and the education.

According to the verbal feedback and observations on the importance of language skills in the area of expertise required at work, the internationality of the RGI's education program seems to be a step in the right direction.

The respondents wished also that the education would place an increasing emphasis on such areas of expertise as sales and marketing. Naturally, it is not appropriate to add these to the Institute's range of courses, because other departments at TUT give instruction in these subjects. However, there is a need to provide students with more information as to what type of abilities may be expected of them in working life.

The Institute was criticised for its very strong orientation towards theoretical studies and scientific research. However, this may probably be at least partially interpreted as praise, since as the number of polytechnics is increasing, it is precisely the theoretical orientation that should be emphasised in academic universities. Of course we have to keep in mind that the education should impart the general abilities needed for working in the service of the industrial sector as well as for working life in general.

More cooperation with industry was called for. Although the Institute's most important cooperation partners are naturally hospitals, it is true that as the field of BME continues to grow in Finland, cooperation with industry should be expanded.

Finally, no matter how good a basis is given by M.Sc. education, the field of BME requires continuous education and the primary objective of the RGI is to instruct and encourage students to continue on their own to educate themselves.

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1. Detailed information on the target, philosophy and content of the BME education program surveyed can be found on the Internet at www.tut.fi/~malmivuo/edu/.

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APPENDIX

RAGNAR GRANIT INSTITUTE
TAMPERE UNIVERSITY OF TECHNOLOGY

Please return the questionnaire by X.X.1997!

Please circle or tick the appropriate alternative and/or write your answer to the reserved space. Fill in the form where appropriate. If you think that a particular question does not concern you, please move directly to the following question. *If necessary, you may specify your answer on the reverse side.*

I. BASIC INFORMATION

1. Name (not required)

_____

2. Sex
1 male
2 female

3. M.Sc.(Eng.) degree completed in
19____

4. Where did you write your Master's thesis
1 TUT
2 VTT or similar research institute
3 other public sector institution
4 working for the industry
5 other _____

5. Number of full years in the profession after completing the Master's degree
_____ years

6. How many employers have you had after graduation

_____

II. EMPLOYMENT SITUATION AFTER GRADUATION

7. Placement in working life after graduation (please subtract periods in the army, on maternity leave or suchlike)
1 immediately
2 within 3 months
3 within 6 months
4 within 1 year
5 longer than one year

8. Nature of first employment (please choose one from each group)

1	permanent	1	full-time job
2	fixed-term	2	part-time job

9. Did the first job correspond with the education provided by TUT
1 to a large extent
2 to some extent
3 a little
4 not at all

10. How would you estimate the significance of your Biomedical Engineering education for acquiring your first job
1 very significant
2 quite significant
3 somewhat significant
4 no significance

11. Type of employer in the first job
1 Finnish-owned company
2 foreign-owned company in Finland
3 entrepreneur or self-employed
4 state-owned company
5 state institution (MTI, VTT, TEKES, universities, educational institutions, etc.)
6 other private sector (banks, insurance companies, associations, unions, etc.)
7 municipality or federation of municipalities (e.g. hospitals)
8 other _____

12. How was the nature of job description in the first job related to Biomedical Engineering
1 fully or almost fully
2 to some extent
3 very little
4 not at all

13. Name of first employer

_____

_____

14. Location of first job (city/municipality)

_____

III. CURRENT EMPLOYMENT SITUATION

15. Your current employment situation (you may choose several alternatives)
1 permanent full-time job
2 fixed-term full-time job
3 permanent part-time job
4 fixed-term part-time job
5 full-time entrepreneur
6 part-time entrepreneur
7 full-time student
8 unemployed
9 in labour market training or subsidized employment
10 laid off or working reduced week
11 on maternity/parental leave, child-care leave

12 retired
13 in military/non-military service
14 not in working life for some other reason

16. Position in the current organization
1 director of company, unit or institution
2 manager (production, marketing, etc.)
3 expert position (researcher, designer, etc.)
4 teaching position
5 salaried employee
6 other _____

17. Does your current job correspond with the education provided by TUT
1 to a large extent
2 to some extent
3 a little
4 not at all

18. How would you estimate the significance of your Biomedical Engineering education for acquiring your current job
1 very significant
2 quite significant
3 somewhat significant
4 no significance

19. Type of employer
1 Finnish-owned company
2 foreign-owned company in Finland
3 entrepreneur or self-employed
4 state-owned company
5 state institution (MTI, VTT, TEKES, universities, educational institutions, etc.)
6 other private sector (banks, insurance companies, associations, unions, etc.)
7 municipality or federation of municipalities (e.g. hospitals)
8 other _____

20. How is the nature of job description in your current job related to Biomedical Engineering
1 fully or almost fully
2 to some extent
3 very little
4 not at all

21. Name of employer
_____
_____

22. Location of job (city/municipality)
_____

23. Number of personnel
1 total number of personnel in your own unit _____ persons
2 total number of personnel of the entire company, group or institution _____ persons

24. Number of subordinates
1 none
2 1-9
3 10-19
4 20-49
5 50-100
6 more than 100

25. Your area of assignments and responsibilities (you may choose several alternatives)
1 general/business management
2 international trade
3 purchasing and materials assignments
4 sales and marketing
5 product development and design
6 research
7 personnel administration
8 financial administration
9 production planning and management
10 quality-related assignments
11 teaching and training
12 data processing
13 operation and maintenance
14 technical and general design
15 consulting
16 project assignments
17 patenting assignments
18 other _____

26. Job title (e.g. Production Manager)
_____

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27. Have you worked abroad after graduation
1 yes country and duration of employment
_____
_____
2 no

28. Have you set up your own enterprise
1 yes
2 no

29. If you have set up an enterprise: name of enterprise, year of establishment, location, branch, turnover, number of personnel?
_____
_____
_____
_____
_____
_____
_____

30. Do you intend to establish (have you considered establishing) your own enterprise
1 yes (branch _____)
2 possibly
3 no

IV. EDUCATION AND INSTRUCTION

31. Expertise required in your job

	Significance for your current job					Capabilities provided by M.Sc. (Eng.) education for job description					
	1 no significance	2 a little	3 to some extent	4 significant	5	1 poor	2 fair	3 average	4 good	5 very good	6
project work	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
teamwork	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
oral communication skills	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
written communication skills	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
negotiation skills	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
language skills *)	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
teaching skills	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
product development and design	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
research	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
use of data processing systems	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
production planning and management	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
sales and marketing	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
financial administration	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
personnel administration	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
occupational safety	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
industrial design	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
others											
_____	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
_____	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐
_____	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐	☐

*) Please list 1-3 of the foreign languages most important for your work

_____

32. Other degrees you have taken in addition to your M.Sc.(Eng.)

_____

33. Have you taken a postgraduate degree

1 yes (1 Licentiate degree 2 Doctoral degree)
2 no

34. Do you intend to take a postgraduate degree (Licentiate/Doctoral)

1 yes (field/degree programme _____)
2 maybe
3 no

		Significance for your current job				
		no significance	a little	to some extent	significant	very significant
35.	**Fields of science and technology required in your job**	1	2	3	4	5
	Automation and Control Technology	☐	☐	☐	☐	☐
	Digital and Computer Technology	☐	☐	☐	☐	☐
	Electronics	☐	☐	☐	☐	☐
	Energy and Process Engineering	☐	☐	☐	☐	☐
	Machine Design	☐	☐	☐	☐	☐
	Biomedical Engineering	☐	☐	☐	☐	☐
	Materials Engineering	☐	☐	☐	☐	☐
	Measurement and Information Technology	☐	☐	☐	☐	☐
	Software Engineering	☐	☐	☐	☐	☐
	Signal Processing	☐	☐	☐	☐	☐
	Power Electronics	☐	☐	☐	☐	☐
	Industrial Economics	☐	☐	☐	☐	☐
	Telecommunications Technology	☐	☐	☐	☐	☐
	Production Engineering	☐	☐	☐	☐	☐
	Occupational Safety Engineering	☐	☐	☐	☐	☐
	Environmental Engineering	☐	☐	☐	☐	☐
	Mathematics	☐	☐	☐	☐	☐
	Physics	☐	☐	☐	☐	☐
	Chemistry	☐	☐	☐	☐	☐
	Medicine	☐	☐	☐	☐	☐
	others					
	_____	☐	☐	☐	☐	☐
	_____	☐	☐	☐	☐	☐
	_____	☐	☐	☐	☐	☐

36. **Please estimate the usefulness of the Institute of Biomedical Engineering (Ragnar Granit Institute) in your career (degree programme, theoretical instruction, methods, equipment, internationality, etc.)**

_____
_____
_____
_____
_____
_____

37. **Your opinion on the Biomedical Engineering education in general (quantity, quality, contents, necessity, etc.)**

_____
_____
_____
_____
_____
_____
_____

38. **Comments/critique/feedback to the Institute**

_____
_____
_____
_____
_____