Professional Engineers' Needs for Managerial Skills and Expertise

This report gives the results of a questionnaire sent to a sample of Chartered Engineers resident in the UK in 2002 to survey what 'managerial' skills and expertise they need in their jobs.

The conclusions are intended to guide employers, teachers, training staff, the professional Institutions, regulatory authorities, government departments and engineers themselves on what may be needed stage by stage in the education and careers of professional engineers.

The report includes comparisons with data obtained in a similar survey in 1979.

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1. OBJECTIVE

This report gives the data obtained from a questionnaire sent out to samples of Chartered Engineer members of ten Institutions in April-June 2002. The objective has been to provide up-to-date data to guide employers, teachers, training staff, the professional Institutions, regulatory authorities, government departments and engineers themselves on what management skills and expertise may be needed stage by stage in the careers of professional engineers.

A first such survey was run in 1979[1]. It was proposed because of lack of agreement between all the interested parties on what management skills and expertise are needed by engineers and how they should obtain them. Agreement on answers to these questions seems to continue to be difficult for two reasons:

- Inadequate information on needs. Reports have stated that engineers feel unprepared for what was described as 'management', but information has been lacking on what they meant by the word and how the needs varied from job to job.

- Inconsistent opinions within industry, for instance that courses cannot turn engineers into managers but that engineers need to be educated on cost control and marketing. These inconsistencies may also be due to the vagueness of the word management.

People initially qualified in engineering are amongst the largest source of the top executives of UK companies[2], and one survey indicated that more than 50% of engineers classified themselves as employed in managerial positions. Engineers' managerial skills and expertise are therefore of national importance. Studies in manufacturing in the UK showed that the ability to organise information and communicate was needed by engineers whether formally managers or not. Other stated needs were the ability to supervise and an understanding of industrial relations, but whether because of temperament, education or training, it seemed that some engineers had difficulty in making the transition from the quantitative analysis of physical problems to the qualitative uncertainty of managerial problems. The data to support some of these statements of needs and difficulties was limited, partly subjective and might not be fair comment on engineers educated in more modern courses and good training schemes, but it indicated that preparation for management may be important for many British engineers. On the other hand, questioning of some UK mechanical engineers on their education had showed that they valued their education in "basic principles of engineering" most highly, meaning the technical subjects. Their view was that 'business studies' should be included only if they did not detract from those basics.

The evidence presented to formal inquiries has demonstrated how much policies on the education and training of engineers and managers in this country tend to be influenced by habit and received wisdom. For instance, comments are made that engineering graduates lack practical sense in design or management, compared to their predecessors who were trained by craft apprenticeship and educated part-time or evenings at technical colleges. The very same criticisms were once levelled at those craft-trained predecessors. The lack of reliable information on many such questions may explain why there has been little previous agreement on what are the problems or what should be the remedies.

One trend in degree and continuing education courses for UK engineers over the past 50 years has been to include studies of economics and management subjects. The policies of the Engineering Council and its predecessors have encouraged this[3], but up-to-date data about the present use or future needs for these subjects or how they vary with age and industry has not been available to guide these policies. Our survey was therefore designed to find our what skills and expertise are needed in tasks related to work planning, costs, markets, organisational relationships, contracts, law, etc. in the work of a sample of professional engineers and to see whether the needs may vary with engineers' ages and between branches of engineering. Comparisons with the data obtained in 1979 also make it possible to see any differences since then.

2. THE SCOPE OF THE 2002 SURVEY

The questionnaire was sent to samples of the members of these ten Institutions:

Institute of Marine Engineering, Science & Technology
Institute of Materials
Institution of Chemical Engineers
Institution of Structural Engineers
Chartered Institution of Building Services Engineers
Royal Aeronautical Society
Institute of Energy
Institution of Civil Engineers
Institution of Electrical Engineers
Institution of Mechanical Engineers

The sample size was planned to be a random selection of at least 1 in 300 of Chartered members resident in the UK and not retired, with a minimum of 10 members per Institution. 1 in 300 had been the sample size in the 1979 survey. It was followed in this 2002 survey on the basis that the research team had the capacity to process answered questionnaires if the response rate was up to 40%.

The questionnaire was posted by the Institutions to the samples of their members, with reply envelopes. The alternative of sending out the questionnaire by email was discussed early in 2002 when planning the work with the Institutions. As a result, half the questionnaire to the Institution of Electrical Engineers members were sent that way, and half by post.

At the suggestion of the Institution of Mechanical Engineers copies of the questionnaire were also sent to a sample of their non-Chartered members for comparisons of data with their Chartered members.

Other Chartered Institutions were not included in this and in the 1979 survey because of their smallness or because managerial qualifications in their industries are controlled under legislation. Some of their members may be included on our sample because of multiple membership.

3. THE SCOPE OF THE QUESTIONNAIRE

The questionnaire requested information from individual engineers on:

- Age and sex.
- Number of years in same job, same organisation.
- Size of organization.
- Qualifications.
- Branch of engineering originally qualified in.
- Job title.
- Technological v. managerial content of job.
- Level of responsibility.
- Number of people responsible to.
- Jobs of people to whom give instructions.
- Number and jobs of people directly responsible for.
- Size of organisations and workplace.
- Extent of autonomy in choosing work objectives.
- Extent of authority in production goals, work schedules.
- Extent that work is co-ordinated by on-the-spot discussion or feedback.
- Extent of freedom to adopt own methods.
- Extent that unexpected problems arise.
- Extent that problems are solved according to known procedures.
- Most difficult or demanding aspect of job
- Detail of managerial skills and expertise required, received in training, required in future – in a table of 47 items or elements of management.
- Whether expecting to change job.
- Type of change expected
- Managerial ambitions. +
- What support expected from Institutions in achieving these ambitions. +
- General comments.

A copy of the questionnaire is attached as Appendix A of this report.

The questionnaire was designed to avoid duplicating the information on the types of jobs, ages, qualifications and salaries of British engineers obtained every year or two by the Institutions, the Engineering Council (UK) and its predecessors.

The questionnaire was based upon one used in the previous surveys since 1979. Following consultations with the Institutions, a few changes made were to revise some of the detailed list of skills and expertise to bring it up to date, and add the two questions marked + above. A question on type of production process that had been included in previous surveys was omitted as it had not yielded useable data. The form and scope of the resulting questionnaire was thus very similar to the one used and pilot-tested for the 1979 survey. Further pilot testing was therefore considered to be unnecessary.

For some Institutions' members a question was added asking whether they would like to take part in follow up discussions of the results of the survey.

4. SCALE OF RESPONSE

227 completed questionnaires were received. The response rate was approximately 30% of those sent the questionnaire. This is above that achieved by other surveys, but below the 40% achieved by us in 1979.

Two factors may have influenced the response rate:

- The selection of samples of Institution members was planned to exclude those retired. Over half the replies from one sample stated that they were in fact retired and returned the questionnaire unanswered as requested in the covering letter. By then spare questionnaires could be sent out to only a few further members of that Institution.

- Not all the samples were sent pre-paid reply envelopes.

5. DATA OBTAINED

This section tabulates the data obtained from the Chartered Engineers who sent in completed questionnaires. Comments on the data follow in Section 6.

The demographic data on the respondents' ages, qualifications, etc. is presented first, followed by the data on their managerial roles and needs. This is different to the sequence of the questions in the questionnaire.

In all the tables the figures in square brackets is the data obtained in the 1979 survey.

Table 1 - Age **%** %

Under 30	4 [3]		All UK	0.9
30-39	24 [33]		Chartered	21.2
40-49	33 [29]		Engineers	34.3
50-59	33 [28]		(not retired)	39.8
60+	6 [7]		in 2001	

Note: The figures in the right-hand column above for UK Chartered Engineers are based upon the Engineering Council's 2001 survey, the latest with data on ages, but as that data includes retired engineers the percentages have been adjusted on the basis that 94% of those who would have responded to the questionnaire were under 60 years of age[4].

Table 2 - Sex **%** %

Male	93.4		All UK Chartered Engineers	96.4
Female	4.8		(not retired) in 2002 [5]	3.6

Table 3 - Number of years in present organization **%**

Less than one year	8 [6]
1-2 years	13 [7]
3-5 years	19 [18]
6-10 years	16 [17]
11-20 years	27 [27]
21+ years	18 [25]

Table 4 - Number of years in present job **%**

	16 [12]
	34 [18]
	23 [30]
	12 [17]
	10 [16]
	3 [6]

Table 5 - How many people employed at own place of work **%**

1-49	23 [26]
50-99	6 [13]
100-499	29 [29]
500-999	17 [13]
1000-4999	18 [15]
5000-9999	4 [1]
10000 +	3 [2]

Table 6 - Place of work is one office, one site or department of a larger organization ? **%**

Yes	76
No *	23

* i.e. is an independent organization

Table 7 - Branch of engineering originally qualified in: **%**

Aeronautical Engineering	6 [3]
Building Engineering	1
Civil/Construction Engineering	18 [21]
Chemical Engineering	6 [7]
Electrical Engineering	13 [15]
Electronic Engineering	13 [4]
Marine Engineering	0.4 [3]
Materials Science	4
Mechanical Engineering	19 [26]
Municipal Engineering	0 [2]
Production Engineering	3 [5]
Structural Engineering	2 [4]
Engineering Science	2 [0.5]
General Engineering	2
Combination of Engineering Subjects	2 [2]
Science Subjects	2 [3]
OTHERS: Computer Systems Engineering, Geotechnical Engineering, Metallurgy, Gas Engineering, Fuel Technology, Environmental Engineering (2), Solar PV Industry, Manufacturing Systems Engineering	5 [1]

Table 8 - Type of qualification **%**

University degree	69 [47]
CNAA degree	9 [3]
Diploma in Technology	2 [3]
Professional Institution examination	10 [20]
HND	4 [5]
HNC	1 [21]
NVQ	1
Other	4 [1]

Table 9 - Hold any other higher educational qualification ? **%**

Yes	47

Table 10 - Type of other higher education qualification **%**

MBA	5 [0.5]
Other Management (a)	6 [8]
Teaching qualification	1 [2]
Masters degree in Engineering, Technology, Mathematics or Science	11 [2]
Postgraduate Diploma / Certificate in Engineering / Technology / Applied Science	4
PhD, DSc	10 [0]
Other professional (b)	1 [0.2]

Notes: (a) e.g. Diploma in Management Studies, MSc in Business Management
(b) e.g. Accounting, Insurance

Table 11 - Technological v. managerial content of job **%**

Predominantly technological	24 [21]
Predominantly managerial	36 [28]
Both equally	40 [50]

Table 12 - Level of responsibility **%**

Director / Partner	20 [18]
Manager / Chief Engineer /Chief Technologist / Principal Engineer / Principal Technologist	49 [41]
Senior Engineer / Senior Technologist	19 [32]
Professional Engineer / Professional Technologist	9 [9]
Others: Consultant, Principal, Professional Teacher and Welfare Worker	2 [0.2]

Table 13 - Number of people respondent responsible to **%**

None	13 [8]
1	48 [64]
2	17 [18]
3	4 [3]
4 or more	12 [6]

Table 14 - Variety of jobs of people responsible to **%**

Scale *

0 (Secretarial or ancillary staff only)	63 [69]
1 (One different level of responsibility or field of expertise)	19 [16]
2 (Two different levels of responsibility or fields of expertise)	10 [4]
3 (Three ditto)	3 [2]
4 (Four ditto)	1 [0.2]
5 (Five ditto)	0.4

* See also Appendix C

Table 15 - Respondent gives instructions to people not Directly responsible for **%**

Yes	74 [73]
No	25 [26]

Table 16 - Variety of jobs of people to whom respondent gives instructions but for whom not directly responsible **%**

Scale (as above)

0	34 [28]
1	25 [26]
2	26 [17]
3	6 [1]
4	0.4 [0.7]
5	0

Table 17 - Number of people respondent is directly responsible for **%**

None	30 [21]
1	7 [5]
2-3	13 [17]
4-6	18 [26]
7-10	13 [13]
11-20	10 [8]
21-50	3 [8]
50+	4 [1]

Table 18 - Range of jobs of people for whom respondent is directly responsible Scale (as above) **%**

0	41 [34]
1	14 [19]
2	20 [15]
3	12 [5]
4	3 [2]
5	0.4 [0.7]

Table 19 - Autonomy, coordination, solution of problems

Table 19 is a reproduction of the set of pair differential questions included in the questionnaire. The numbers written on to this copy show the percentage distribution of the answers.

I have a great deal of say in choosing between different work objectives to be adopted.	24 [32]	38 [34]	17 [10]	6 [7]	6 [6]	7 [8]	1 [4]	I have no say. Decisions about work objectives are made by someone else.
I have a great deal of say in decisions about production/ project goals and/or work schedules.*	27 [29]	34 [30]	17 [13]	8 [6]	4 [5]	5 [8]	3 [8]	I have no say. Decisions about production/ project goals and/or work schedules are made by someone else.*
I co-ordinate the work of others by on-the-spot discussion and feedback as it progresses.	12 [14]	15 [14]	13 [11]	20 [32]	20 [8]	15 [11]	2 [10]	I co-ordinate the work of others by advance regular planning and programmes.
My own work is co-ordinated by on-the-spot discussion and regular feedback as it progresses.	8 [15]	13 [15]	13 [10]	27 [26]	16 [12]	14 [13]	7 [8]	My own work is co-ordinated by advance planning and programmes.
I have freedom to adopt my own methods of work.	38 [52]	45 [34]	12 [8]	4 [4]	1 [1]	0.4 [1]	0 [1]	The methods of work I use are decided in detail by someone else.
Unexpected problems rarely arise in my work	2 [2]	4 [5]	8 [3]	12 [13]	17 [11]	32 [29]	22 [38]	Unexpected problems frequently arise in my work.
Most problems are solved according to known procedures	1 [5]	8 [14]	15 [14]	26 [27]	23 [18]	19 [17]	6 [6]	Most problems require novel solutions.

*** Note**: The word "project" was not included in the above questions in the 1979 survey.

Table 20 - Most difficult or demanding aspect of job

The answers to this open-ended question ranged widely, and are of course in each respondent's own words. All their individual statements of what is the most difficult or demanding aspect of their job are listed in Appendix B. For the purpose of analysis these statements have been classified under the following 12 headings:

	%
None	1 [13]
Industrial relations	0 [6]
People management (a)	15 [14]
Communications (b)	3 [13]
Control (c)	26 [7]
Keeping up with new developments (d)	5 [9]
Dealing with other senior managers (e)	7 [19]
Technical (f)	9 [8]
Business (g)	14 [11]
Political interference, bureaucracy	1
Risk (h)	4
Improvements and change (i)	7 [1.9]
Safety	0.4

Notes:

(a) including staff recruitment, selection and management, managing a diverse team, motivating others, morale, redundancy, interfacing with out-sourced business, discipline of children in school teaching

(b) including extracting information from colleagues, briefing seniors, assimilating information, writing reports

(c) including targets, budgets, finance, resources, time management, workload, being called out at any hour, balancing competing time demands, travelling and hours worked, having time to do everything, priorities, flexibility, immediacy of decision-making, paperwork, managing service with limited resources, cost control, providing client satisfaction while meeting profit targets, balancing attention to detail against risk of oversight

(d) including new standards, legislation, technical literature

(e) including holding company together, relationships with senior management, getting business to accept need for change, obtaining consensus, not having executive control

(f) including design, innovation, project management, commissioning of new plant, research projects, setting technical standards, moving from technical work to managerial , understanding requirements, design fit for purpose, certification, identifying a new method and getting it implemented, managing new developments, planning new courses, teaching

(g) including strategy, policy development, obtaining work, preparation of bids, contracts, relationships with client, assessing clients' requirements, specifications and changes, insurance, relationships with other consultants, with public and non-technical organizations, intercultural relationships, decision processes in a multi-national

(h) including risk assessment, getting performance to quality standards, problem solving, investigating failures, correcting mistakes made by others.

(i) including variety and wide scope, thinking outside the box and changing mindset, being proactive all the time, coming up with novel solutions, persuading technical managers to improve their skills

Table 21 - Expecting to change job in foreseeable future?

	%
Yes	41 [40]
No	58 [59]

Table 22 - Type of job change expected **%**

Promotion in same organisation	13 [19]
A transfer in same organisation	10 [6]
A move to another organisation	11 [13]
A move to self-employment or consultancy	3
Retirement	8 [8]

Table 23 - Management ambitions, in terms of responsibilities **%**

No further management responsibilities	8
Develop my present role, self development, recognition	9
Less responsibility	2
Greater responsibility, promotion to next level up	15
Become responsible for multi-disciplinary schemes	2
Setting policy on standards, etc	0.4
Manage several projects, manage all work in an area	11
Senior line management role	5
Strategic planning	2
Consultancy, management consultant, adviser, self-employed	4
Managing Director of own company, strategic management	2
Voluntary work, hobbies	0.9

Support expected from the Institute / Institution / Society to assist in achieving management ambitions

The respondents' answers to the question what support they expected from their Institute / Institution / Society to assist them in achieving their ambitions are listed in Appendix D.

These answers are listed in Appendix D as read from the questionnaires and not in any particular order.

Note: The questions on management ambitions and support expected from Institution were not included in the 1979 survey.

Table 24 - Managerial skills and expertise required in job and in future

The form of the page of questions on managerial skills and knowledge required and the data obtained from the whole sample of Chartered Engineers are shown overleaf in Table 24.

The numbers written into this copy of the page show the percentage of respondents who said 'Yes' to each topic. Respondents were asked to tick in a column to indicate 'Yes'. No tick meant 'No'.

The first column in the table in the questionnaire offered the alternatives of 'Frequently' or 'Sometimes'. No definition of frequently or sometimes was given by us, as to do so we thought would complicate the questionnaire and deter respondents. In Table 24 the two are shown separately. In later tables these 'Frequently' and 'Sometimes' figures are combined.

The respondents' 'OTHER' entries of skills and expertise added to the table were: Office management; Interpretation of contract conditions; Quality control; Technical auditing; Safety audit/review; Environmental audit; Environmental law; Policy; Teaching; Incident investigation.

Where no figure appears in square brackets the topic was not included in the 1979 survey.

Table 24 – Detailed 'Management' Skills and Expertise

SKILLS AND EXPERTISE	REQUIRED IN PRESENT JOB		INSTRUCTION RECEIVED IN BASIC TRAINING	INSTRUCTION RECEIVED IN SUBSEQUENT TRAINING	ADDITIONAL REQUIREMENT IN FUTURE CAREER
	Frequently	Sometimes			
Costing, estimating	44 [33]	45 [47]	33 [26]	43 [32]	16 [10]
Project financing	26	41	15	39	22
Evaluate projects	47 [45]	35 [33]	18 [16]	40 [28]	21 [18]
Analyse project risks	42	39	14	46	19
Analyse corporate risks	17	35	5	26	20
Plan and control budgets	52 [45]	25 [21]	19 [10]	44 [28]	18 [21]
Company accounting	12 [7]	21 [14]	12 [5]	25 [17]	15 [14]
Corporate (business) strategy	17	33	4	28	24
Plan and schedule project	47 [39]	39 [34]	30 [17]	52 [28]	16 [12]
Plan new product	20 [11]	26 [14]	6 [5]	20 [11]	11 [4]
Patenting	3 [2]	12 [11]	2 [1]	7 [4]	5 [1]
Plan research	10 [7]	18 [16]	5 [4]	12 [6]	4 [3]
Plan design and development	25 [25]	29 [22]	20 [20]	23 [17]	11 [8]
Plan construction	18 [20]	25 [23]	16 [18]	18 [14]	8 [5]
Plan production	12 [13]	10 [10]	11 [11]	15 [11]	5 [4]
Plan maintenance	14 [14]	21 [20]	11 [10]	19 [15]	7 [6]
Plan stocks and materials distribution	7 [10]	9 [11]	6 [4]	8 [11]	2 [4]
Plan services	14 [14]	15 [17]	6 [6]	12 [8]	7 [4]
Marketing of products	8 [6]	21 [7]	6 [1]	19 [10]	8 [7]
Marketing of consultancy, technical services	15 [8]	21 [12]	4	19 [6]	12 [6]
Use of company law	6 [3]	30 [18]	12 [5]	21 [12]	19 [12]
Use of health & safety law	30 [23]	39 [44]	23 [6]	45 [35]	20 [18]
Use of employment law	10 [8]	36 [25]	10 [3]	27 [17]	16 [15]
Use of consumer safety law	4 [3]	13 [11]	3	9 [6]	8 [6]
Draft contracts	15 [17]	30 [27]	12 [12]	27 [18]	17 [12]
Negotiate contracts with client/customer	23 [18]	34 [23]	8 [4]	34 [13]	19 [14]
Negotiate with supplier/contractor	26 [28]	37 [31]	6 [5]	32 [15]	14 [10]
Negotiate with employees	20 [17]	27 [24]	7 [4]	30 [17]	14 [15]
Negotiate with T.U. representatives	5 [9]	13 [14]	3 [2]	15 [13]	7 [16]
Negotiate with public authorities (not as customers)	11 [13]	17 [20]	1 [2]	11 [7]	6 [6]
Negotiate with senior management	36 [34]	33 [24]	4 [1]	23 [13]	12 [12]
Statistics	10 [6]	23 [31]	25 [20]	13 [16]	3 [6]
Operational research	3 [3]	9 [11]	8 [6]	5 [9]	3 [4]
Systems analysis	7 [4]	17 [18]	8 [5]	12 [9]	4 [6]
Organisation and Methods (O & M)	7 [4]	13 [17]	9 [7]	8 [13]	4 [6]
Work study (methods study)	3 [5]	8 [16]	10 [12]	8 [14]	1 [4]
Data processing	12 [12]	17 [28]	14 [12]	9 [22]	3 [12]
Make formal presentations	50	37	27	56	11
Plan and chair formal meetings	51	34	15	43	13
Plan personnel requirements	39 [39]	26 [26]	8 [6]	26 [16]	14 [16]
Recruit and select personnel	27 [29]	36 [36]	7 [6]	35 [23]	15 [18]
Motivate others	62 [66]	24 [15]	13 [8]	42 [30]	13 [15]
Supervise others	63 [67]	25 [16]	16 [9]	42 [30]	14 [16]
Appraise personnel	44	26	9	50	14
Employee training – manual workers	8 [6]	12 [13]	2 [2]	10 [8]	4 [6]
Employee training – supervisors	8 [10]	18 [18]	3 [3]	11 [10]	6 [7]
Employee training – management	13 [11]	23 [17]	4 [2]	19 [14]	11 [8]
OTHERS……..	3 [7]	2 [2]	0 [1]	4 [4]	0.4 [1]

Skills and Expertise Used at Different Levels of Responsibility and Ages

Table 25 shows the data on skills and expertise required in their present jobs for the respondents in each of the four levels of responsibility.

Table 26 shows the data on skills and expertise required in their present jobs for the respondents in each age range.

Formal Instruction in Skills and Expertise Required in Present Job

Table 27 shows the percentage of respondents requiring a skill in their present job for which they had received no instruction. To indicate the relative importance of each item, the first column of data repeats the percentage of respondents stating that they required them in their present jobs.

Data Institution by Institution

Tables 28 and 29 show the responses on skills and expertise required in their present job from the members of each Institution. Table 28 shows this data for the relatively small number of members of seven of the Institutions. Table 29 shows this data for the members of three Institutions for which comparable data is available from the 1979 survey. Table 29 also shows the data obtained from a sample of members of the Institution of Civil Engineers in 1984 in a repeat of the 1979 survey.

In the report on the 1979 survey the data from the members of the Institution of Chemical Engineers and the Institute of Fuel was combined. To provide a comparison the last column in Table 29 also show the combined data obtained in 2002 from their members.

Comparisons of the data obtained in 1979 and in 2002 are affected by two amalgamations of Institutions. In that time the Institution of Municipal Engineers amalgamated with the Institution of Civil Engineers, and the Institution of Production Engineers amalgamated with the Institution of Electrical Engineers. In Table 29 the data obtained in 1979 from the members of those pairs of Institutions has been combined to provide a basis for comparisons with the 2002 data.

Table 25 – Skills and Expertise Required by Level of Responsibility

SKILLS AND EXPERTISE REQUIRED IN PRESENT JOB	Professional Engineer / Technologist	Senior Engineer / Technologist	Manager / Chief Engr. / Technologist Principal / Engr./Techngst.	Director / Partner
Costing, estimating	95	82	88	93
Project financing	62	55	67	82
Evaluate projects	71	80	81	96
Analyse project risks	71	80	81	96
Analyse corporate risks	14	34	53	91
Plan and control budgets	52	55	85	93
Company accounting	19	11	26	80
Corporate (business) strategy	14	32	52	84
Plan and schedule project	86	84	87	89
Plan new product	43	50	43	56
Patenting	0	21	14	22
Plan research	5	21	33	36
Plan design and development	57	57	49	62
Plan construction	52	34	46	44
Plan production	24	14	23	31
Plan maintenance	48	25	38	36
Plan stocks and materials distribution	24	11	14	20
Plan services	43	27	25	40
Marketing of products	19	23	23	56
Marketing of consultancy, technical services	29	18	32	69
Use of company law	14	16	33	69
Use of health & safety law	67	57	71	80
Use of employment law	19	18	55	62
Use of consumer safety law	14	14	13	33
Draft contracts	43	30	42	71
Negotiate contracts with client/customer	38	41	55	87
Negotiate with supplier/contractor	43	61	62	76
Negotiate with employees	48	25	52	64
Negotiate with T.U. representatives	5	7	23	24
Negotiate with public authorities (not as customers)	19	32	26	31
Negotiate with senior management	62	61	74	67
Statistics	29	21	33	44
Operational research	5	9	14	16
Systems analysis	10	30	23	29
Organisation and Methods (O & M)	10	11	23	24
Work study (methods study)	5	5	10	24
Data processing	24	34	23	38
Make formal presentations	81	80	90	89
Plan and chair formal meetings	76	71	88	93
Plan personnel requirements	52	41	73	80
Recruit and select personnel	48	32	75	80
Motivate others	71	75	92	93
Supervise others	81	84	89	91
Appraise personnel	62	43	79	80
Employee training – manual workers	38	9	23	16
Employee training – supervisors	29	11	33	24
Employee training – management	29	16	38	60
N	21	44	111	45

Table 26 – Skills and Expertise Required by Age Range

SKILLS AND EXPERTISE REQUIRED IN PRESENT JOB	30 – 39	40 – 49	50 – 59	60 +
Costing, estimating	89	93	85	80
Project financing	71	64	67	62
Evaluate projects	87	80	83	85
Analyse project risks	93	79	76	69
Analyse corporate risks	44	52	60	54
Plan and control budgets	69	80	81	62
Company accounting	33	33	36	39
Corporate (business) strategy	46	59	49	39
Plan and schedule project	91	89	83	69
Plan new product	53	49	37	46
Patenting	9	20	13	31
Plan research	24	29	31	31
Plan design and development	56	55	47	69
Plan construction	49	40	41	31
Plan production	29	23	12	46
Plan maintenance	33	33	39	39
Plan stocks and materials distribution	20	11	12	31
Plan services	31	35	27	23
Marketing of products	27	29	29	39
Marketing of consultancy, technical services	29	35	43	54
Use of company law	35	33	39	46
Use of health & safety law	60	75	69	69
Use of employment law	40	52	48	23
Use of consumer safety law	11	17	20	31
Draft contracts	40	48	47	46
Negotiate contracts with client/customer	60	48	68	46
Negotiate with supplier/contractor	67	60	60	54
Negotiate with employees	53	44	48	31
Negotiate with T.U. representatives	16	15	23	8
Negotiate with public authorities (not as customers)	24	24	35	8
Negotiate with senior management	75	65	71	39
Statistics	44	28	27	46
Operational research	16	9	7	39
Systems analysis	27	23	15	62
Organisation and Methods (O & M)	20	15	17	39
Work study (methods study)	11	9	9	21
Data processing	35	32	19	46
Make formal presentations	84	91	85	77
Plan and chair formal meetings	85	85	88	62
Plan personnel requirements	71	69	61	39
Recruit and select personnel	60	72	61	54
Motivate others	93	83	85	77
Supervise others	95	88	83	69
Appraise personnel	67	77	76	23
Employee training – manual workers	27	19	16	15
Employee training – supervisors	27	32	21	23
Employee training – management	26	41	41	31
N	55	75	75	13

Table 27 – No Formal Instruction in Skills and Expertise Required in Present Job

SKILLS AND EXPERTISE	Required in their present job by %	Percentage of those requiring each item who report no instruction in it
Costing, estimating	89	34 [44]
Project financing	67	37
Evaluate projects	82	42 [53]
Analyse project risks	81	36
Analyse corporate risks	52	46
Plan and control budgets	77	34 [55]
Company accounting	33	25 [46]
Corporate (business) strategy	50	47 [51]
Plan and schedule project	86	27 [78]
Plan new product	46	51 [57]
Patenting	15	68 [82]
Plan research	28	56 [69]
Plan design and development	54	42 [51]
Plan construction	43	41 [49]
Plan production	22	32 [42]
Plan maintenance	35	40 [52]
Plan stocks and materials distribution	16	46 [58]
Plan services	29	49 [66]
Marketing of products	29	41 [51]
Marketing of consultancy, technical services	35	48 [78]
Use of company law	36	35 [55]
Use of health & safety law	69	25 [47]
Use of employment law	46	33 [50]
Use of consumer safety law	17	49 [67]
Draft contracts	45	35 [51]
Negotiate contracts with client/customer	57	39 [72]
Negotiate with supplier/contractor	63	47 [77]
Negotiate with employees	47	38 [61]
Negotiate with T.U. representatives	18	30 [52]
Negotiate with public authorities (not as customers)	28	57 [78]
Negotiate with senior management	69	66 [77]
Statistics	33	21 [35]
Operational research	12	33 [50]
Systems analysis	24	37 [58]
Organisation and Methods (O & M)	20	41 [42]
Work study (methods study)	11	21 [29]
Data processing	29	45 [39]
Make formal presentations	87	26
Plan and chair formal meetings	85	41
Plan personnel requirements	65	56 [74]
Recruit and select personnel	63	41 [65]
Motivate others	86	42 [59]
Supervise others	88	44 [60]
Appraise personnel	70	27
Employee training – manual workers	20	49 [64]
Employee training – supervisors	26	54 [66]
Employee training – management	36	47 [56]

Table 28 – Skills and Expertise Required in Present Job by Institution Members (see also next page)

SKILLS AND EXPERTISE REQUIRED IN PRESENT JOB	IMarEST	IMtls	IChemE	IStructE	CIBSE	RAero Soc	IEnergy
Costing, estimating	100	75	100	91	100	92	100
Project financing	33	75	83	64	89	54	67
Evaluate projects	100	63	83	73	100	69	78
Analyse project risks	100	63	92	64	89	77	78
Analyse corporate risks	67	50	50	47	67	38	56
Plan and control budgets	100	50	92	73	89	77	89
Company accounting	33	13	33	27	56	8	67
Corporate (business) strategy	33	38	67	18	56	62	56
Plan and schedule project	100	63	100	82	100	92	89
Plan new product	33	38	58	27	33	46	44
Patenting	0	38	0	9	0	15	22
Plan research	0	50	17	46	33	15	66
Plan design and development	33	25	58	64	67	54	33
Plan construction	33	25	75	55	67	8	22
Plan production	33	38	42	18	22	15	22
Plan maintenance	33	25	58	18	56	31	33
Plan stocks and materials distribution	33	38	25	9	0	15	11
Plan services	67	25	33	18	67	15	44
Marketing of products	33	25	42	9	22	23	33
Marketing of consultancy, technical services	33	38	42	46	56	23	89
Use of company law	0	25	33	36	11	8	67
Use of health & safety law	33	50	67	55	78	46	67
Use of employment law	0	50	42	27	44	39	56
Use of consumer safety law	0	38	17	18	11	8	33
Draft contracts	67	25	67	36	44	39	56
Negotiate contracts with client/customer	67	25	83	55	78	23	67
Negotiate with supplier/contractor	100	50	75	55	78	62	78
Negotiate with employees	67	38	75	27	44	39	56
Negotiate with T.U. representatives	0	25	33	9	0	8	22
Negotiate with public authorities (not as customers)	33	50	42	36	33	8	22
Negotiate with senior management	67	75	83	55	67	77	56
Statistics	33	50	42	9	33	23	78
Operational research	33	38	25	0	11	16	22
Systems analysis	33	38	17	9	22	31	33
Organisation and Methods (O & M)	0	50	33	0	22	8	11
Work study (methods study)	0	25	17	9	22	16	11
Data processing	0	50	25	27	44	46	44
Make formal presentations	100	75	75	82	78	92	100
Plan and chair formal meetings	100	75	100	64	89	85	78
Plan personnel requirements	67	50	75	73	44	62	56
Recruit and select personnel	67	63	92	55	33	54	44
Motivate others	100	100	92	82	78	77	89
Supervise others	100	75	92	91	78	92	78
Appraise personnel	100	75	92	55	56	69	67
Employee training – manual workers	33	50	25	9	0	15	33
Employee training – supervisors	0	50	42	18	11	8	44
Employee training – management	33	50	58	36	44	39	44
N	3	8	12	11	9	13	9

Table 29 – Skills and Expertise Required in Present Job by Institution Members (continued)

SKILLS AND EXPERTISE REQUIRED IN PRESENT JOB	All CEng (from Table 24)	ICE [+ IMunE]	IEE [+ IProdE]	IMechE [CEng]	IChemE + IEnergy [IFuel]
Costing, estimating	89 [80]	92 (87)[88]	84 [84]	82 [77]	100 [78]
Project financing	67	57	64	78	76
Evaluate projects	82 [78]	78 (80)[82]	84 [84]	89 [76]	81 [67]
Analyse project risks	81	78	83	85	86
Analyse corporate risks	52	49	55	56	52
Plan and control budgets	77 [66]	76 (72)[66]	73 [75]	78 [66]	91 [67]
Company accounting	33 [21]	32 (24)[14]	35 [27]	44 [27]	48 [20]
Corporate (business) strategy	50	49	52	63	62
Plan and schedule project	86 [73]	81 (74)[71]	88 [80]	78 [76]	95 [67]
Plan new product	46 [25]	22 (14)[9]	68 [33]	26 [34]	52 [17]
Patenting	15 [13]	5 (4) [2]	23 [18]	7 [21]	10 [17]
Plan research	28 [23]	16 (20)[20]	25 [21]	22 [26]	38 [25]
Plan design and development	54 [47]	49 (46)[43]	55 [44]	48 [59]	48 [42]
Plan construction	43 [45]	62 (58)[59]	38 [40]	33 [35]	52 [30]
Plan production	22 [23]	11 (13) [6]	22 [29]	30 [29]	33 [28]
Plan maintenance	35 [34]	35 (27)[20]	31 [40]	44 [35]	48 [39]
Plan stocks and materials distribution	16 [21]	5 (16)[15]	16 [25]	22 [24]	19 [20]
Plan services	29 [31]	11 (22)[19]	29 [37]	37 [35]	38 [25]
Marketing of products	29 [13]	22 (8) [2]	31 [17]	37 [18]	38 [14]
Marketing of consultancy, technical services	36 [20]	41 (27)[17]	27 [16]	37 [22]	62 [34]
Use of company law	36 [21]	38 (20)[17]	43 [28]	41 [20]	48 [20]
Use of health & safety law	69 [67]	84 (54)[67]	69 [69]	78 [71]	67 [58]
Use of employment law	46 [33]	57 (29)[32]	43 [34]	59 [35]	48 [33]
Use of consumer safety law	17 [14]	0 (6) [2]	23 [22]	15 [13]	24 [17]
Draft contracts	45 [44]	54 (62)[62]	40 [41]	52 [37]	62 [28]
Negotiate contracts with client/customer	57 [41]	68 (49)[40]	55 [39]	63 [41]	76 [39]
Negotiate with supplier/contractor	63 [59]	76 (60)[60]	60 [57]	48 [62]	76 [50]
Negotiate with employees	47 [41]	57 (38)[39]	40 [40]	56 [45]	67 [50]
Negotiate with T.U. representatives	18 [23]	19 (15)[17]	13 [26]	26 [25]	29 [33]
Negotiate with public authorities (not as customers)	28 [33]	60 (46)[59]	18 [25]	4 [22]	33 [28]
Negotiate with senior management	69 [58]	81 (46)[55]	61 [57]	67 [63]	71 [67]
Statistics	33 [37]	27 (27)[31]	35 [44]	26 [38]	57 [22]
Operational research	12 [14]	0 (7)[11]	12 [13]	15 [14]	24 [11]
Systems analysis	24 [22]	11 (13)[17]	34 [29]	15 [20]	24 [8]
Organisation and Methods (O & M)	20 [21]	16 (14)[22]	20 [22]	22 [22]	24 [6]
Work study (methods study)	11 [21]	0 (14)[18]	10 [22]	15 [25]	14 [11]
Data processing	29 [40]	22 (44)[42]	33 [45]	15 [35]	33 [36]
Make formal presentations	87	81	84	93	100
Plan and chair formal meetings	85	97	83	82	91
Plan personnel requirements	65 [65]	70 (63)[61]	61 [87]	67 [73]	67 [56]
Recruit and select personnel	63 [65]	70 (60)[59]	64 [75]	67 [64]	71 [69]
Motivate others	86 [81]	89 (79)[77]	86 [85]	89 [85]	91 [72]
Supervise others	88 [83]	95 (88)[84]	84 [80]	85 [84]	86 [89]
Appraise personnel	70	78	64	74	81
Employee training – manual workers	20 [19]	16 (15)[14]	20 [16]	22 [18]	29 [33]
Employee training – supervisors	26 [28]	30 (26)[22]	21 [36]	30 [28]	43 [31]
Employee training – management	36 [28]	43 (26)[26]	30 [29]	30 [28]	52 [17]
N	227	37	77	27	21

Note: The figures in round brackets are the results obtained from ICE members in 1984.[6]

Final questions:

Table 30 - Would like a copy of the report on this survey ? **%**

Yes	56 [54]

Table 31 - Would like to take part in follow up discussions of the results of the survey ? * **%**

Yes	41

* The percentage shown is the response of the members of the Institute of Materials, Institution of Civil Engineers, Institution of Mechanical Engineers, Royal Aeronautical Society and Institute of Energy whose questionnaires included this question.

Respondents' General Comments

The final page of the questionnaire invited respondents to add any general comments. Their responses to this invitation are listed in Appendix E.

These comments are listed in Appendix E as read from the questionnaires and not in any particular order.

6. VALIDITY OF THE DATA OBTAINED

The Respondents

The distributions of the respondents by age and by sex shown in Tables 1 and 2 correspond to the data on Chartered Engineers from the recent surveys by the Engineering Council (UK). That our 2002 respondents are older than those questioned in 1979 accords with the report by the Engineering Council (UK) of the change in the age profiles of Chartered Engineers in 2001 compared to 1988. Also consistent with this is our data that a greater proportion of the 2002 respondents state that they are in the higher levels of responsibility compared with those in 1979.

The data on the respondents' autonomy and authority in their present jobs shown in Table 19 is consistent with data obtained by the Engineering Council (UK), as discussed in the next section.

No other data on UK engineers is known to be available for comparison with the data obtained from our questionnaire.

Half of the sample of the Institution of Electrical Engineer's members were sent the questionnaire by post, and half by email. Appendix G shows that there were some differences between the two in their qualifications, ages, levels of responsibilities and technological v managerial content of jobs, and the respondents sampled by email were rather younger than is typical of that Institution's Chartered Engineer membership as a whole.*

Answers to the Questions

The few interviews conducted when pilot testing the questionnaire in 1979 indicated that those respondents had had little difficulty in understanding the questionnaire and that we could make valid interpretations of their answers to it.

Some of the answers to the questionnaire as used in 2002 indicate that two questions in it may have been unsatisfactory:

- Negotiations with senior management - Table 24 shows that 67% of the respondents who classified themselves as in the top level of responsibility also stated that they needed skill etc. in negotiating with 'senior management'. They presumable meant negotiating amongst their fellow top managers. By 'senior' we meant superiors in a hierarchy. The responses to this question are therefore dubious.

- To how many people are you directly responsible ? - Some respondents answered the question "To how many …" with the same detail as they answered the question "For how many …". We have not included the answers which seemed clearly addressed to the latter question. Others may have read the question the same way, so the net results shown in Table 13 remain dubious.

Inspection of the other answers obtained in 2002 shows no overall bias of characteristics which would suggest that it is unrepresentative of the population of Chartered Engineers. As in any voluntary survey, the questionnaire was more likely to be answered by those with an interest in the subject and actions on it. Engineers whose jobs were predominantly managerial might therefore be unduly represented in the data. But so might engineers who, as quoted earlier, value their education in "basic principles of engineering" and wish to balance the current view that courses should be broader. Other than the respondents' possible interests in responding to the survey we therefore have no reason to doubt that the answers obtained are representative.

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* Organisers of surveys should therefore note that the make-up of the respondents answering by post and by email was different and that there were differences between their answers to the questionnaire.

7. COMMENTS ON THE DATA OBTAINED

Present Jobs – Authority and Autonomy – Table 19

The respondents' answers shown in Table 19 show that they are highly autonomous in choosing their work objectives, decisions about schedules and adopting methods of work. These are characteristics of a profession. This data is consistent with the answers to the question "Which of the following best describes the extent your work is supervised ?" obtained in the 2002 Engineering Council (UK) survey of Registered Engineers and reproduced in a table in Appendix H at the end of this report.

The data in Table 19 shows the extent of our respondents' authority and responsibilities for supervision. Their answers correspond with the answers to the question "Which of the following best describes the extent of your present authority ?" obtained in the 2002 Engineering Council (UK) survey of Registered Engineers also reproduced in Appendix H.

The data in Table 19 also shows that unexpected problems are dominant, and that many require novel solutions. This combined with great autonomy indicates that many engineers need to be quite self-sufficient in understanding the business implications of their decisions and to be equipped with the management techniques to implement these decisions effectively.

Present Jobs – Most Difficult or Demanding Aspect – Table 20

The respondents' statements reproduced in Appendix B range very widely. They are best appreciated from the respondents' own words, but even from the summary of the answers in Table 20 it is evident that control, people-related and business problems dominate the answers and that most of their jobs at all levels of responsibility demand personal and organizational skills and expertise. The statements shown in Appendix B thus provide a basis for defining actions to improve management systems and to plan training and continuing education programmes.

Comparisons with the data obtained in 1979 follow later.

Managerial Skills and Expertise Required in Present Job – Table 24

The data in the first two columns in Table 24 shows that every one of the 47 management skills and expertise listed in the questionnaire were stated as required in their present jobs by at least 10% of this sample of Chartered Engineers as a whole. Some were required by up to 88% of them.

The following were required by at least 75% of all the respondents:

- Costing, estimating
- Supervise others
- Make formal presentations
- Motivate others
- Plan and schedule project
- Plan and chair formal meetings
- Evaluate projects
- Analyse project risks
- Plan and control budgets

Table 24 shows that the following were required by at least 50% of all the respondents:

- Project financing
- Analyse corporate risks
- Corporate (business) strategy
- Plan design and development

- Use of health & safety law
- Negotiate contracts with client/customer
- Negotiate with supplier/contractor
- Negotiate with senior management
- Plan personnel requirements
- Recruit and select personnel
- Appraise personnel

The following were required by less than 25% of the respondents:

- Work study (methods study)
- Operational research
- Plan stocks and material distribution
- Patenting
- Negotiate with T.U. representatives
- Use of consumer safety law
- Employee training – manual workers
- Organisation and Methods (O & M)
- Plan production
- Systems analysis

The prominence of the project-related as well as people-related topics is consistent with choices made by engineers and others when choosing between options in continuing education courses, and also the answers obtained in an early survey of chemical engineers.

Comparisons between Levels of Responsibility, Ages and Institutions

To provide a basis for comparing the skills and expertise required in the respondents' present jobs at different levels of responsibility, ages and Institutions, we have grouped the 47 items in Table 24 into 9 groups, as shown in the following Table 32.

The grouping of the 47 skills and expertise into these 9 groups is based upon factor analysis of the data obtained in 1979, with the additional items added where most closely related.

The right-hand column in Table 32 shows the percentages of the average requirement of the set of managerial skills and expertise included in each of the 9 groups, calculated from the detail in Table 24. The effect of grouping the 47 items is to reduce the range of the data, but the resulting range nevertheless varies from 21% to 86%. In Table 32 the groups are placed in descending order of average requirement group by group.

Following this, Figure 1 displays the relative importance of the 9 groups of skills and expertise in the respondents' present jobs. It illustrates the dominance of the Projects and Leadership groups of requirements.

A series of such figures is then used to see how the requirements vary between different levels of responsibility, ages and Institutions.

Table 32 – Management Skills and Expertise Groups

GROUP OF SKILLS AND EXPERTISE	DETAILED SKILLS AND EXPERTISE INCLUDED	REQUIRED IN PRESENT JOB GROUP AVERAGE %
LEADERSHIP	Make formal presentations	86
	Plan and chair formal meetings	
	Motivate others	
	Supervise others	
PROJECTS	Costing, estimating	82
	Evaluate projects	
	Analyse project risks	
	Plan and schedule project	
BUSINESS	Project financing	53
	Analyse corporate risks	
	Plan and control budgets	
	Company accounting	
	Corporate (business) strategy	
	Use of company law	
PERSONNEL	Use of employment law	51
	Negotiate with employees	
	Negotiate with T.U. representatives	
	Plan personnel requirements	
	Recruit and select personnel	
	Appraise personnel	
COMMERCIAL	Marketing of products	46
	Marketing of consultancy, technical services	
	Draft contracts	
	Negotiate contracts with client/customer	
	Negotiate with supplier/contractor	
R & D	Plan new product	36
	Patenting	
	Plan research	
	Plan design and development	
OPERATIONS	Plan construction	32
	Plan production	
	Plan maintenance	
	Plan stocks and materials distribution	
	Plan services	
	Use of health & safety law	
	Use of consumer safety law	
	Negotiate with public authorities (not as customers)	
TRAINING	Employee training – manual workers	27
	Employee training – supervisors	
	Employee training – management	
TECHNIQUES	Statistics	21
	Operational research	
	Systems analysis	
	Organisation and Methods (O & M)	
	Work study (methods study)	
	Data processing	

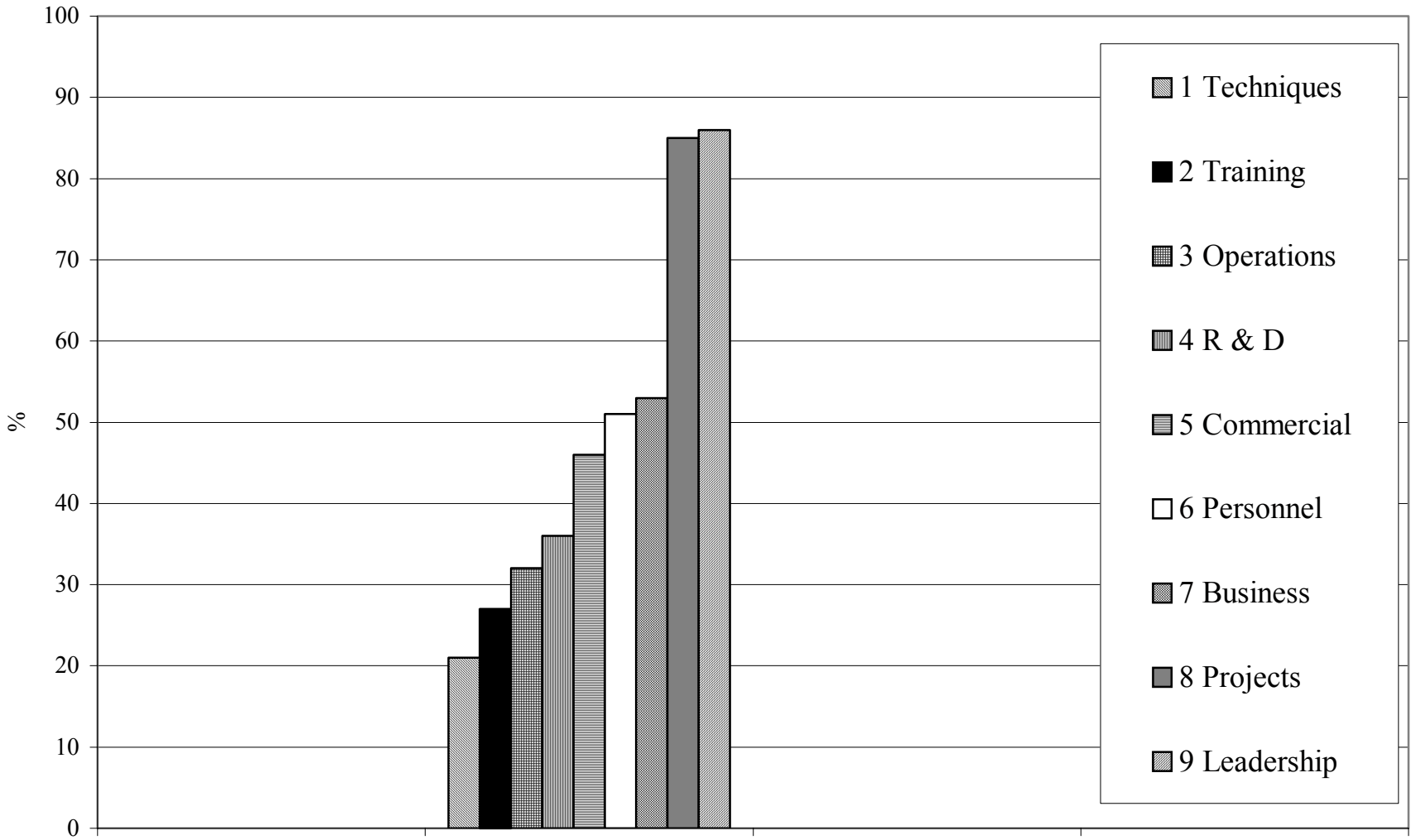

Figure 1 - Groups of Skills and Expertise Required by Chartered Engineers in Present Jobs
Members of 10 Institutions

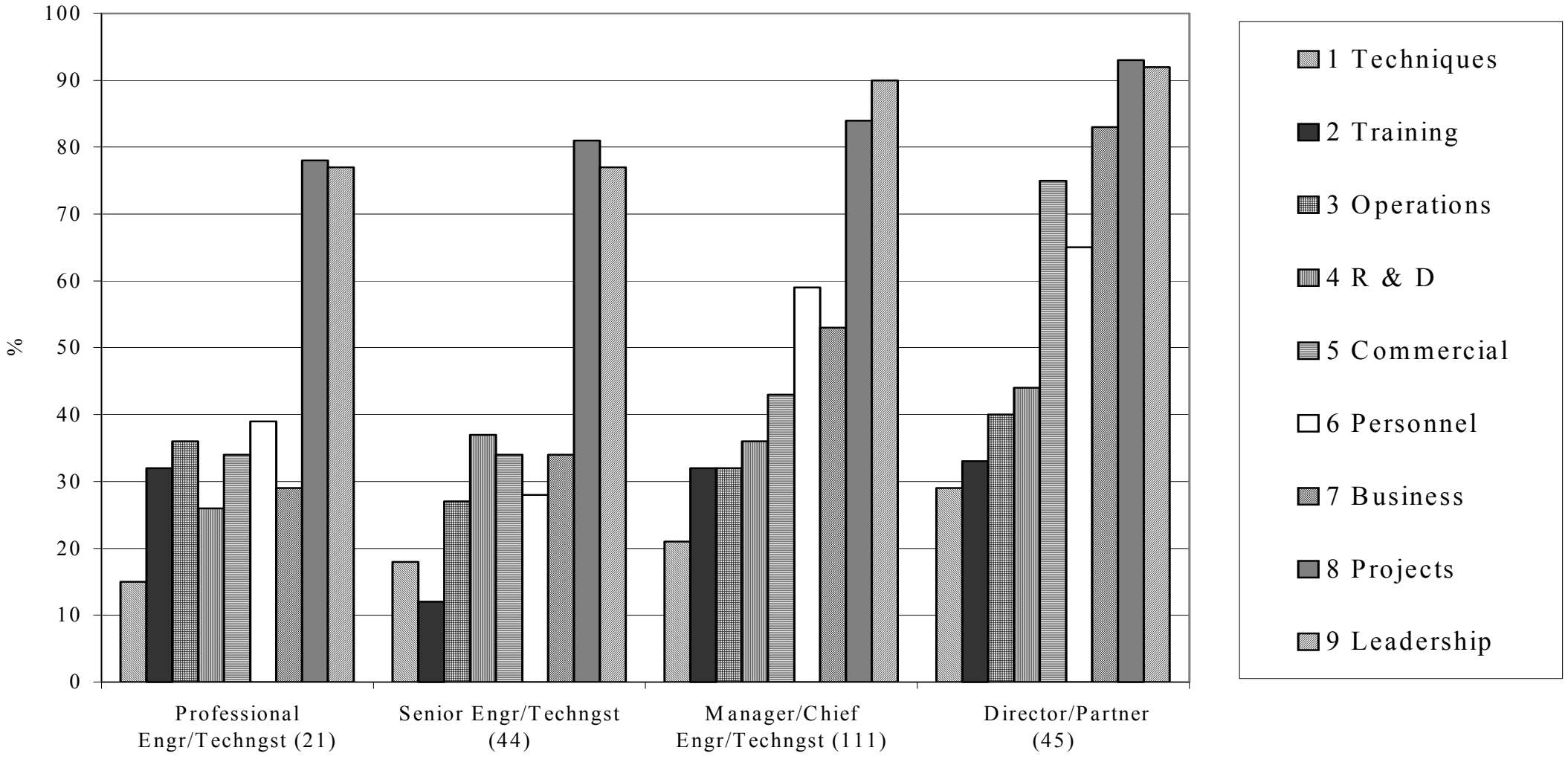

Figure 2 - Groups of Skills & Expertise Required compared with Level of Responsibility

Skills and Expertise Required by Level of Responsibility – Figure 2

Differences in the requirements for the 9 groups of managerial skills and expertise at different levels of responsibility are illustrated in Figure 2. This summarises the detailed differences to be seen in the data shown in Table 25.

Figure 2 shows that the greater requirements for managerial skills and expertise are at the higher levels of responsibility, as expected, but that the requirements do not increase uniformly level by level. Across all four levels the Projects and Leadership groups remain dominant, but the Professional Engineer/Technologist level have a greater requirement for the Training, Operations and Personnel skills and expertise than do the Senior level.

Skills and Expertise Required by Age Range – Figure 3

Differences in the requirements for the 9 groups of managerial skills and expertise at different ages are illustrated in Figure 3. This summarises the detailed differences to be seen in the data shown in Table 26.

Figure 3 shows that the requirements for managerial skills and expertise do not necessarily increase with age. The requirements for the dominant Leadership and Projects groups decrease a little from age to age, and the decrease in the Leadership group amongst the 60+ respondents is accompanied by a decrease in their requirement for Personnel skills and expertise. These respondents show the highest use of Techniques, particularly compared with the respondents in the middle age ranges.

These results of requirements by age compared with those in the previous figure suggest that the respondents tend to be at the peak of level of responsibility is between 40 and 59. We therefore analysed these two variables. The results are shown in Table 33. They confirm that the peak level of responsibility was typically around age 50 rather than later.

Though they overall required less, Figure 3 shows that the 60+ respondents required the most even mix of the 9 groups of skills and expertise. We thought that this and their relatively low requirements for the Personnel and the Leadership skills and expertise may be due to more of them being self-employed than are the other respondents. The questionnaire did not ask directly whether respondents were self-employed, but this may be inferred from the answers given to the questions on how many people they are responsible to and for. Table 33 shows that the 60+ age group reported the lowest levels of responsibility to others and for others. This is consistent with their being more self-employed than are the respondents in the other age groups.

Table 33	**Percentage of Age group at the Director / Partner level**	**Percentage of Age group not responsible to others**	**Percentage of Age group not responsible for others**
Age Group	%	%	%
30-39	11	11	32
40-49	31	10	21
50-59	42	19	31
60+	16	30	73

Roles as consultants and having to be managerially more self-sufficient may explain why the 60+ age group have the highest requirements for the Techniques group of skills and expertise.

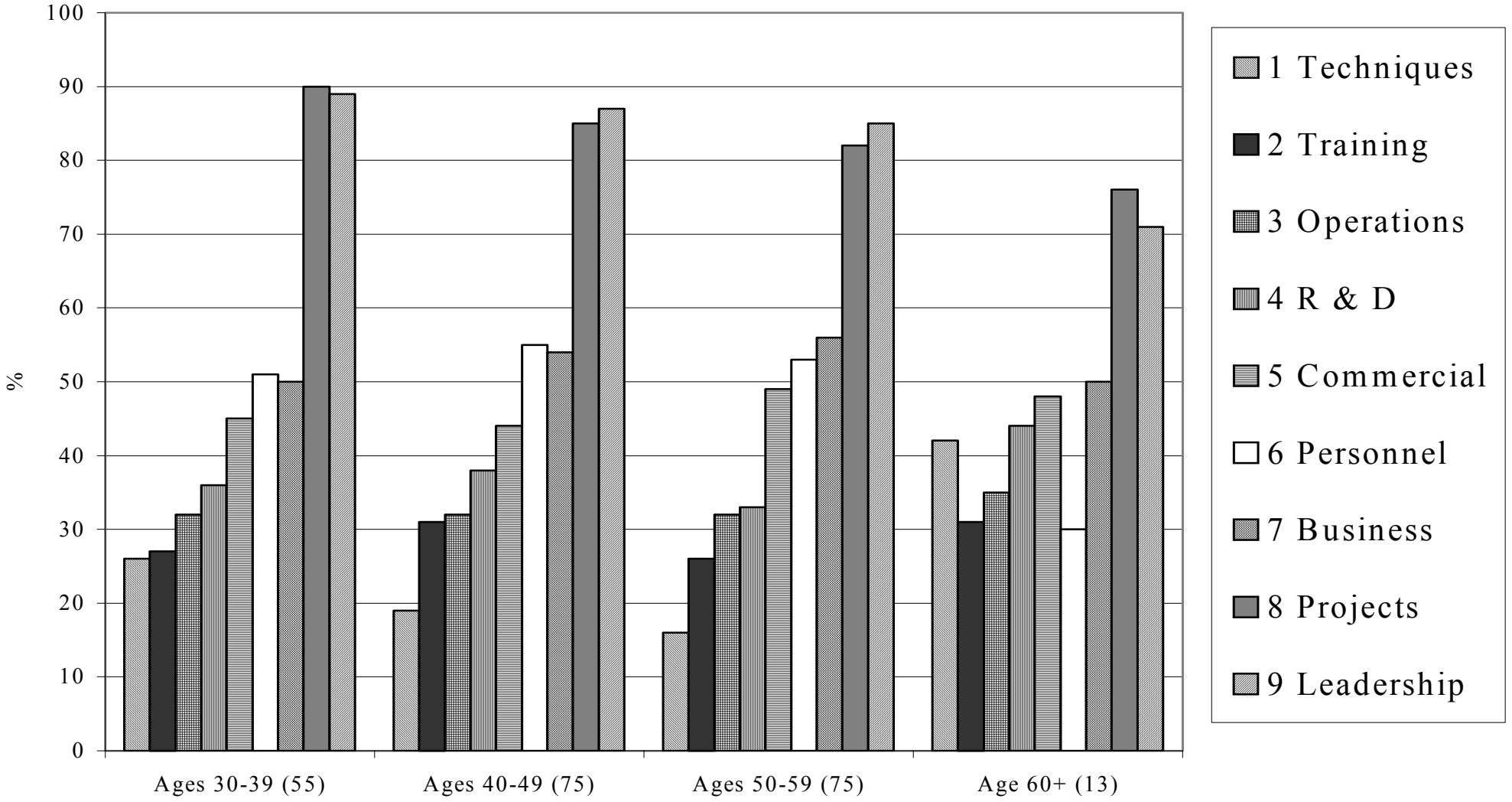

Figure 3 - Groups of Skills & Expertise Required compared with Age

Differences between Skills and Expertise Required by Institution Samples – Figures 4 to 6

Differences in the requirements for the 9 groups of managerial skills and expertise required by the respondents from each of the Institutions are illustrated in Figures 4, 5 and 6. These tables summarise the detailed differences to be seen in the data shown in Tables 28 and 29. The data from all the Institutions is displayed though the samples are small in order to get at least an indication of differences in the relative use of managerial skills and expertise.

Figures 4 to 6 show that the respondents of all ten Institutions are similar in most requiring the Leadership and Projects groups of skills and expertise in their present jobs, though with differences in extent, and some differences between all of them in the relative need for the 9 groups of skills and expertise.

Within each of the 9 groups of topics there are also significant but predictable differences to be seen in the data in Tables 28 and 29. For instance, though in Figure 5 the Institution of Mechanical Engineers and Institution of Civil Engineers respondents are shown to have similar requirements for the Operations group skills and expertise, Table 29 shows that the former have the greater involvement in planning production, and the latter in planning construction. Both of these require similar skills and expertise, so that Figure 5 may correctly show the relative importance of the Operations group of topics, but their application varies from one type of work to another.

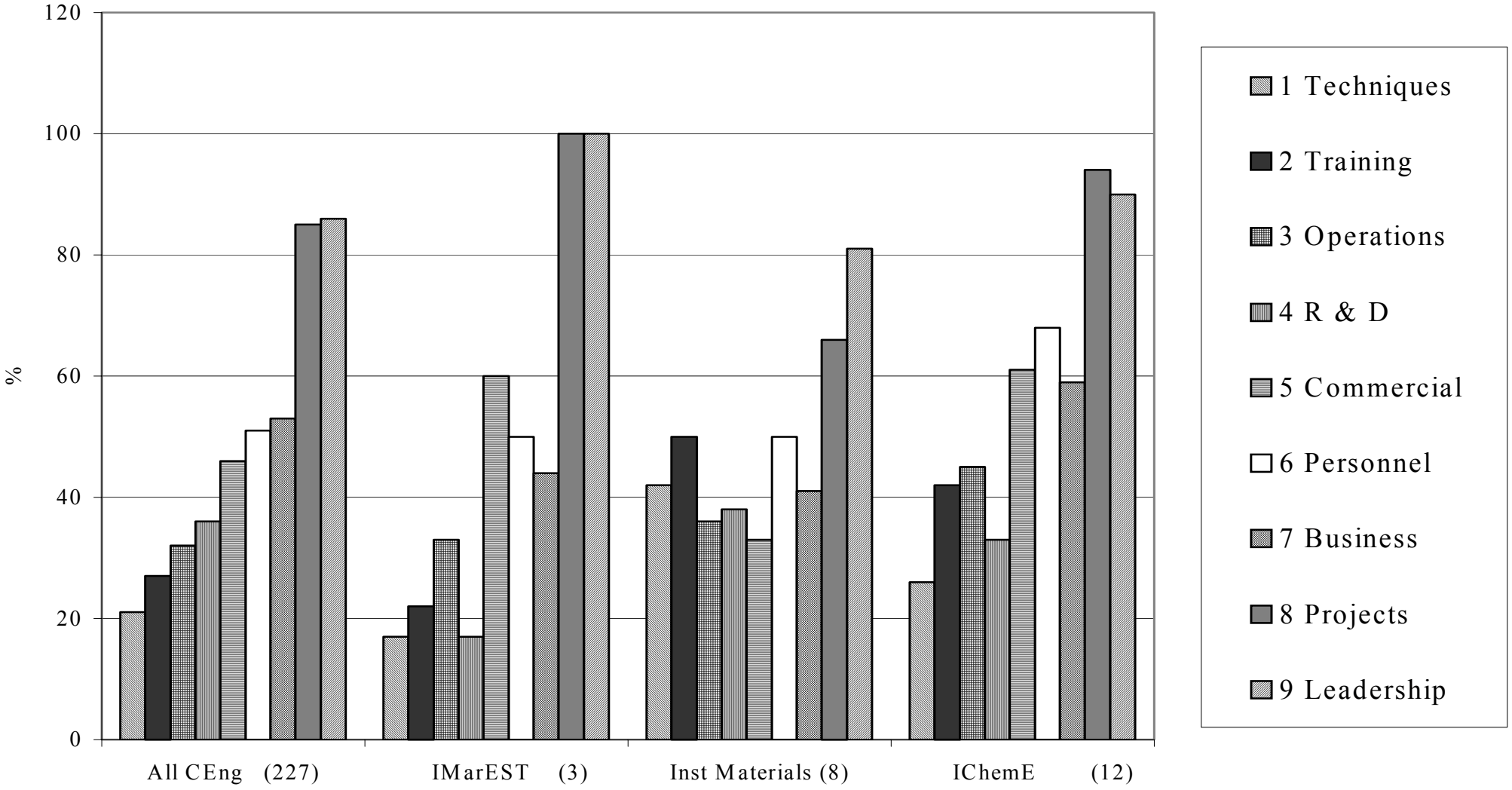

Figure 4 - Use of Groups of Skills & Expertise by Institution Members I

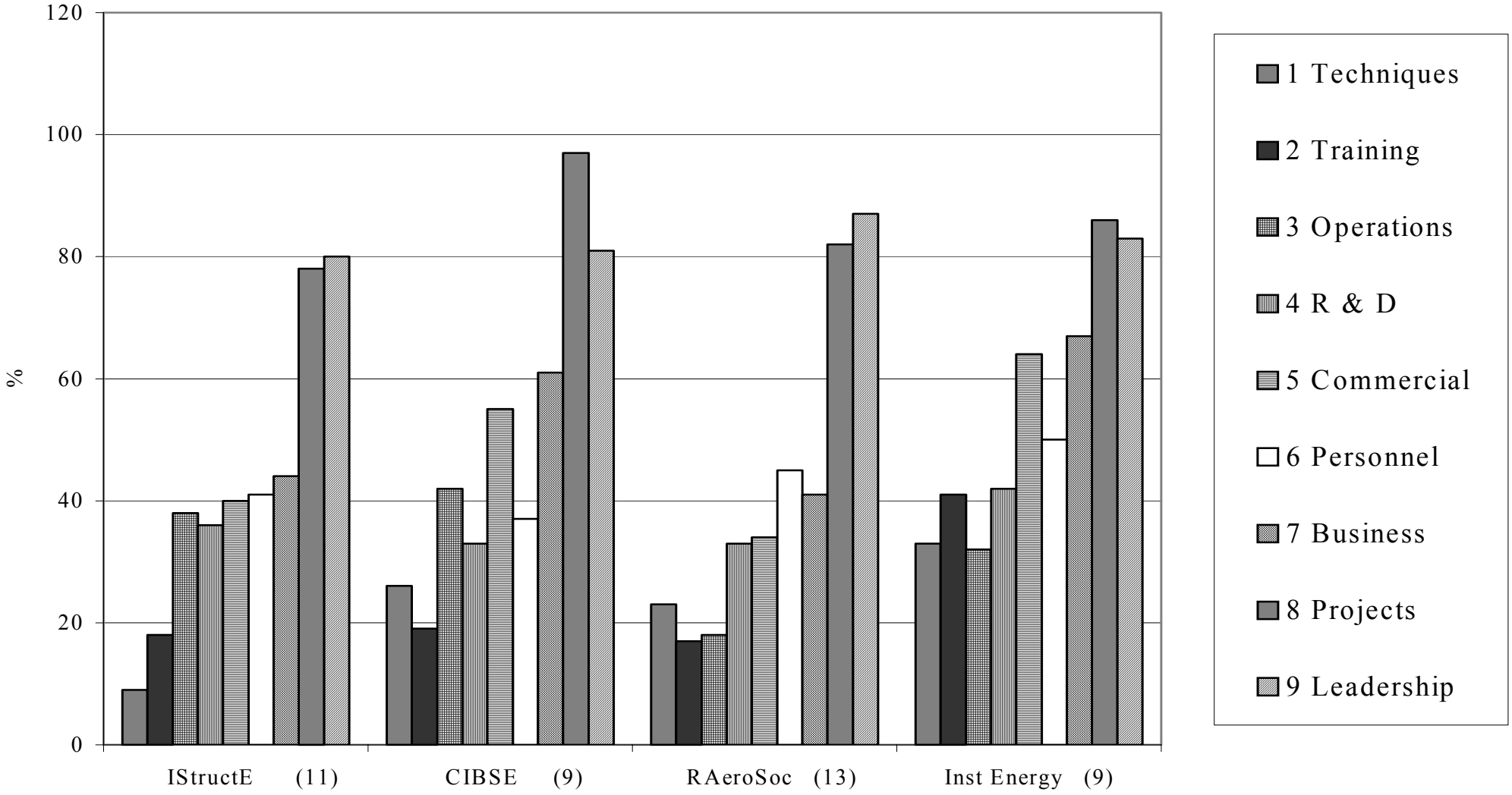

Figure 5 - Use of Groups of Skills & Expertise by Institution Samples - II

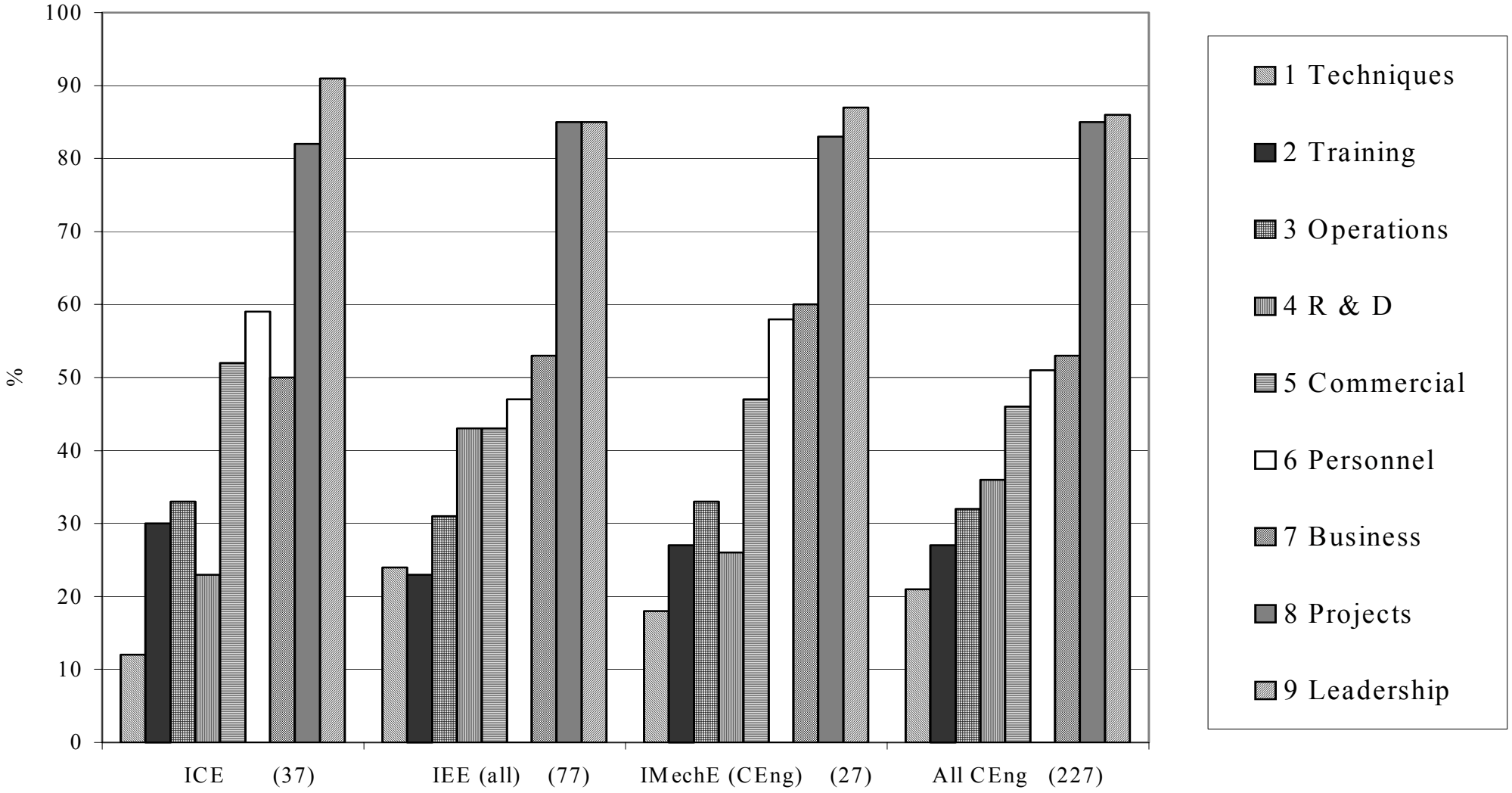

Figure 6 - Use of Groups of Skills & Expertise by Institution Samples - III

Changes Compared with the 1979 Data

As expected, Table 8 shows an increase in the proportion of respondents with university degrees and a great increase in the proportion of respondents with higher degrees, including MBA's.

The 2002 data in Table 5 on how many people employed at place of work shows little change since 1979. The downsizing policies of companies might have shown in changes in that data, but we have not found data on the scale of downsizing in UK business or public services to see whether it might have affected engineering employment over this time. If a continuing trend, downsizing would be expected to increase the importance of buying and selling compared to organizational skills and expertise. An investigation of the trends and effects of downsizing on the content of jobs could be of value to all concerned with the training of engineers.

The 2002 data in Table 21 on whether expecting a job change also shows little change since 1979, yet what is commonly thought to be greater uncertainty today in business and public employment might have caused differences in the answers to the answers to this question. Though only of note in this survey, this is also an issue for investigation.

Compared with 1979, Table 20 shows a marked decrease in the proportion of respondents who did not report anything as the most difficult or demanding aspect of their present job. Financial and other pressures may have increased the difficulties and demands, and perhaps engineers in 2002 were more willing to be specific. The difficulties and demands categorised as 'Control' are mentioned much more in the 2002 answers than in 1979. The detailed statements reproduced in Appendix B indicate that control of costs is a major cause of difficulties and demands. This seems logical given the increasing pressures of competition in business and public services. Perhaps the lower reporting in the 'Communications' category is due to improvements from more use of IT effectively.

The decrease in stating "Dealing with other senior managers" as the most difficult or demanding aspect of job may be misleading because of doubts about the interpretation of 'senior managers'.

The ranking of the 47 items of skill and expertise in the first column in Table 24 as stated by the respondents in 2002 is very similar to 1979, but there is an increase in their requirements for skills and expertise in:

- Costing, estimating
- Company accounting
- Plan new product
- Marketing of products
- Marketing of consultancy, technical services
- Use of company law
- Use of employment law
- Negotiate contracts with client/customer
- Negotiate with senior management

There is a decrease in:

- Plan stocks and material distribution
- Negotiate with T.U. representatives
- Negotiate with public authorities (not as customers)
- Statistics
- Work study (methods study)
- Data processing

but in any case none of the latter are greatly used items.

Preparation Received for Managerial Tasks – Table 27

The data in the second column of Table 27 indicates that many of the respondents to the 2002 questionnaire had not received any training in some important managerial items. Compared to 1979, instruction in many of them has increased, but is still lacking in the heavily used Leadership, Personnel and Project skills, and in most others. Surprisingly, a large number report no instruction in Data processing.

Instruction Received in Subsequent Training – Table 24

The fourth column of data in Table 24 shows that the respondents report considerable increase in instruction received in subsequent training, compared to the 1979 respondents, except in a few items that are those less required in their present jobs. That the respondents report an increase in instruction received in subsequent training is what we would expect given the development of requirements for Chartered Engineers to follow CPD programmes.

In answering that part of the questionnaire the respondents were not saying that they had obtained all the instruction they needed for the rest of their careers. Their statements listed in Appendix B can be taken to mean that many need better instruction, guidance and support in their managerial tasks. Evidence that instruction received is inadequate (or ineffective) in managerial skills such as communications is also to be found in another review of statements by engineers and others in industry questioned on what are the greatest problems in project management[7].

Requirements in Future Careers – Table 24

The data in the last column in Table 24 indicates that respondents considered that they would require most of the skills and expertise for their future careers, and in particular:

- Corporate (business) strategy
- Project financing
- Evaluate projects
- Analyse corporate risks
- Costing, estimating
- Use of health & safety law
- Analyse project risks
- Use of company law
- Negotiate contracts with client / customer
- Plan and control budgets
- Costing, estimating

and the need for these has on balance increased since the 1979 survey.

Support Expected to Assist in Achieving Management Ambitions – Appendix D

Respondents stated in their own words their answers to the question what support they expected from their Institute / Institution / Society to assist them in achieving their ambitions. All are listed in Appendix D. They vary widely. They are not readily classifiable, but the following are the most common categories:

- Continuing professional development, including for senior colleagues
- Career advice
- Meetings
- Networking
- Library and journals, including job opportunities
- Standards and best practices

- Help for small and medium size enterprises (SME's)
- Promoting the role and recognition of engineers
- Business Centre services
- Professional indemnity insurance

It was helpful to this survey that respondents who stated that they expected little or no support from their Institution to assist in achieving their managerial ambitions were nevertheless willing to answer the questionnaire.

Respondents' General Comments – Appendix E

The general comments given by some respondents were also of course stated in their own words. The comments vary widely. They provide comments on maintaining Institution standards, problems of management, careers and employment, engineers in management and issues also mentioned in the statements about support from the Institutions. Some were comments on the questionnaire and the answers given to it.

Non-Chartered Members – Appendix F

At the suggestion of the Institution of Mechanical Engineers the questionnaire was also sent to a random sample of 1 in 300 of their non-Chartered members.

Tables in Appendix F show the data from the non-Chartered and the Chartered members of that Institution. There were some differences between the two in their qualifications, ages, levels of responsibility and technological v managerial content of jobs, as would be expected. Table F1 in Appendix F shows that the Chartered members had the greater needs for some managerial skills and expertise, particularly in: Company accounting; Corporate (business) strategy; Company law; Employment law; Negotiating contracts with client/customers; and Data processing. The non-Chartered members had the greater needs in: Planning new products, research, design and development, and construction; Patenting; and Negotiating with public authorities (not as customers). Both groups had similar high needs for the Personnel-related skills.

Postal and Emailed Responses to the Questionnaire – Appendix G

Half of the sample of the Institution of Electrical Engineer's members were sent the questionnaire by post, and half by email.

Tables in Appendix G show data from these two half samples of members of that Institution. There were some differences between the two in their qualifications, ages, levels of responsibilities and technological v managerial content of jobs. For instance, the respondents sampled by post were at more senior levels and older. Interestingly more of them reported technical issues as the most difficult or demanding aspect of their job. The email respondents reported people management as the most difficult or demanding aspect of their job.

Appendix G shows the age distribution of these two sets of respondents and of the whole Chartered membership of their Institution. Our sample has a higher proportion aged 30-39, and a lower proportion aged 60+. This first difference appears to be in those who answered by email. The second difference may be because members do not necessarily notify the Institution that they are retired. Members who were sent the questionnaire but were retired were asked not to answer the questionnaire, so there should be none amongst the respondents to the survey, whereas the Institution totals may include members who are retired. The age distribution of the two half samples combined are closer than is either half sample to the age distribution of the whole Institution. We have therefore used their combined data in the main body of this report, but the result may be that their younger members are over-represented in the data.

8. CONCLUSIONS

The purpose of these surveys has been to obtain quantitative evidence to help provide a basis for reviewing and planning the education and continuing development of professional engineers.

Many of the results are no surprise. They accord with common sense. Comparison with the data from the previous surveys was not the objective, but the differences are what might be expected from known trends. The similarity of the data obtained from the small sample of engineers questioned in 2002 compared with 1979 also suggests that valid information was obtained.

The data shows that most engineers' careers include managerial tasks though many remain in predominantly technological jobs. A quarter of the respondents described their jobs as predominantly technological but over 80% indicated that they needed some of the 'managerial' skills and expertise listed in Table 24. The people-related answers to the question what is the most difficult or demanding aspect of job outweighed the technologically-related answers. For engineers generally, managerial and social skills and expertise may therefore be as important as technical ones, and not least for newly Chartered Engineers. The respondents to the 2002 questionnaire reported a considerable increase in instruction received in subsequent training, compared to the 1979 survey, but they also clearly indicated their wish for more preparation for their future managerial tasks.

It does not follow that engineering students should study management equally with technology. One obvious reason is that some managerial tasks are not encountered until later in a career. The problems may have changed by the time today's students reach the higher levels of responsibility. On the other hand, what is not studied as a student may never be learnt at all, or not learnt at all thoroughly. The increase in 2002 in the proportion of respondents with higher degrees in management subjects indicates that some engineers and employers recognise the need for more professional preparation. This is consistent with the trend for studies to precede experience that is characteristic of the evolution of all professional work.

These surveys were not intended to define a standard scheme of management studies for engineering students and the stages in their careers. The data obtained indicates that the needs vary between the members of the Institutions. We would expect that a survey which questioned a larger sample might well also show differences between different careers within each sector of employment. In any case, variety can be argued as the right pattern in all education policies, to avoid all being wrong, as well as to meet different interests and careers.

Various objectives can be important in planning engineering courses. One argument is that subjects such as economics can have value in educating engineers as citizens, whatever utility they may have vocationally. Also it can be argued that Britain's dependence upon invisible exporting requires the maximum internal investment in education and that for engineers management skills and expertise have higher added-value than more technological ones. That is not to say that academic studies can be a substitute for experience. What can be achieved is a disciplined basis for learning from experience better and faster. Including "management" in engineering courses may also attract good students and help them to obtain jobs. These arguments may explain the current view that engineering courses should be broader. But we have to note that there has been much opinion but little evidence to support or to contradict any of these views. The preference of some of industry's middle and junior managers may be to recruit engineering graduates who have immediately useful knowledge. Employability and then success in the first years of an engineer's career may thus depend upon competence in technical matters combined with communications and managerial skills.

The respondents' statements of the most difficult and demanding aspect of their jobs are an indicator of actions needed by them and their employers. Many of these are probably well known to employers and their advisers and accepted as needing action. Corporate systems also need to be seen to learn. The respondents to this survey stated what they saw as the difficulties and demands. Statements of current problems do not necessarily represent future needs, and the needs as seen by employees do not necessarily correspond with what their employers recognize as important for their business[8]. But

the engineers questioned were at all levels in their organizations. They do or they direct the work which influences the success of their employers. If what they have said is right, corporate actions are needed to reduce the costs of the problems. If what they say is wrong, corporate systems need to learn why they are wrong. Actions which don't appear to address the problems as seen by the people influential on the quality, safety, delivery and cost of products, processes and services may fail to be supported by them.

The surveys have concentrated on the managerial needs of engineers' jobs. The data obtained has indicated that engineers need considerable expertise in some 'managerial' tasks early in their careers even when not in predominantly management jobs, but there is a lack of comparable surveys of the technological content of their jobs to provide a balanced basis for discussing possible changes to courses, training and career development policies. Our samples of the membership of each Institution were also relatively small, and are only another 'snapshot' of jobs at the time. More extensive and regular surveys are needed covering all the work and future needs of engineers at stages in their careers.

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APPENDIX A

April 2002

Dear Member

THE MANAGERIAL CONTENT OF ENGINEERS' JOBS

We should be very grateful if you would help us by giving some information for a survey of the 'managerial' knowledge and skills used by Chartered Engineers. Samples of the membership of other engineering Institutions are being asked to give the same information. The purpose is to provide data to guide policies as to how much expertise in finance, planning, negotiating, industrial organisation, the law, etc, if any, should be included in engineering courses or at various stages of a career in engineering. A similar survey was carried out in 1979, so we shall also be able to see any changes in needs since then.

We therefore ask you to complete the attached questionnaire and return it in the enclosed addressed envelope. Replies will be strictly confidential. Our analysis and conclusions will be circulated to the Institutions, the new Engineering & Technology Board, the Engineering Council (UK), committees and others concerned with engineering and management education.

Please answer the questionnaire in terms of your present work. For our results to be representative, it is important to have replies from people in all sorts of engineering jobs, regardless of 'managerial' content. The variety of work which people trained in engineering go on to do is obviously very wide, so if some of the questions do not appear to be directly relevant to your present work, please answer as best you can. The extent to which engineers not working in industry may have managerial responsibilities is relevant to this enquiry, so if, for example, you are a teacher, please complete the questionnaire.

If you are retired, unemployed, or the questionnaire as a whole is inapplicable to you for another reason, please return it unanswered with a note of the reason.

Many of the spaces for your answers include code numbers for our use in analysing the information. Please ignore these numbers. Please tick the appropriate box corresponding to your answer, or write an answer in where this is indicated.

We shall be most grateful for your help.

Yours truly

In order to be able to contrast skills in different branches of engineering some information on your education is requested:

Q. 1 (a) What is the major subject of your basic educational qualification in engineering

(Please tick one box)

	7	
Aeronautical Engineering …….		01
Building Engineering ……		02
Civil/Construction Engineering …		03
Chemical Engineering ……..		04
Electrical Engineering ……..		05
Electronic Engineering …….		06
Marine Engineering ……..		07
Materials Science …….		08
Mechanical Engineering ……..		09
Municipal Engineering ……		10
Production Engineering ……..		11
Structural Engineering ……		12
Engineering Science ……		13
General Engineering ……		14
Combination of Engineering Subjects		15
Science Subjects ……..		16
Other ……		17

(Please specify)

…..…….

(b) Which of the following is your highest level of qualification in this subject?

(Please tick one box)

	8	
University degree ……		1
CNAA degree ……..……		2
Diploma in Technology ……..		3
Professional Institution examination ….. …		4
HND ……		
HNC ……		5
NVQ at Level …. (Please enter) …….		6
Other ……		7

(c) In which year did you attain this qualification ? …… … (Please write in)

(d) Do you hold any other higher educational qualification ?

	9	
YES		1
NO		2

IF YES, please write in

Title	Year Obtained	10
……	……..	
……	……..	

Q. 2 (a) Please give the full title of your present job

……..

……..

(b) Brief description of duties

……..

……..

……..

Q. 3 Thinking of all aspects of your job, what would you say is the one most difficult or demanding aspect of it, if any? . ……

…… 12

(Please write in)

11 ☐

☐

Q. 4 While acknowledging the complexity of most jobs, do you consider the work you do is

(Please tick one box)

13

Predominantly technological? ….	1 ☐
Predominantly managerial ? ….	2 ☐
Technological and managerial equally? ……	3 ☐
Don't know …….	4 ☐

Q. 5 Which of the following best corresponds to the level of responsibility which you have in your job?

(Please tick one box)

14

Director / Partner …..……..…....	1 ☐
Manager / Chief Engineer / Chief Technologist / Principal Engineer / Principal Technologist ..…...	2 ☐
Senior Engineer / Senior Technologist …….	3 ☐
Professional Engineer / Professional Technologist ..	4 ☐
Other (Please specify below) ……..	5 ☐

……

Q. 6

Here are some pairs of contrasting phrases which might be used to describe your job.
For each pair, please read both phrases before deciding which one best describes your job, then circle one number on each scale accordingly.
If you consider that one or other of the phrases is a very close description of your job, you should circle number 1 or number 7. If one of the phrases is a fairly close description, circle number 2 or 6. If one phrase applies only slightly more than the other, circle number 3 or 5. If both apply equally, circle number 4.

a.	I have a great deal of say in choosing between different work objectives to be adopted.	1	2	3	4	5	6	7	I have no say. Decisions about work objectives are made by someone else. *15*
b.	I have a great deal of say in decisions about production/ project goals and/or work schedules.	1	2	3	4	5	6	7	I have no say. Decisions about production/ project goals and/or work schedules are made by someone else. *16*
c.	I co-ordinate the work of others by on-the-spot discussion and feedback as it progresses.	1	2	3	4	5	6	7	I co-ordinate the work of others by advance regular planning and programmes. *17*
d.	My own work is co-ordinated by on-the-spot discussion and regular feedback as it progresses.	1	2	3	4	5	6	7	My own work is co-ordinated by advance planning and programmes. *18*
e.	I have freedom to adopt my own methods of work.	1	2	3	4	5	6	7	The methods of work I use are decided in detail by someone else. *19*
f.	Unexpected problems rarely arise in my work	1	2	3	4	5	6	7	Unexpected problems frequently arise in my work. *20*
g.	Most problems are solved according to known procedures	1	2	3	4	5	6	7	Most problems require novel solutions. *21*

The next question (Q.7 facing page) refers to a list of skills and areas of expertise which people trained in the various branches of engineering might use. We would like to ask FOUR questions about each item on the list.

In COLUMN 'A' : or COLUMN 'B' :	Are you required to do this type of work FREQUENTLY as part or all of your present job? Are you required to do this type of work SOMETIMES as part or all of your present job?
In COLUMN 'C'	Did you receive any instruction in this area during your BASIC training to qualify as an engineer?
In COLUMN 'D'	Have you received any formal training or instruction in this area SUBSEQUENTLY ?
In COLUMN 'E'	Which of these skills and expertise IN ADDITION TO THOSE YOU ALREADY USE in your present job (Column 'A') do you expect to require in your FUTURE career?

For each item, please TICK (√) if your answer is 'YES'. Leave blank each item which you neither use in your present job, nor have had any training in, nor expect to require in the future.

Q.7

SKILLS AND EXPERTISE	A REQUIRED IN PRESENT JOB		B	C INSTRUCTION RECEIVED IN BASIC TRAINING	D INSTRUCTION RECEIVED IN SUBSEQUENT TRAINING	E ADDITIONAL REQUIREMENT IN FUTURE CAREER	
	Frequently	Sometimes					
Costing, estimating							01
Project financing							02
Evaluate projects							03
Analyse project risks							04
Analyse corporate risks							05
Plan and control budgets							06
Company accounting							07
Corporate (business) strategy							08
Plan and schedule project							09
Plan new product							10
Patenting							11
Plan research							12
Plan design and development							13
Plan construction							14
Plan production							15
Plan maintenance							16
Plan stocks and materials distribution							17
Plan services							18
Marketing of products							19
Marketing of consultancy, technical services							20
Use of company law							21
Use of health & safety law							22
Use of employment law							23
Use of consumer safety law							24
Draft contracts							25
Negotiate contracts with client / customer							26
Negotiate with supplier/contractor							27
Negotiate with employees							28
Negotiate with T.U. representatives							29
Negotiate with public authorities (not as customers)							30
Negotiate with senior management							31
Statistics							32
Operational research							33
Systems analysis							34
Organisation and Methods (O & M)							35
Work study (methods study)							36
Data processing							37
Make formal presentations							38
Plan and chair formal meetings							39
Plan personnel requirements							40
Recruit and select personnel							41
Motivate others							42
Supervise others							43
Appraise personnel							44
Employee training – manual workers							45
Employee training – supervisors							46
Employee training – management							47
OTHERS……..							48
……							49

Q. 8 (a) To how many people are you directly responsible?

(Please tick one box)

22

None ……..		0
One ……		1
Two ……		2
Three …….		3
Four or more ….		4

(b) What jobs do they have?

(Please write in their job title(s))

a ……..

b ……..……

c ……..……

d ……...……...…..

23

(c) Are there people to whom you give instructions but for whom you are NOT DIRECTLY responsible?

24

YES ……		1
NO …….		2

IF YES,

(d) What jobs do these people have?

(Please write in job titles of the main categories)

a ……...…

b ……

c ..……..…

25

(e) For how many people's work are you DIRECTLY responsible? (Your immediate subordinates only)

(Please write in how many ……. and tick appropriate box)

26

None ……..		0
1 ……..		1
2 – 3 …….		2
4 – 6 …….		3
7 – 10 ……		4
11 – 20 ……		5
21 – 50 ……		6
50+ …….		7

IF APPLICABLE,

(f) What jobs do these people have?

(Please write in job titles of the main categories)

a……...……

b ……...……...

c ……..…….……...

27

The various types of organisations which engineers work in may influence the managerial aspects of their jobs. The following questions, therefore, ask about the organisation for which you work.

Q. 9 Approximately how many people are Employed at your own place of work ?

	28	
1-49 …….		1
50-99 …….		2
100-499 …..		3
500-999 …..		4
1000-4999 ...		5
5000-9999 ...		6
10000+ …….		7

Q. 10 Is your place of work one office, one site or department of a larger organization or is it an independent organization ?

	29	
Is one office, etc. of a larger organization …		1
Is an independent organization ……..		2

(Please tick one box above)

Q. 11 How long have you been working

i) With your present organisation ?

ii) In your present job ?

(Please tick one box in each column)

	Years in i) Organisation 30		ii) Job 31	
Less than one year …..		1		1
1 – 2 years ……..		2		2
3 – 5 years ……..		3		3
6 – 10 years ……		4		4
11 – 20 years ……		5		5
21+ years ……..		6		6

FINALLY, SOME QUESTIONS ABOUT YOURSELF

Q. 12 (a) Your age

	32	
Under 30 ….		1
30 – 39 …..		2
40 – 49 …..		3
50 – 59 …..		4
60+ ……		5

(b) Sex

	33	
Male ..…		1
Female …		2

pto

0 i

Q. 13 (a) Are you expecting to change your job in the foreseeable future ?

34

YES … [ ] 1

NO …. [ ] 2

IF YES, (b) Are you expecting -

35

Promotion within the same organisation ? …… [ ] 1

A transfer in the same organisation ? …… [ ] 2

A move to another organisation ? ……. [ ] 3

A move to self-employment or consultancy ? …….. [ ] 4

Retirement ……. [ ] 5

Q. 14 What are your management ambitions, in terms of job title and responsibilities ?

36

Job Title

……

Responsibilities

37

……

……

……

Q. 15 What support do you expect from the Institution to assist you in achieving these ambitions ?

38

……..

……..……

……..

YOUR GENERAL COMMENTS:

THANK YOU VERY MUCH FOR YOUR HELP

Would you like to have a copy of our report on this survey ? …… [ ] 39

Would you like to take part in a follow up discussions of the results of this survey to be organised by the Institution ? …… [ ] 40

(Please tick)

IF YES to either question above, please enter your name and address here:-

……..……..……

…..……..

…… Post Code: …… ……

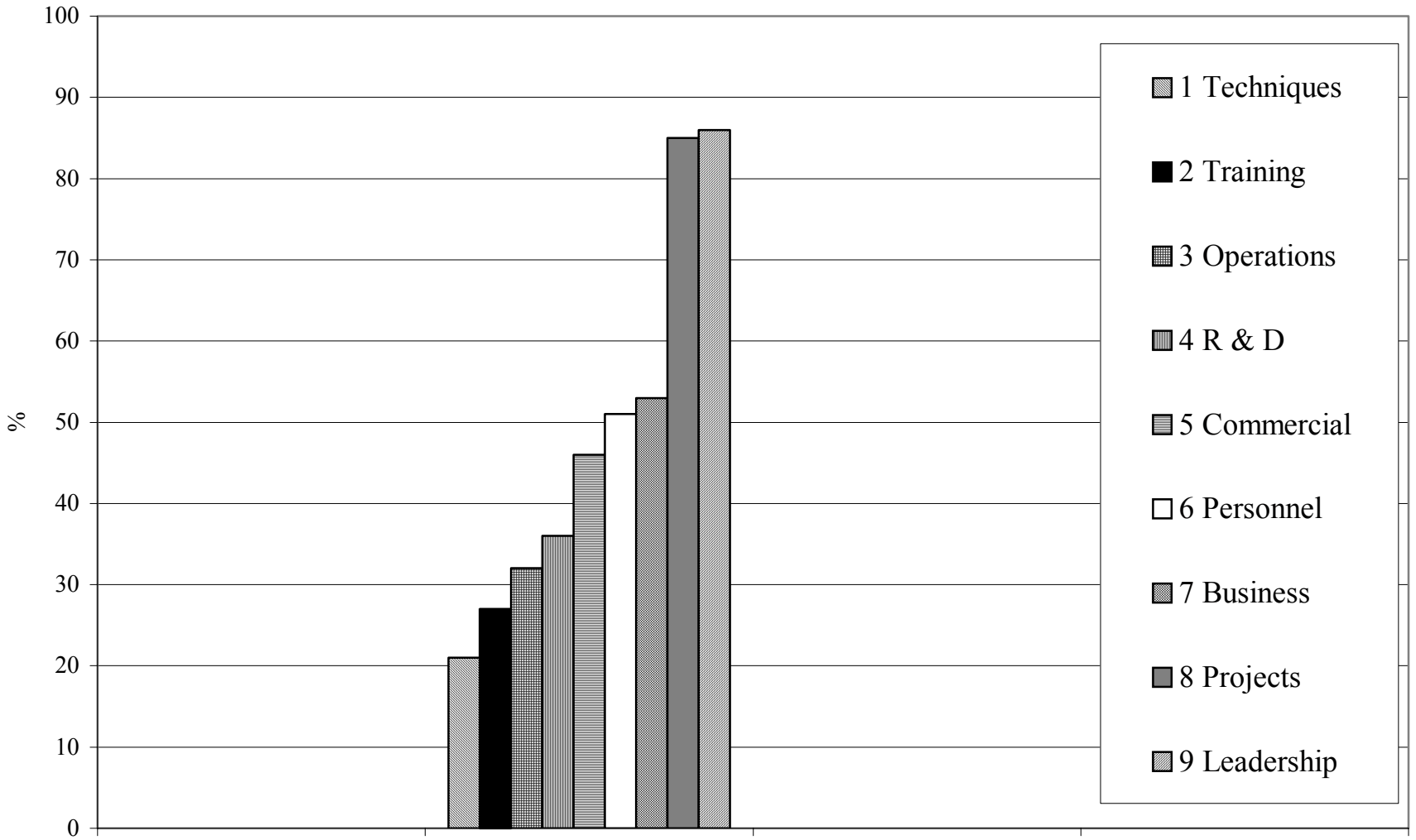

Figure 1 - Groups of Skills and Expertise Required by Chartered Engineers in Present Jobs
Members of 10 Institutions

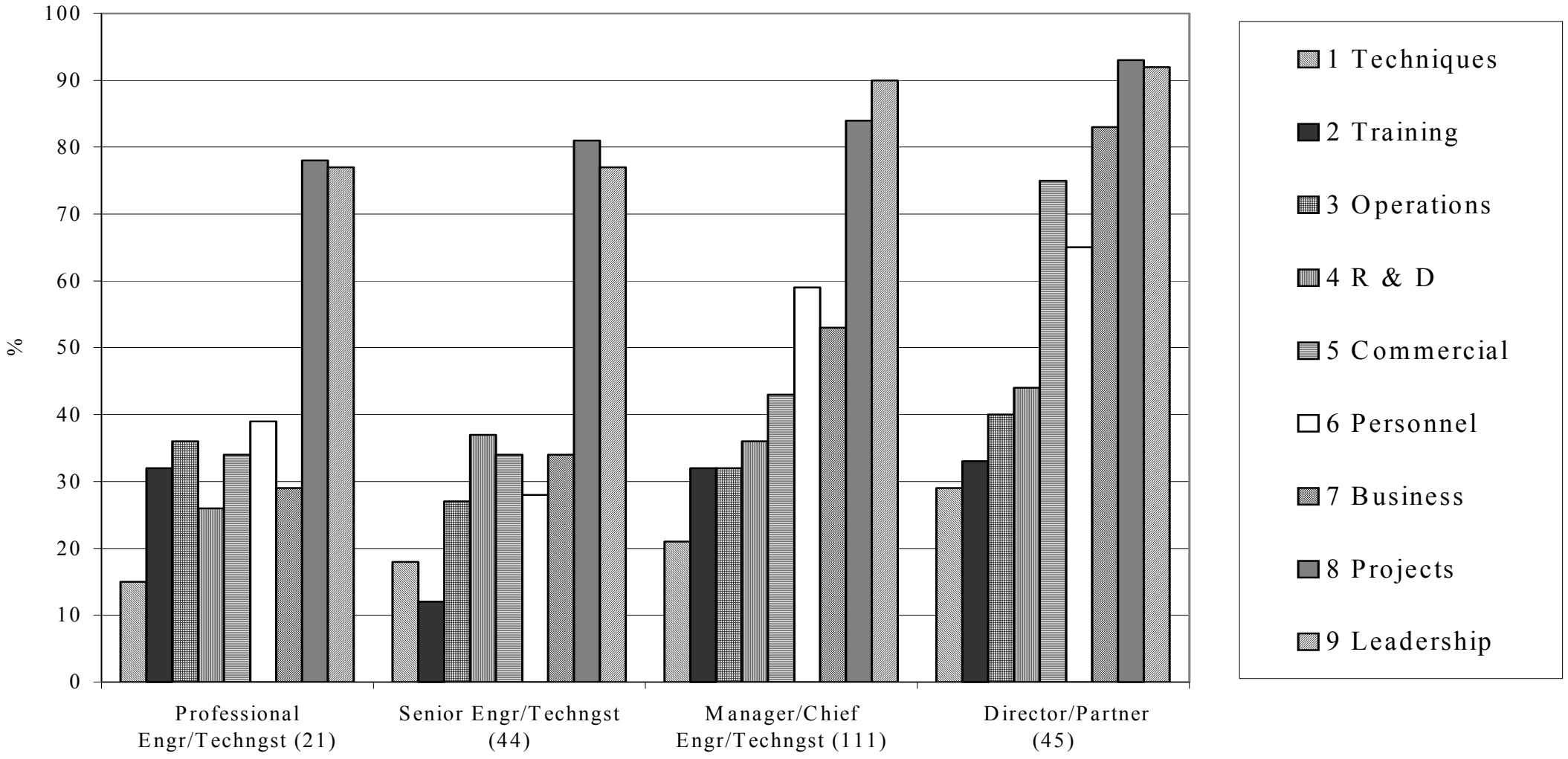

Figure 2 - Groups of Skills & Expertise Required compared with Level of Responsibility

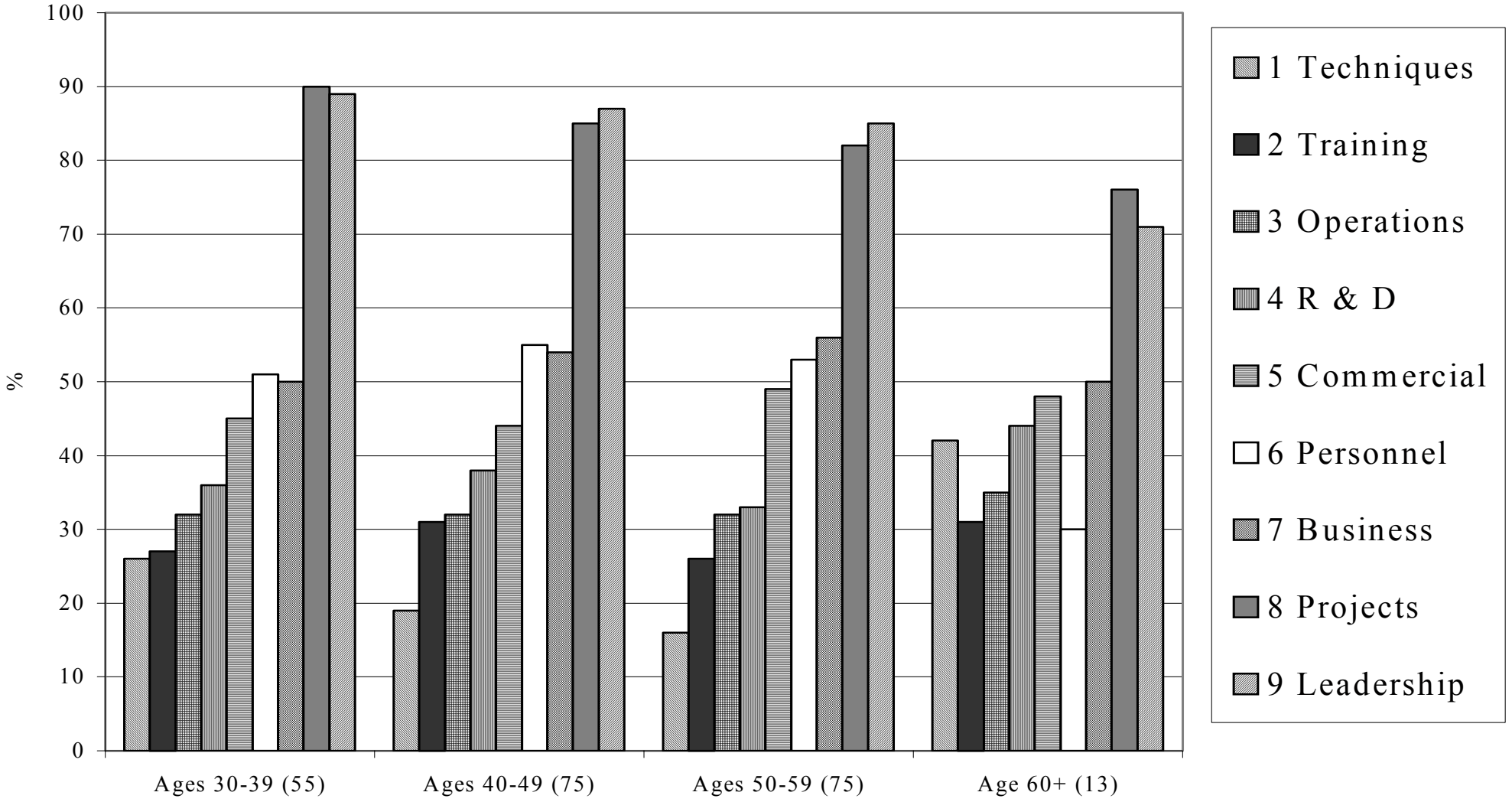

Figure 3 - Groups of Skills & Expertise Required compared with Age

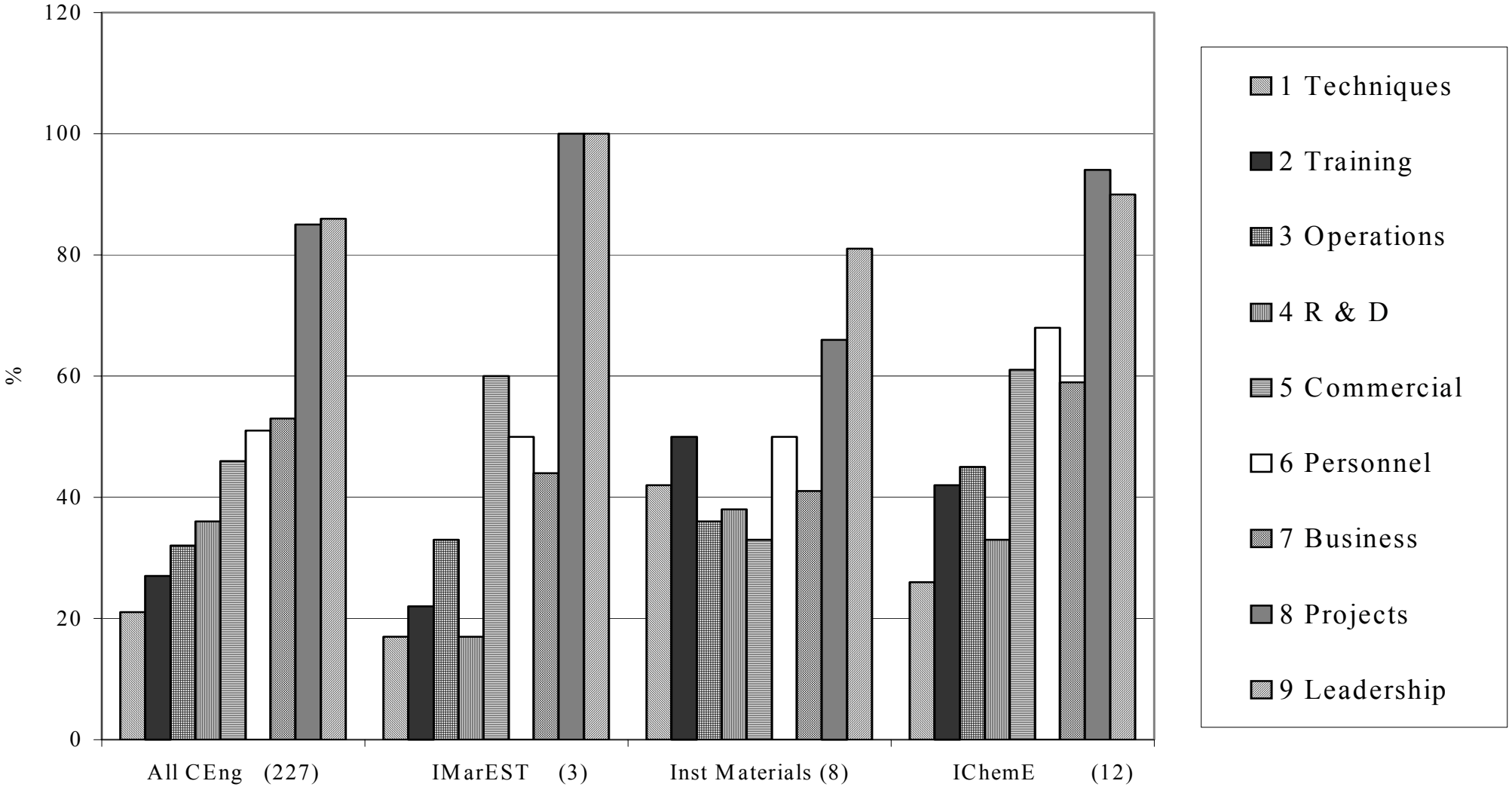

Figure 4 - Use of Groups of Skills & Expertise by Institution Members I

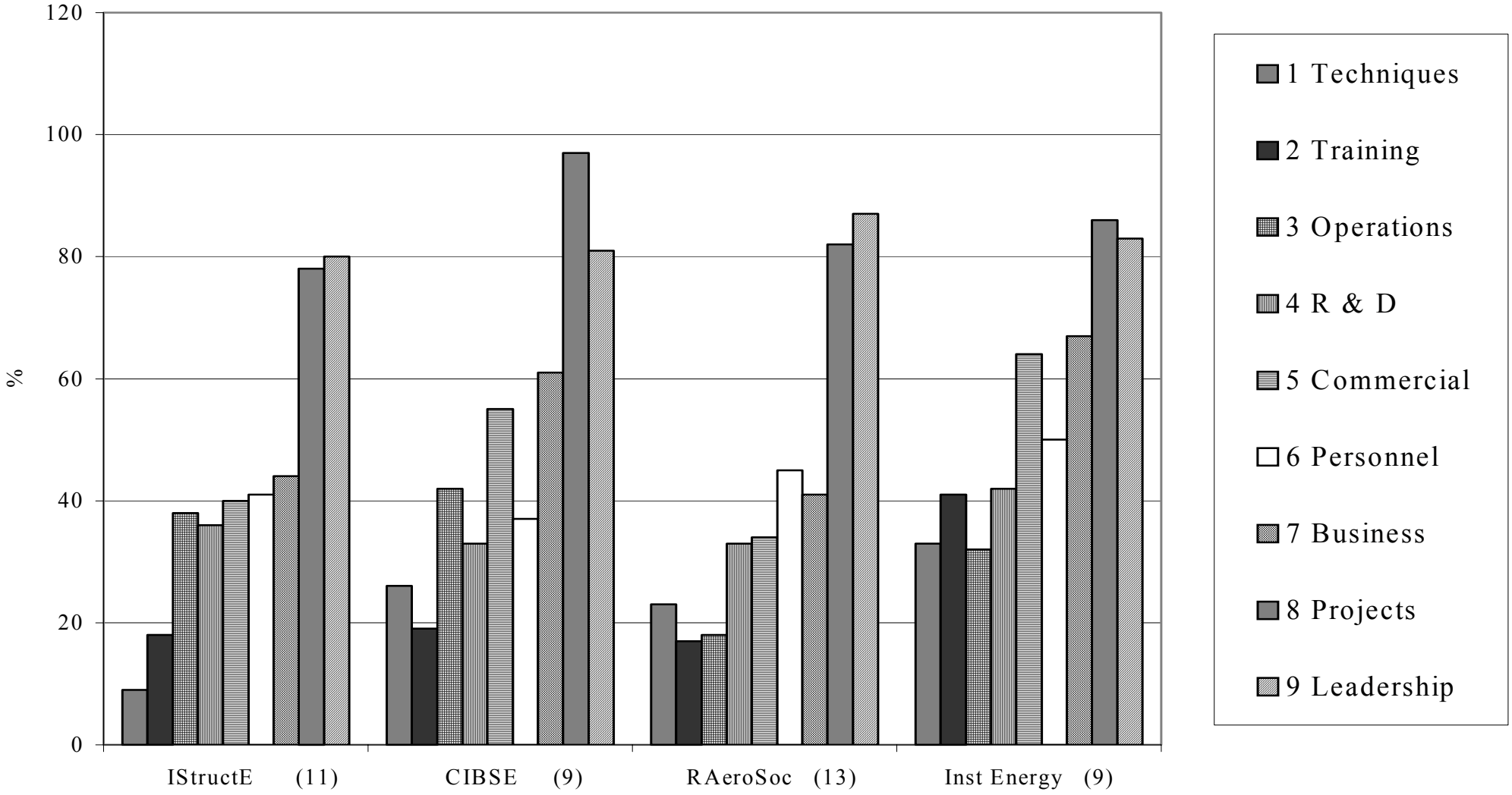

Figure 5 - Use of Groups of Skills & Expertise by Institution Samples - II

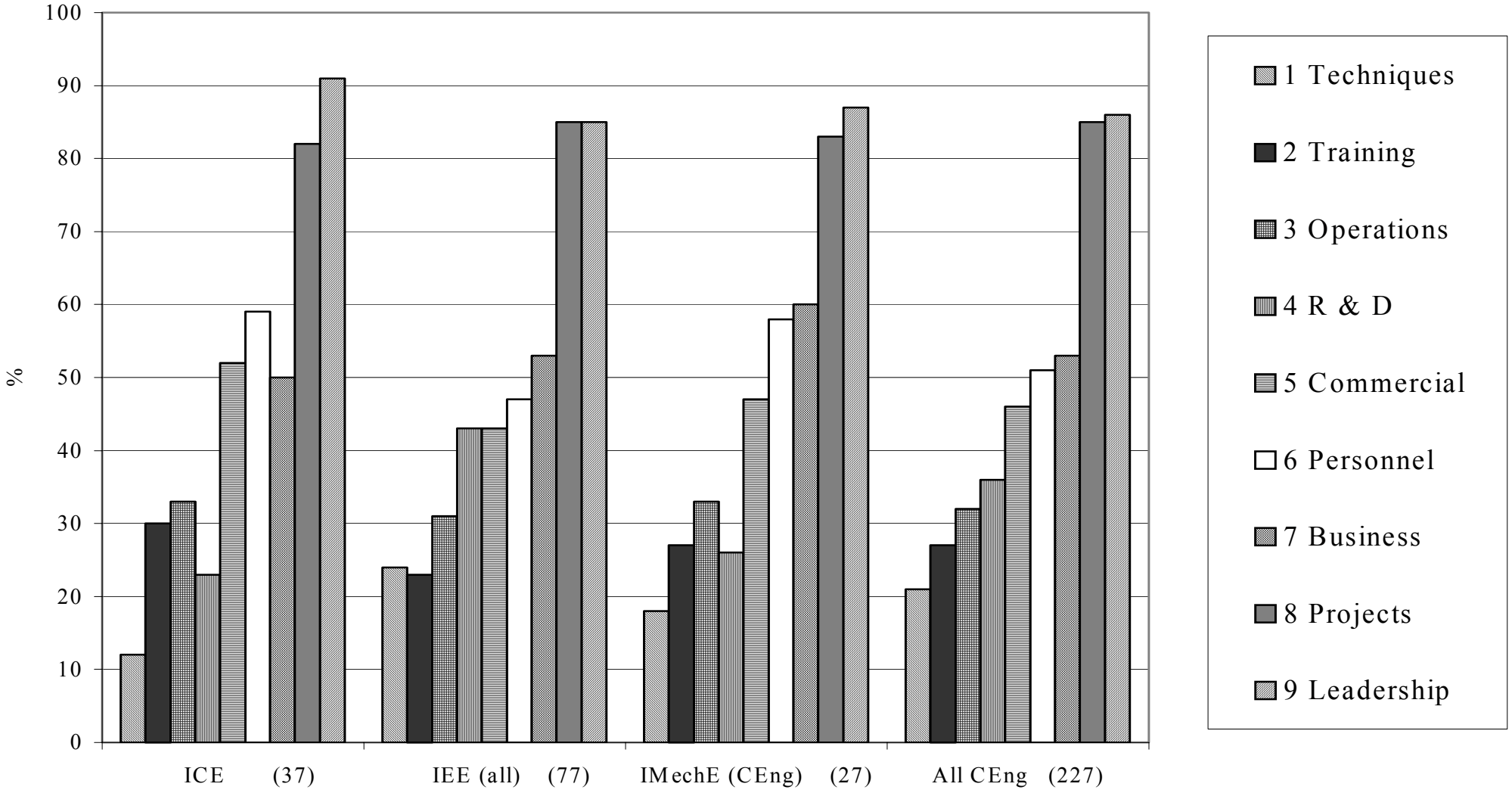

Figure 6 - Use of Groups of Skills & Expertise by Institution Samples - III

APPENDIX B

ANSWERS TO Q. 3 ON MOST DIFFICULT OR DEMANDING ASPECT OF JOB
Defining engineering strategy in the light of business environment.
Ensuring that all relevant parties are involved in our process.
Organisational change to meet evolving business needs.
Financial management.
People management.
Managing people.
Need for rapid & continuous change / improvement to remain viable.
Dealing with superiors. Dealing with staff.
Ensuring all managers & supervisors understand the requirements of the specifications and the client understands what he has bought.
Managing a large number of diverse technical support services.
To lead the team through persuasion without appearing authoritative.
Bureaucracy (approvals from government, partners, etc).
Managing business changes.
People management.
Holding company together.
Making investigations into several tasks at once.
Management of my personnel.
Clarity of expression & determination of the vital clues over a range of possible causes of an accident / breakdown.
Organisational development – building from scratch a significantly sized department.
Ensuring compliance of teams with legislation with production environment.
Just one of me (!) and the very wide range of subjects within duties.
Redundancy.
People related issues.
'Selling'.
Predicting when aspects of work will be complete, to issue notice of "testing" as required by contract. Failure to issue correct notice has major contractual implications.
Managing income stream / overheads.
Wide variety of disparate issues. Duties varying from visionary to technical detail.
Specification of new products.
Time management.
Winning new business.
Resourcing key skills.
Extracting information from colleagues which supports a clear understanding of the overall picture.
Balancing long and short term resource allocation having regard to skills requirements, personal attributes and the individual's development needs.
Time management.
Understanding details of ever changing telecommunications technology.
Managing IT developments.
Interaction with Senior Company Management.
Being called in out in the middle of the night and solving problems.
Persuading the organisation to take on more efficient management practices.
Providing my product on time, to cost and to the required quality with requirements constantly changing and short timescales.
Trying to match suitable staff with project needs in order to meet programmed delivery dates
Investigation into wrongside (unsafe) failures.
People relationships.
Persuading design and development staff that Safety is important.
Motivating others.
Organisation of staff.
Following the plan.
Changing organisational behaviour.
The people.

Getting engineers to understand the concepts of running projects to budgets !
Coming up with novel solutions.
Meeting deadlines.
Getting designers to understand the principles of 'Smart' requirements and apply them to unique, unambiguous, singular and solution-independent system requirements.
Meeting the timescales for project work.
Getting contractors to understand that safety related systems need special design, development etc.
Keeping my team fully occupied at all times.
Managing resources including people – academic staff, administrative staff, students and clients.
Fighting the company system to ensure the planned resource and material are available at the right time in the right place.
Amount of time spent away from home on business.
Developing realistic investment costs when incomplete information available at time of project sanction.
Commissioning a sewage works.
Frequent changes in customer requirements (demands).
Sterile manufacture.
Becoming technically credible across a large range of topics.
Managing a diverse team of traders.
Coordinating (with others) the group sales pipeline.
Multi-interfacing with so much non-core business outsourced.
Managing a large workload with limited resources.
Understanding cultural differences and defining implementation logic.
Getting business to accept the need for change.
Frustration at decision processes within a multi-national.
Balancing attention to detail with limited resources against risk of an oversight.
Training graduates & academics in aspects of safety law that they must address.
Correcting mistakes made by other people.
Obtaining continued commitment to the system from senior management.
Thinking outside of the box and changing mindset.
Creative research.
Fund raising.
Coping with continuous change to computer systems, company organisation and admin – in fact all the things which get in the way of doing my present job .
Satisfying business and customer demands at the right cost.
(a) Performance of suppliers. (b) Competing for resource not directly in my control.
Recruitment of systems engineering staff.
Task / responsibilities definition.
Getting other departments / agencies to do their work in a timely fashion and correctly.
Preparation of bid documents.
Managing transnational relationships.
The political dimension. Trying to help other companies while no being seen to intrude – consultancy.
Making my team flexible enough to deliver our customers requirement.
Internal justification of prioritising my effort.
Maintaining client demand for the service provided.
Breadth of skill and knowledge for strategic planning.
Balancing resources & workload.
Time management.
Accommodating all views of public perspective.
The diversity of designs involved with.
Workload and pressure to meet deadlines.
Having time to do everything.
Juggling multiple projects.
Identifying a new method of working & getting it operational.
Demanding – Travel and hours worked.
Difficult – Successfully winning new work.
Partner alignment.

Ensuring continuity of workload.
Budgets.
Dealing with managers (team leader and above, 'the top') who do not know very much about bridge engineering. It is very frustrating.
Intercultural management issues.
Structural design.
Achieving programme targets with too little information.
Working with businesses and business organisations whose main sector is not transport or engineering.
Not having ultimate executive control as a consultant.
Assessing clients' requirements.
Political interference.
Delivering projects with ever reducing staff numbers.
Staff motivation and management.
Managing those not directly responsible to me.
Managing high level of "on demand" service provision with limited resources.
Keeping up with legal and regulatory requirements in a politically sensitive industry.
Obtaining the quality of subcontractors to carry out the work to the required standards.
Keeping up with current British Standards & other technical standards / literature.
Providing client satisfaction while meeting own company's profit targets.
Maintaining positive relationships with enterprise representatives.
Dealing with other professors.
People management skills.
Resolving conflicting agendas under time / budget pressure.
Keeping staff and clients happy.
Meeting project deadlines when timescales and resources are short.
General management.
Personnel management.
Being right ! i.e. identifying the probability component in risk assessment.
Writing reports.
Keeping up to date.
Immediacy of the decision making on many occasions.
Strategy – Direction.
Managing research projects.
Convincing potential clients of their need for our services.
Working with other consultants who have poor knowledge or understanding.
Sales.
Technology and innovation.
Complying with various clients briefing documentation.
Changing and increasing legislation regulations etc.
Planning and managing resources to achieve a first class service.
Forcing a quality installation from builders intent on meeting programmes.
Impossible / unrealistic targets.
Marketing.
Generating sufficient workload.
Making a profit.
Defending claims from contractors who regard PI insurance as a source of revenue.
Coping with lack of infrastructure, eg no electricity, phone etc.
Time management in dealing with students.
Time management.
Being able to do the quality of work in the budget & time available.
Juggling conflicting demands and unrealistic timescales.
Keeping up to date with changes in design codes & procurement methods.
Understanding & applying new design standards.
Keeping up to date / leading edge.
Persuading people to do what they don't want to do.
Maintaining up to date knowledge & compliance with legislation.

Morale – it can be difficult in the face of the manufacturing climate.
Financial operations side of product dev / setting up contracts with sub-contractors.
Balancing conflicting and time consuming roles.
The motivation and development of staff.
Prioritisation and delegation, including follow-up.
Finding sufficient qualified, experienced staff.
Time management.
Moving from technical work to managerial.
Programme management.
Cost control (estimating engineering m/hours).
Trying to keep track of over 70 graduates !
Everything in running a business !
Dealing with main contractors.
Meeting customer expectations.
Business development.
Satisfying a multitude of customer requirements with limited resource.
Flexibility.
Ensuring the design is fit for purpose.
Major fleet sales contracts overseeing sales from enquiry through production to delivery.
Time and volume.
Supervising and managing staff.
Teaching.
Creativity.
Long hours.
Dealing with awkward customers.
Obtaining consensus from all parties to a single set of plans.
Financial planning.
Admin' ie invoicing, pricing, tax and VAT.
Being proactive all the time – never being able to take a back seat.
Managing the expectations of others.
Planning for the unexpected whilst having minimal contingency time.
Project management involving multi-disciplines and suppliers.
Clinical understanding of use of devices.
Obtaining information in a politically sensitive area.
Planning new courses.
Discipline of children.
Finance.
Policy development and ensuring an intellectually respectable basis exists.
Managing uncertainty – technical Risks vs timescales.
Translation of operational requirements to scientific / technical requirement – Assessment of deliverables.
Management of people.
Project management.
Strategic direction.
Persuading technical managers to improve their management skills.
International collaboration with Continental company, their MOD and politicians.
Balancing competing time demands.
Briefing senior officers / seminars.
Problem solving.
Volume of paperwork.
Teaching adults.
Understanding medical certification requirements in all major markets.
Specification interpretation.
Assimilation of information, decisions and dependencies across a range of business units, disciplines, technologies.
Huge and unpredictable variations in workload, and the variety of that workload. (It's also one of the most satisfying aspects !).

APPENDIX C

SCALES FOR ASSESSING VARIETY OF JOBS OF PEOPLE DEALT WITH

Question 8 in the questionnaire included questions on the range of jobs of the people that respondents directly reported to, gave instructions to and were directly responsible for.

The respondents' answers on the range of jobs were assigned a numerical value on a scale according to the number of different jobs or disciplines represented, following the method used in the earlier surveys. In the case of superiors, their level of responsibility was taken into account if the respondent reported direct responsibility to two or more superiors with distinct responsibilities. For example, a construction manager responsible to the managing director and the engineering director of a process plant designer and supplier's firm was assigned to point 2 on the scale; a principal design engineer responsible to a technical director, chief engineer of the division and the manager of the department was assigned to point 3 on the scale.

Similarly, the respondents were placed on the scales for jobs of people to whom they gave instructions and people for whom they were directly responsible according to the number of different jobs or disciplines represented. 0 on the scale represented responsibility for secretarial or ancillary staff only. A general manager directly responsible for 3 senior commercial officers and a commercial manager was placed at point 1 of the scale, because, although two distinct levels of responsibility are represented they are in a single field of expertise. A general manager responsible for giving instructions to an insurance division, lawyers and accountants was placed at point 3 of the scale for this question. A civil engineer working as a contacts manager reporting direct responsibility for contracts engineers, solicitors, secretaries and clerical staff was placed at point 2 of the scale, i.e. 1 point for contracts engineers and 1 for solicitors and 0 for secretarial staff. An engineer responsible only for posts in a road division of a municipal authority was assigned to point 1 on the scale. A principal municipal engineer responsible for resident engineers, clerk of works, quantity surveyors and clerks was assigned to point 3, a chemical engineering lecturer responsible for research students to point 1, and an aeronautical engineering manager giving instructions to a works manager and a chief buyer to point 2 on that scale and to point 3 on the scale of jobs for which he was directly responsible: chief projects engineer, chief inspector and print room supervisor.

Thus, the higher the point on the scale of any individual, the greater the range of disciplines or branches of engineering with which he or she is involved in communicating. It is taken that such communication across the boundaries of different disciplines require skills and experience of a higher order than those required in communicating with persons with the same professional or vocational background.

APPENDIX D

ANSWERS TO Q.15 ON SUPPORT EXPECTED FROM INSTITUTE / INSTITUTION / SOCIETY IN ACHIEVING MANAGERIAL AMBITIONS

Maintain CPD (.. unreadable).
Communication on mgt. Programmes available.
Better support for senior technical managers.
Job adverts in Professional Engineer.
I expect none.
More higher management content to magazine, etc.
None. I don't think the Institution has been very helpful to Engineers in furthering Engineering as a profession !
Updating.
Maintain standards of Engineers. Represent Engineers to Government.
Provision of management training courses.
Notification of legislation changes.
Course and conferences.
Good technical papers.
Not sure at present.
Forum for industry networking through topical technical seminars etc.
Good technical information & publications. Appropriate conference & seminars.
None, really.
Not a lot.
Backup for consultancy / qualifications in case I get made redundant.
Opportunities for professional development.
CPD information, career progression advice.
Relevant meetings and literature on developing areas of power engineering and the opportunity to meet and network with other professionals and potential clients.
Consultancy career advice.
Seminars, contacts (networking), updating on technical advances, course (at somewhat less expense that the current course rates if I am to finance this myself). Continued and improved use of the PN's to provide these.
Access to relevant information.
Continued Professional Development.
Briefings through articles in journals.
Further provision of engineering management related meetings. Mentoring/training support of engineers to IEE standards.
Keeping me up to date on technical, safety and contractual issues related to electrical engineering.
Why not make the results of this survey electronically ?
I expect little direct support. I do expect to use the Professional networks to gather key information, etc.
Have not considered this.
As a source of technical and management information.
Nothing other than general industry awareness.
Promote the abilities of engineers in managing businesses.
None (although I read their publications, which, along with the IEEE's, keep me generally informed.
On-line reference library and pdf versions of tech magazines.
None. It doesn't seem to have any support for engineers working at my level or in my technical discipline.
Help to develop my engineering skills & expertise.
Library facilities, CPD courses.
Support from colleagues to help achieve aims and resources.
Access to any relevant materials and courses with the ability to request information on services, and the services of people, that may be required.
Expecting little results in no disappointment.
Contacts.

To improve the profile (& money) of chemical engineers to levels..in Europe & US.
Good networking opportunities. Affordable training for self-employed.
Limited – keeping me abreast of the industry & technology.
Appropriate training courses.
Courses on contract / commercial sales & marketing / project management.
More of the same. The Institute is already doing a good job supporting the .. industry.
Suitable management courses on CD ROM' etc.
No more than at present !!
Training courses. Networking.
None directly.
None at present.
Direction as to useful courses / qualifications and the future.
On-the-job training. Gradually more responsibility.
None.
Industry knowledge through magazines and conferences.
Networking. Industry awareness.
Keeping abreast of latest aerospace news. Conferences.
Professional training ie Airworthiness Course.
What support can I expect ?
NCE useful for gaining general knowledge.
Ensure course providers offer a varied range of courses.
Ensure that there are sufficient engineers for me to be responsible for.
Programme / course / web pages on starting or running your own civil consultancy.
More support activities for mid career (35-45) engineers.
Expansion of the business centre at the Institution out of the dark basement + lap top connection points.
Targetted training.
Information on current industry practices / best practice.
Background information through periodicals and presentations.
By providing better 'education' to senior member and non-member managers about what they are managing .. and promoting the image and importance of the engineer.
Raise professional profile.
None.
I am a realist. None as usual !
Dissemination of information on technical developments and practice.
Information / training for staff / members on change management, e.g. such as the book "Who Moved My Cheese ?"
Information on trends, standards, legal changes, etc. Some professional / business info, training courses.
Institution is stuck in the last Century. Should be more like BMA.
I expect none.
To set the agenda for public debate about infrastructure and by doing so control the influence of the money men.
Continue to drive for increased recognition for the profession.
I don't really expect any support from Institution.
Keep abreast of current developments and best practices.
Networking; continuing professional development.
CPD. Networking. Professional status.
Access to appropriate training (which is quite good).
Not relevant.
Institution increasing its professional status in UK.
Unfortunately the Institution cannot help me, other than the provision of technical information and guidance.
Good sound technical advice and an open community for job opportunity.
Promote the image and necessity of professional structural engineers.
A more sensible work load as I progress my managerial skills.
Leading edge updates.

CPD opportunities.
Technical support and sharing best practice.
Introduction of MPD's, maintenance of goals & level, technical bulletins.
Annual personal development appraisal.
Guidance on management programmes to progress through career. To achieve Fellowship status
Senior management training.
I expect the Institute to raise the profile of engineers so that engineers are regarded as highly as other professionals (accountants, doctors, etc).
CPD, workshops, networking, forums.
Training.
Professional indemnity & other insurance scheme assistance (i.e. discounted focussed schemes).
A small amount of management training.
Managing people does not come naturally to all. More 'general' rather than 'technical' personal development courses.
Keeps me up to date with latest tech.
Nothing. The Institute is geared towards SME's i.e. Educational/Gov' organisations and has little relevance to small business.
Professional recognition & consistency.
Networking. Technical support.
Suggestions ?
Knowledge – Access to people with similar expertise & experience.
More help !
Perspectives on the challenges of successfully implementing technology solutions.

APPENDIX E

REPONSES TO INVITATION TO GIVE GENERAL COMMENTS

Please don't lower standards for entry to enable more people to join. If you do this there's no point in being a member.
Current job has direct responsibility for a full shift team 'during silent hours' nut not between 08.00 and 16.00 ! Can lead to confusion for some team members. Therefore I am the manager focus figure at all times.
Although I am CEng,…, I have never to become a Member of my first Institution. I went to America soon after graduation & graduate apprenticeship & could never find a member to propose & second me.
Keep modernising and attracting youngsters.
My present role maybe somewhat unusual as I am on secondment in Japan. I am responsible technically for a project, but not directly for the team members – a result of the language barrier.
At the moment my professional work has entered a cul-de-sac in that I am not using my skills and experience to any great extent. However my rewards and benefits are good and that, coupled with currently depressed state of the communications industry, makes for little incentive to seek a move for the moment.
I have reached age (over 50) where I have found that many companies do not employ new starters. Therefore, it is not worth me investigating the job market.
Some additional legal advice would be welcomed, for both supporting members in personal problems and to advise managers to help resolve personnel, employment, contractual and company issues. Perhaps a subscription based service to members.
The default 'send' button at the bottom of this form caused me to submit a partially completed form by inadvertently pressing the 'return' key.
I am at the final stages of an MBA sponsored by my company. My dissertation addresses organisational behaviour in a sales environment.
Long table difficult to fill in when the headings have scrolled off the top of the screen.
No questions about the politics of management ? Relationship abilities ?
Can you send a pdf of the report to me. I'm trying to reduce the paper on my desk…
Knowledge of developments in technology and in processes, and current best practice.
With reference to Q15, the question is: why do I still bother with membership ?
The Institution must change to help all its members progress eg creche at courses/lectures, womens network (there are many more working mothers in the I that I suspect its male dominated senior membership realise).
The activities of the Institution tend to be directed towards a number of specialised aspects of electrical engineering. There is little for consultants .. who operate over a wide range of applications.
I am very much in support of this initiative. You should know about our recent new MBA course aimed at professional engineers – as engineering business managers.
Mass redundancies from 'special' steel industry. Very difficult to find work if 60 or older.
I feel very strongly that engineers & scientists should be given at east a basic training in health, safety & environment law, and be introduced to the concepts of risk management. It is very difficult to introduce these ideas to engineers 10, 20 or more years after they have entered work – they simply do not see them as issues.
I believe training in planning/costing/risk management should be included in degree courses. I use these (along with many working in engineering) regularly.
Most training I have received has been "on the job" experience.
"Management" is all part of "Engineering".
Much of my basic training at university is used to solve and understand any engine issues especially performance related issues.
I found within large organisations that management positions require removal from engineering activities to a certain extent. I didn't do an engineering degree to become a manager so how do you progress ? I became Director of my own consultancy 6 years ago but thanks to IR35 taxation this is no longer viable and next month my business ceases to trade. I love aerospace engineering but until the respect and rewards for engineers are forthcoming I will resent the career choice I made.

I would be grateful if the Institution could inform me of the support it can give during my career development.
The standards of education, training and examination must be kept high ……..
I moved away from straight engineering 10 years ago and focused on general management.
Quite a difficult form to fill in, e.g. Q6 and Q7 !
You would have had better response if envelope had been pre-paid postage.
Obtaining the quality of subcontractors to carry out the work to the required standards.
My work tends to oscillate between contract and freelance.
After 39 years I am beyond job titles and pecking orders. I enjoy working with and meeting new people, young and old …..
Q.7 makes no reference to technical skills & expertise; such skill & expertise may form a lesser part of my actual work but lies at the heart of most of it.
The survey could awareness of need and not need itself (of management / technical skills).
CPD through technical meetings / seminars.
Engineers are still generally under-valued in society.
Management training in industry is poor.
It is difficult to complete this questionnaire for members in education. Management skills are extremely important when one is an infinite resource for one's employer. However the skills necessary to motivate students and to help them manage their learning are priceless.
The cost of Institution run seminars / courses is prohibitively expensive for small businesses, particularly when travel, accommodation & loss of earnings is taken into account. CPD in the conventional sense is not a viable option.
My job is unique; I doubt if my input will help with your survey. The job is politically important, but no commercial organisation would be prepared to fund it.
I welcome this initiative.
Instances of potentially sound developments failing as a result of badly managed implementation are all too common.

APPENDIX F

COMPARISON OF DATA RECEIVED FROM CHARTERED AND NON-CHARTERED MEMBERS OF THE INSTITUTION OF MECHANICAL ENGINEERS

The purpose of the appendix is to compare the responses on managerial skills and expertise used in their present jobs by the samples of Chartered and non-Chartered members of the Institution of Mechanical Engineers. First we compare some of the general data from them.

Age	**%**	**%**
Under 30		10
30-39	26	29
40-49	22	38
50-59	41	24
60+	11	

Type of qualification	**Chartered IMechE members %**	**Non-Chartered IMechE members %**
University degree	74	43
CNAA degree	4	19
Diploma in Technology	4	
Professional Institution examination		
HND	15	19
HNC		
NVQ	4	5
Other		14

(The percentages are not mutually exclusive)

Hold any other higher educational qualification ?	**%**	**%**
Yes	48	52

Type of other higher educational qualifications	**%**	**%**
MBA	15	
Other Management	4	14
Masters degree in Engineering, Technology, Mathematics or Science	19	19
Postgraduate Diploma / Certificate in Engineering / Technology / Applied Science	7	5
PhD	7	14

Technological vs. managerial content of job	**Chartered IMechE members %**	**Non-Chartered IMechE members %**
Predominantly technological	19	24
Predominantly managerial	56	14
Both equally	26	62

Level of responsibility	**%**	**%**
Director / Partner	41	5
Manager / Chief Engineer /Chief Technologist / Principal Engineer / Principal Technologist	48	48
Senior Engineer / Senior Technologist	11	19
Professional Engineer / Professional Technologist		24
Other		5

Most difficult or demanding aspect of job	**%**	**%**
Industrial relations		
People management	33	24
Communications	4	
Control	11	19
Keeping up with new developments		5
Dealing with other senior managers	19	
Technical	7	5
Business	7	14
Political interference, bureaucracy	4	
Risk		
Improvements and change	11	5
Safety		

Table F1

SKILLS AND EXPERTISE REQUIRED IN PRESENT JOB	**Chartered IMechE members %**	**Non-Chartered IMechE members %**
Costing, estimating	82	91
Project financing	78	76
Evaluate projects	89	86
Analyse project risks	85	86
Analyse corporate risks	56	52
Plan and control budgets	78	81
Company accounting	44	19
Corporate (business) strategy	63	33
Plan and schedule project	78	91
Plan new product	26	48
Patenting	7	24
Plan research	22	52
Plan design and development	48	71
Plan construction	33	48
Plan production	30	24
Plan maintenance	44	33
Plan stocks and materials distribution	22	19
Plan services	37	43
Marketing of products	37	33
Marketing of consultancy, technical services	37	29
Use of company law	41	19
Use of health & safety law	78	62
Use of employment law	59	29
Use of consumer safety law	15	24
Draft contracts	52	33
Negotiate contracts with client/customer	63	48
Negotiate with supplier/contractor	48	52
Negotiate with employees	56	48
Negotiate with T.U. representatives	26	29
Negotiate with public authorities (not as customers)	4	24
Negotiate with senior management	67	71
Statistics	26	24
Operational research	15	10
Systems analysis	15	19
Organisation and Methods (O & M)	22	19
Work study (methods study)	15	14
Data processing	15	24
Make formal presentations	93	91
Plan and chair formal meetings	82	76
Plan personnel requirements	67	81
Recruit and select personnel	67	62
Motivate others	89	76
Supervise others	85	91
Appraise personnel	74	71
Employee training – manual workers	22	19
Employee training – supervisors	30	33
Employee training – management	30	29
N	27	21

Note that only the data from the Chartered members is used in the other tables in this report.

APPENDIX G

COMPARISON OF DATA RECEIVED BY POSTAL AND BY EMAIL QUESTIONNAIRES FROM MEMBERS OF THE INSTITUTION OF ELECTRICAL ENGINEERS

The purpose of the appendix is to compare the responses on managerial skills and expertise used in their present jobs obtained by postal and by email to the sample of members of the Institution of Electrical Engineers. First we compare some of the general data from them.

Age	**IEE members sampled by post %**	**IEE members sampled by email %**	**IEE samples combined %**	**Whole IEE Corporate membership* %**
Under 30	0	0	0	0.5
30-39	20	39	29	22
40-49	32	28	30	31
50-59	37	33	35	33
60+	12	0	7	6

* excluding those known to be retired

Type of qualification	**IEE members sampled by post %**	**IEE members sampled by email %**
University degree	68	78
CNAA degree	15	17
Diploma in Technology		
Professional Institution examination	8	3
HND		
HNC		
NVQ		
Other		

(The percentages are not mutually exclusive)

Hold any other higher educational qualification ?	**%**	**%**
Yes	44	36

Type of other higher educational qualifications	**%**	**%**
MBA	5	3
Other Management	2	3
Teaching qualification	5	
Masters degree in Engineering / Technology	7	14
Postgraduate Diploma / Certificate in Engineering / Technology / Applied Science	7	
PhD, DSc	7	8

Technological vs. managerial content of job	IEE members sampled by post %	IEE members sampled by email %	IEE samples combined %
Predominantly technological	27	36	31
Predominantly managerial	42	28	35
Both equally	29	33	31

Level of responsibility	%	%	%
Director / Partner	29	6	18
Manager / Chief Engineer /Chief Technologist / Principal Engineer / Principal Technologist	39	53	46
Senior Engineer / Senior Technologist	20	31	25
Professional Engineer / Professional Technologist	7	8	8
Other	5		3

Most difficult or demanding aspect of job	%	%	%
People management	5	25	16
Communications	7	3	6
Control	15	19	19
Keeping up with new developments	2	3	3
Dealing with other senior managers	2	6	5
Technical	12	8	12
Business	12	3	9
Risk	5	3	5
Improvements and change	7	6	8
Safety		3	2

Table G1

SKILLS AND EXPERTISE REQUIRED IN PRESENT JOB	**IEE members sampled by post** **%**	**IEE members sampled by email** **%**
Costing, estimating	88	81
Project financing	76	50
Evaluate projects	85	83
Analyse project risks	78	89
Analyse corporate risks	54	56
Plan and control budgets	76	69
Company accounting	42	28
Corporate (business) strategy	61	42
Plan and schedule project	88	89
Plan new product	49	89
Patenting	24	22
Plan research	24	25
Plan design and development	49	61
Plan construction	34	42
Plan production	22	22
Plan maintenance	34	28
Plan stocks and materials distribution	20	11
Plan services	22	36
Marketing of products	34	28
Marketing of consultancy, technical services	24	31
Use of company law	44	42
Use of health & safety law	73	64
Use of employment law	49	36
Use of consumer safety law	34	11
Draft contracts	44	36
Negotiate contracts with client/customer	63	44
Negotiate with supplier/contractor	59	61
Negotiate with employees	44	36
Negotiate with T.U. representatives	15	11
Negotiate with public authorities (not as customers)	20	17
Negotiate with senior management	71	50
Statistics	42	28
Operational research	17	6
Systems analysis	37	31
Organisation and Methods (O & M)	24	14
Work study (methods study)	15	6
Data processing	37	28
Make formal presentations	85	83
Plan and chair formal meetings	85	81
Plan personnel requirements	59	64
Recruit and select personnel	68	58
Motivate others	88	86
Supervise others	85	83
Appraise personnel	71	56
Employee training – manual workers	20	19
Employee training – supervisors	22	19
Employee training – management	42	17
N	41	36

Note that the data obtained by post and by email is combined in the other tables in this report.

APPENDIX H

AUTHORITY AND AUTONOMY IN PRESENT JOBS

Autonomy

The respondents' answers to the multiple Q.6 about their authority and responsibilities for supervision can be compared with the answers to the question "Which of the following best describes the extent of your present authority ?" in this table in the 2001 Engineering Council (UK) Survey of Registered Engineers:

Which of the following best describes the extent of your present authority ?			
	Chartered Engineer	Incorporated Engineer	Engineering Technician
I have overall responsibility for a substantial organisation including policy making	14.6%	10.5%	11.1%
I have full control over senior staff	8.5%	5.8%	3.5%
I supervise leaders of more than one group of qualified staff and others	19.5%	16.9%	12.9%
I supervise a group of qualified staff	274.%	28.1%	27.0%
I have no managerial responsibilities, but may be assigned one or more assistants	19.3%	24.3%	24.2%
I have no authority, but may give guidance to others	10.5%	14.2%	20.9%
I am under full-time training	0.2%	0.2%	0.4%

2001 Engineering Council (UK) Survey of Registered Engineers
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Autonomy

The respondents' answers about their autonomy can be compared with the answers to the question "Which of the following best describes the extent your work is supervised ?" in this table in the 2001 Engineering Council (UK) Survey of Registered Engineers:

Which of the following best describes the extent to which your work is supervised ?			
	Chartered Engineer	Incorporated Engineer	Engineering Technician
My work is unsupervised other than complying with policy	48.8%	47.9%	54.2%
My work is occasionally reviewed in outline	40.6%	39.0%	29.0%
My work is regularly reviewed	8.8%	11.0%	13.1%
My work is frequently reviewed in detail	1.2%	1.4%	1.4%
All my work is checked in detail	0.6%	0.6%	2.2%

2001 Engineering Council (UK) Survey of Registered Engineers
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APPENDIX I

RESEARCH STAFF

A DUDMAN

1990 to date: Computer Services, Manchester School of Management, University of Manchester Institute of Science & Technology, and part-time consultant, employed on data input and analysis, creating web pages, design of Internet sites and data research projects for city authorities, police and RAF.

S H WEARNE

1984 to date: Visiting Senior Research Fellow, Project Management Division, University of Manchester Institute of Science & Technology. Originally engineering apprentice and 'Sandwich' course student followed by postgraduate training in hydro-power engineering. Employed in design, planning, construction and co-ordination of water power schemes in Spain, UK and South America and then construction , design and project management of nuclear power contracts in UK and Japan. Senior Lecturer, Leader of Project Management Group, University of Manchester Institute of Science & Technology and then Professor of Technological Management, University of Bradford (Professor Emeritus).

Committees: Council of Engineering Institutions 'The Engineer in Society' syllabus panel.
Engineering Management Board, Institution of Mechanical Engineers.
Syllabus Sub-Committee, Diploma in Engineering Management.
Engineering Management Committee, Institution of Civil Engineers.
Continuing Professional Development panel, Institution of Chemical Engineers.
Planning group, European Institute for Advanced Project and Contract Management.

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Professional Engineers' Needs for Managerial Skills and Expertise

SUMMARY OF CONCLUSIONS

The information obtained from the samples of Chartered Engineers leads to the following general conclusions:

- Most engineers' careers demand a variety of 'managerial' skills and expertise, particularly in two groups of topics: leadership, and the management of projects.

- These demands vary with age and level of responsibility. Some management skills and knowledge are required early in engineers' careers. As might be expected, some are needed later.

- Some topics classically included in 'management' courses are little used by most engineers, for example work study and operational research.

- There are some differences in the needs between the members of different Institutions, but all are similar in most requiring skills and expertise in leadership and the management of projects.

- Compared with a similar survey in 1979, managerial skills and expertise have become relatively more important in engineers' jobs, particularly in costing, accounting, new product planning, marketing, negotiating and law.

- The engineers questioned in the survey need and want more preparation for their current and future managerial tasks.

Many of the results are no surprise. They confirm earlier surveys or accord with common sense. They indicate that valid information was obtained.

The time available limited the size of the sample to 1 in 300 of Chartered Engineers. Not all the results are therefore conclusive and several questions require further investigation.

This report replaces an interim report issued in October 2002.

ACKNOWLEDGEMENTS

Our great thanks are due to the engineers who sent back completed questionnaires. The willingness of so many to do so was vital. We are also grateful to the individuals and organizations who gave advice and comments on the design of the questionnaire and on the analysis of the results.

SUPPORT

Running the survey in 2002 was proposed by the EMTA, an educational and training charity owned by the engineering industry. EMTA met the costs of printing the questionnaires, the survey coordinator's expenses, data processing, production of data CD's and printing the reports.

Other costs of this survey were shared thus:

The Engineering Council (UK): Staff time for advice and data analysis.

The Institutions: Posting the questionnaire to samples of their members, providing reply envelopes and returning the answered questionnaires for data processing.

UMIST Centre for Research in the Management of Projects: Staff time for planning and coordinating the survey, data processing and drafting the reports.

CONTENTS OF THE REPORT

APPENDICES

DEFINITIONS

In this report the word *engineer* is used as recognised in the U.K. by membership of a chartered institution.

The word *Institution* is used to mean a chartered engineering institution.

The word *management* is used to mean the process of effecting some purpose and managing business. For this survey 47 topics are listed as constituting the elements of management.

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