Operations research in the Netherlands *

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Abstract. A questionnaire by telephone of 98% of the Netherlands Society for Operations Research personal membership is the basis for a description of their activities and for an extrapolation of OR/MS developments in a wide sense in a country like the Netherlands.

Keywords: Practice, Netherlands

1. Introduction

The title of this paper has some pretence, which should be explained. In the literature, one finds quite a number of papers entitled something like: "Operations research in ...", follows the name of a country, usually one of the smaller and more exotic ones. For examples, see [3,5,7,9,10,11,13,14,15,16,20,21]. On the other hand, one finds papers describing the application of operations research methods, based on empirical research and it turns out that a certain country has been implied, usually, of course, the U.S.A. For examples, see [6,18,19,24,25].

What is the use of describing operations research in a certain country? The sad reason is, that OR in different countries is developing along different paths, endangering the unity of the OR world as incorporated in IFORS and EURO or even sailing under foreign colours such as, 'management science', 'decision science', 'cybernetics', 'automatic control' or 'information

processing'. If we want to defend the common ground of OR, first we need to be aware what is the ground where operations researchers in different parts of the world stand.

What is a sound basis for describing OR in a country? Often, descriptions are subjective, based on a personal view and experience. For examples, see [3,5,10,12,14,15,16,17,20,21]. This approach is perfectly legitimate if the author is an expert and authority in the field. It is unfortunate, for instance, that Bob Machol has not published in the regular OR literature more than a few bits in *Interfaces* and [12] on OR in various European countries in the period 1979–1981 when he was stationed in London as Liaison Scientist to the American Office of Naval Research, at the same time writing hundreds of pages on this topic in *European Scientific Notes*, which are freely accessible but beyond the horizon of most OR workers in Europe.

Sometimes, descriptions are more objective, based on empirical research—analysis of the literature, analysis of OR education, analysis of cases, interviews, written or oral questionnaires. For examples, see [1,2,4,6,7,9,11,13,18,19,24,25]. It seems as if especially Americans are fond of this approach. The problem with written questionnaires is that response is often so low as to detract from objectivity. Are people overquestionnaired and starting to hate forms that don't accommodate what they have to say? A written questionnaire from TIMS, for instance, had a response of 31% [1] and one from the Belgian Society for the Application of Scientific Methods in Management only 10% [2]. Many written questionnaires used the *Fortune* list of largest firms for a mailing list. They had responses like 16% [6], 19% [18], 23% [24] or 16% [25].

The present article is based on an oral questionnaire, by telephone, of 98% of the Dutch operations research population as organized in the Netherlands Society of Operational Research (NSOR). This does not cover all operations research applied by non-members and all quantitative methods in management applied under all sorts of fancy names but, if compared to other articles carrying similar titles, this seems enough

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introductory justification to warrant the encompassing title of this article.

The order of presentation is as follows. In Section 2 the aim and organization of the questionnaire are detailed. Sections 3–7 deal with results; i.e., respectively, personal characteristics of NSOR members (3), the relation between OR and economic activities (4), OR activities themselves (5), the link between OR and computers (6), and developments in the Netherlands (7). Summary and conclusions are given in Section 8.

2. Aims and setup of the questionnaire

The primary reason for wanting to call up all members of the Netherlands Society of Operational Research (NSOR) was not to perform the questionnaire, but to discuss a possible contribution to the NSOR 25th anniversary collection of papers [23], just like the previous time, three and a half years before, the primary reason was not the questionnaire [22], but the raising of funds for the EURO III conference.

The oral invitation resulted in 36 members or 10% of the membership writing a contribution to the anniversary volume, details of which are given in the first chapter of [23]. If a similar approach had been followed with the ORSA/TIMS membership with the same proportions, this would have resulted in a collection of 1200 papers! Once talking, I put my other questions, to whom all of my partners responded, only one or two of whom reluctantly. Incidentally, I tried to achieve two other aims:

(1) to find referees for the *European Journal of Operational Research*,

(2) to collect wish-slips from the members as regards the activities of NSOR.

Table 1 specifies some numbers regarding the questionnaire. In the three and a half years between the previous [22] and the present questionnaire, nearly a third of the membership was turned over. Bad news for male heterosexuals: only 2% of NSOR membership is female.

To set up a questionnaire by telephone, a cheap and efficient telephone service is needed and, perhaps, a small country. I reckoned an average of twenty minutes for each call: ten minutes to get the right person on the right number and ten minutes to talk to him. Moreover, it seemed un-

Table 1

Data about the questionnaire among the membership of the Netherlands Society of Operational Research (NSOR)

	Number	Percentage
Membership beginning 1978	467	
Withdrawals 1978–1981	./ 153	
Entries 1978–1981	111	
Membership mid 1981	425	
Institutional members, no person's name mentioned	./ 47	
Members abroad	./ 8	
Population	370	100
Contacted and interviewed	363	98
Female	6	2

wise to delegate the calls to an unknown secretary or student. Hence, a telephone questionnaire is time-consuming, but I found it rewarding.

3. Personal data of NSOR members

As for personal data of NSOR members, their age and their education were asked. (Amusingly, respondents needed, of all questions, the longest time to think of their age.)

Table 2 gives the two-way distribution. The average age is 40.6 years. Three and a half years earlier, it had been 40.0 years [22]. NSOR does not grow grey quickly, but NSOR is rather grey. Younger members should be recruited.

The average educational level is high, too high, I daresay. 85% have an academic title at least equivalent to a Master's degree; of those younger than 35 years, this is even 93%. Compared to the fact that about 0.9% of the total population has a Master's degree (120 000 in a population of 14 million), this indicates how learned a society NSOR is. (For some notes about Dutch university education see Section 3 of [22]. It should be added that, as of 1982, the Dutch government forced all universities to cut down all their programs leading up to the Master's degree to four years, with a maximum actual study time allowed to individual students of six years.)

Education is also very much biased towards mathematics and econometrics. (Econometrics includes 'business econometrics', which is synony-

Table 2
Age and education of NSOR members

Age	Education						Total	Percentage
	Drs. ^a econo- metr- ics	Drs. ^a mathe- matics	Ir. ^b mathe- matics	Ir. ^b other- wise	Drs. ^a other- wise	No univer- sity degree		
20-24		1	1			1	3	1
25-29	16	6	19	4	1	2	48	13
30-34	20	15	16	6	2	5	64	18
35-39	18	14	14	12	7	13	78	21
40-44	14	14	12	10	3	6	59	16
45-49	5	5	5	6	7	8	36	10
50-54	3	7		9	4	7	30	8
55-59	1	3		9	7	7	27	7
60-64	1	1		4	2	3	11	3
≥ 65		1		1	4	1	7	2
Total	78	67	67	61	37	53	363	100
Percentage	21	18	18	17	10	15	100	

^a Doctorandus degree = Master's degree in non-engineering studies; higher degrees (Dr., Prof.) included.

^b Ingenieur degree = Master's degree in engineering studies; higher degrees (Dr. Ir., Prof.) included.

mous to operations research, in the Netherlands.) 58% have a degree in mathematics or econometrics; of those younger than 35 years, this is even 82%. If this is perpetuated, and only 18% of NSOR members will be non-mathematicians and non-econometricians in the future, where has the original interdisciplinary character of OR then gone? If the answer is: into the interdisciplinary discipline of a university education in operations research, then surely this is a paradox.

4. OR and economic activity

Some questions were asked about the economic activities of NSOR members.

Figure 1 gives the geographical dispersion by provinces. 63% of the NSOR membership is employed in the 'Randstad' (Border town), the Western agglomeration including cities like Amsterdam, The Hague, Rotterdam and Utrecht. It seems that Utrecht, which is also a central railway junction, is a nice centre of gravity of geographical dispersion for the NSOR to hold its monthly afternoon meetings!

Table 3 gives employment by sectors and branches of industry. It is not surprising that agriculture, where only 6% of the Dutch population works, has 0% NSOR membership. Manufac-

turing industry, where 30% of the population works, has 21% NSOR membership—I find this percentage rather low. An OR society should be especially concerned about its percentage of academics. If this is too high or too low, the

Fig. 1. Employment of NSOR members by provinces (institutional members included). Numbers in roman, percentages in italics and brackets.

Table 3
Employment of NSOR members by sectors and branches of industry

Sector/branch	Number of NSOR members ^a	Percentage	Willing to referee articles and review books for EJOR
1. Primary sector (agriculture)	2	0	0
2. Secondary sector (manufacturing industry)			
– process industry	57	14	11
– assembling industry	29	7	13
	86	21	
3. Tertiary sector (services)			
– trade, transportation, etc.	45	11	15
– banks, insurance	30	7	14
– consultancy	51	13	24
	126	31	
4. Quaternary sector (non-profit and government)			
– central government	16	4	5
– local government	11	3	3
– research institutions	32	8	19
– higher professional education	17	4	5
– universities	116	29	96
	192	47	205
	406	100	

^a Institutional members included.

possibilities of practitioners meeting theoreticians and educators are suboptimal. The present proportion of about three practitioners to two theoreticians (employment in research institutions, higher professional education and universities together being 41%) works fine in our country, I think.

The last column of Table 3 specifies the number of people who declared their willingness to referee articles or review books for EJOR on specified topics. Almost 50% of the NSOR members are willing to perform such activities and even 83% of

the members in academia. I am pleased with such a quantity of Dutch names in my referees files, which unfortunately I have of no other country.

Table 5
Concentrations of NSOR members

Firm/organization	Number of NSOR members
1. Philips	17
2. Erasmus University of Rotterdam	16
3. Eindhoven University of Technology	16
4. Twente University of Technology	15
5. State University at Groningen	14
6. Tilburg University	12
7. Royal Dutch/Shell Group	10
8. Netherlands Organization for Applied Scientific Research	10
9. University of Amsterdam	10
10. Ministry of Defence	9
11. Netherlands Railways	9
12. Delft University of Technology	8
13. Free University, Amsterdam	8
14. Hoogovens	7
15. Rabobank	7
16. Algemene Bank Nederland	6
Total	174

Table 4
Firms/organizations with NSOR members

Numbers of NSOR members (<i>i</i>)	Number of firms/organizations with <i>i</i> NSOR members
1	113
2	25
3	9
4	4
5	5
≥ 6	16 ^a
	172

^a These are named in Table 5.

Apart from the facts that communication lines are shorter and I am more at home in the Netherlands, one reason that I have far less referees from other countries must be the fact that no other OR society that I know of has had such a direct oral contact with its membership.

Table 4 considers firms/organizations and the number of their NSOR members. NSOR is represented in 172 firms/organizations. The average

number of NSOR members is 2.4 per firm/organization. Particularly meaningful are the 113 firms/organizations that have just one NSOR member; it may be expected that these representatives are linking pins, communicating OR and NSOR within their firm/organization.

Three and a half years earlier, fewer firms/organizations (158) were represented by more members (372) [22]. Have firms and other

Table 6
Dutch top-clubs and their NSOR members

(a) Firms	Sales 1980 ^a	Number of NSOR members
1. Royal Dutch/Shell Group	184.4	10
2. Unilever	51.5	5
3. Philips	36.5	17
4. Gasunie	19.0	2
5. DSM	14.9	3
6. Estel	14.0	7
7. Akzo Group	12.5	5
8. NAM	10.5	0
9. SHV	10.1	0
10. V&D	8.4	2
11. PTT	8.2	5
12. Nationale Nederlanden	8.0	1
13. Esso Nederland	5.7	0
14. AHOLD	4.9	1
15. Netherlands Railways	4.3	9
16. Chevron Nederland	4.1	0
(b) Banks	Assets 1980 ^a	
1. Algemene Bank Nederland	108.7	6
2. Rabobank	97.6	7
3. Amsterdam-Rotterdam Bank	94.3	3
4. NMB-bank	47.9	3
5. WUH-bank	16.7	0
(c) Universities	Number of students ^b	
1. State University of Utrecht	21.6	4
2. University of Amsterdam	21.2	10
3. State University at Groningen	15.8	14
4. Leiden State University	15.6	5
5. Catholic University Nijmegen	13.8	3
6. Free University, Amsterdam	11.7	8
7. Delft University of Technology	10.9	11
8. Erasmus University of Rotterdam	8.6	16
9. Agricultural University, Wageningen	5.9	2
10. Tilburg University	4.8	12
11. Eindhoven University of Technology	4.6	16
12. Twente University of Technology	3.0	15
13. State University of Limburg	0.7	0

^a Billions of guilders. Source: *NRC-Handelsblad*, 10 November 1981.

^b Thousands. Source: Central Bureau of Statistics.

organizations been economizing on multiple memberships?

Table 5 gives the 16 firms/organizations that have the largest numbers of NSOR members. They comprise nearly half of all NSOR members. Eight of them are universities. It is hoped that they will promote OR and NSOR in the Netherlands. Some Dutch firms are among the largest in the world. For instance, on the *Fortune* 1981 list of the 500 largest industrial corporations outside the U.S., Royal Dutch/Shell Group ranks first, Unilever 6th, Philips' Gloeilampenfabriek 10th, DSM 47th, Estel 53rd, Akzo Group 63rd and Esso Nederland 182nd; on the list of the 50 largest commercial-banking companies outside the U.S., Algemene Bank Nederland ranks 25th, Rabobank 34th and Amsterdam-Rotterdam Bank 35th.

Table 6 puts it the other way round: firms/organizations are ranked according to some criterion of size—sales for business firms, assets for banks, number of students for universities—and their number of NSOR members are specified. It is seen that the latter have by no means the same ranking (except for banks). The more technologically oriented firms/organizations—Philips, PTT, Netherlands Railways; Twente and Eindhoven Universities of Technology—have a relatively large number of NSOR members.

5. OR activities

We come to the heart of the questionnaire: what do NSOR members do? This is indicated by the kind of department they work in, the problem areas they work on and the OR techniques they make use of.

Table 7 gives departments. After operations research departments proper, first come EDP-departments, last come finance and administration and marketing departments. The low score of the latter two is ascribed to the usually non-quantitative education of administrators and marketers, not to the nature of the administrative and marketing functions.

Also the functions within the departments by sizes of departments are given. If NSOR members had been a random sample of the personnel of departments, the number of department heads expected in the sample would have been about 50. Their actual number is nearly three times as large. Here again we probably have a linking pin phenomenon, department heads communicating OR and NSOR to their co-operators.

Table 8 gives the average working time distribution of NSOR members over an exhaustive list of eleven problem areas. Some figures were surprisingly high to me: 40% for non-OR activities, 11% for information systems. Other figures were

Table 7
Departments and functions of NSOR members

(a) Kind of department	NSOR members	
	Number	Percentage
Operations research, etc.	149	41
Electronic data processing	69	19
Organisation and efficiency	38	10
Planning, etc.	38	10
Finance and administration	27	7
Marketing and market research	6	2
Various	36	10
	363	100

(b) Size of department	head	co-operator	total
1-5	42	19	61
6-15	54	92	146
16-50	28	60	88
> 50	18	50	68
	142	221	363

Table 8
Average percentage working time distribution over eleven problem areas ^a

Problem area	Percentage
1. Anything outside OR	39.5
<i>Indirect OR</i>	
2. Teaching OR	9.7
3. Research in OR (theoretical)	8.6
4. Standard software of OR (development)	2.2
5. Management of OR (e.g., management of an OR department)	5.6
<i>Direct, executive OR</i>	
6. External, short term (purchasing, selling, marketing incl. market research, physical distribution, routing problems)	3.0
7. Internal, short term (materials management, inventory management, production planning, logistics management, scheduling and sequencing problems)	6.6
8. Project planning (planning and management of projects in the areas of maintenance, innovation, research and development, etc.)	2.1
9. Planning one or more years ahead (medium term and long term planning, strategic planning, personnel planning, location problems)	7.1
10. Financial planning (budgeting, cost-benefit analysis, investment analysis, portfolio management)	4.0
11. Information systems (development of management information systems, decision support systems)	11.4
	100

^a Tables 8, 9 and 12 of this paper are also partly used in chapter 1 of C.B. Tilanus, O.B. de Gans and J.K. Lenstra (eds.), *Kwantitatieve methoden in het management*, Aula-paperback 69, Spectrum, Utrecht, 1983; English translation to be published by Wiley in 1984 under the title: *Quantitative Methods in Management: 36 Failures and Successes*; used with permission of the publishers.

surprisingly low: 2% for OR standard software development, 2% for project planning, 3% for external, short term OR, 4% for financial planning. Probably most people doing the latter four kinds of activities just don't become NSOR members.

The data underlying Table 8 reveal that 94 NSOR members (26%) professed to be working outside OR between 81–100% of their time (it was left to the respondents to implicitly define what they understood by operations research); 21 NSOR members (6%) spent 81–100% of their time on information systems.

Table 9 specifies OR techniques dealt with in practice, teaching and research, respectively, ranked by the number of times they have been mentioned for practice. No exhaustive list had been drawn up in advance, hence overlaps occur (e.g., mathematical programming is usually called by a more specific name). It is seen that the rankings for teaching and research differ from the ranking for practice but, given all we know about the practice, teaching and research of OR, the table is more a confirmation than a surprise.

6. OR and computers

Three questions referred to the role of computers in OR, which according to my hypothesis, could not be overestimated. Only 15 NSOR members that professed to be active in OR did not use computers, either directly themselves or indirectly through the help of co-operators.

Table 10 specifies the computer makes used by NSOR members or their co-operators. To my mind, high figures occur for DEC and CDC and low for Univac. The trend towards mini- and microcomputers is not yet visible in these figures.

Table 11 specifies software packages used directly or indirectly. Many packages were mentioned once or twice—isn't the dividing line between standard OR software packages and ad hoc OR software rather vague?

Table 12 specifies computer languages used. Here the typical OR bias towards technical-scientific computing is most evident. Fortran has the overwhelming majority (although the Netherlands is said to be a bulwark of Algol). High scores were made, to my mind, for Pascal and APL; low scores for PL/1 and Lisp.

7. Developments

It is difficult to discuss developments of OR in the Netherlands, because earlier surveys have not been made, as far as I know, except the one in the first half of 1978 [22]. Only three and a half years elapsed between the previous survey and the present one.

Figure 2 pictures the only quantity that is known from the beginning of organized OR in the Netherlands: the development of NSOR member-

Table 9

OR techniques dealt with in practice, teaching and research (number of times mentioned, with overlaps)

Technique	Practice	Teaching	Research
1. LP (including mixed-integer programming)	66	27	15
2. Statistical methods	58	9	5
3. Simulation	57	14	12
4. Heuristics	26	5	1
5. Forecasting techniques	24	5	3
6. Project planning, networks	17	10	3
7. Queueing theory	15	15	8
8. Regression analysis	14	2	0
9. Non-linear programming	12	12	10
10. Dynamic programming	9	16	11
11. Inventory theory	8	13	5
12. Cost-benefit analysis	8	0	1
13. Multi-criteria decision making	7	0	4
14. Markov programming	6	9	8
15. Factor and cluster analysis	6	0	1
16. Scheduling, routing	5	4	2
17. Production planning (including MRP)	4	4	4
18. Stochastic processes	4	7	8
19. Probability theory	4	4	2
20. Fuzzy sets	3	0	1
21. Mathematical programming	2	9	7
22. Combinatorial programming	1	10	11
23. Control theory	0	0	3
24. Game theory	0	5	4

Table 10

Computers used directly or indirectly

Computer make	Number of times mentioned
IBM	99
DEC	74
CDC	63
Burroughs	19
Amdahl	15
ICL	11
Univac	10
HP	8
Honeywell-Bull	8
Ten other makes, each	< 5

Table 11

Software packages used directly or indirectly

Software package	Number of times mentioned
SPSS	52
MPSX	26
APEX	21
NAG	12
GPSS	6
MPOS	6
LANDO	5
IMSL	5
Many other packages, each	< 5

Table 12

Computer languages used directly or indirectly

Computer language	Number of times mentioned
Fortran	144
Algol	57
Basic	49
Pascal	47
APL	42
Cobol	39
Simula	36
PL/1	19
Assembler (various)	8
RPG	6
C-language	5
Mark IV	1
Lisp	1

ship. Individual rises and falls can be explained by individual incidents but more important is the fact that membership stagnates since ten years ago. This can be ascribed in part to the world depression, but other factors are specific to NSOR:

- hardly any membership recruitment is done (except in 1978);
- no effort is made to promote OR through sub-university education; a diploma in OR offered by

Fig. 2. NSOR membership development.

NSOR has such complicated examination rules and is so badly organized that only 27 people took it since 1965—an average of 1.5 per year;

- the society has three publications, which is two too many for such a small society: a beautiful, red, monthly bulletin, *VvS-bulletin*; an informal, quick, blue periodical, *Kwantitatieve methoden*; and a would-be prestigious, English-language, green journal, *Statistica Neerlandica*. (NSOR is a section of the Netherlands Society for Statistics and Operations Research, which has 1200 members, but even so.);

- the contribution is too high; Dfl. 105 is about double the contribution of some other OR societies and therefore nearly exclusively full-time, specialised OR-workers (applied mathematicians and econometricians and academics) can be attracted; for 'part-time' OR-workers, managers interested in quantitative methods and other 'marginally' interested 'outsiders', Dfl. 105 'extra' is prohibitive.

Considering the turnover of one third of the membership in the three and a half years between the 1978 and 1981 surveys (cf. Table 1), if NSOR had fewer publications, lowered its prices and were more active in promoting OR, it should be possible to retain more new and old members and grow by thirty per cent in three years!

Since the survey of 1981 was much more

Table 13

Some developments in NSOR between the surveys of 1978 and 1981 (percentages)

Quantity	1978	1981
Mathematicians	34	36
Econometricians	20	21
Mathematicians and econometricians in age classes below 35	73	82
Members in manufacturing industry	28	21
Members in services	20	31
Members in educational institutions	36	33

elaborate than the 1978 one and since the time elapsed is short, it is not very rewarding to compare the two. In the present paper, only Tables 2 and 3 are comparable to Tables 3–6 of [22].

Table 13 specifies some developments of NSOR between the surveys of January–March 1978 and the second half of 1981. I can only conclude: beware of the young mathematicians and econometricians and foster the members in manufacturing industry.

8. Summary and conclusions

Some itemized highlights of the results and conclusions of this study are as follows:

(1) A questionnaire by telephone of 98% of the membership of the Netherlands Society of Operational Research has been held. The aims were

- to collect a 25th anniversary volume of case studies [23];
- to find referees and reviewers for EJOR;
- to collect feedback from the members about the activities of NSOR;
- to compile the statistical survey presented in this article.

(2) NSOR membership is 40.6 years of age on average and is dominated by mathematicians (36%) and econometricians (21%) (Table 2). The society should aim at more diversification in disciplines.

(3) Employment is predominantly in the quarry sector (47%) with 29% employed in academia (Table 3). The secondary sector (21%) should be reinforced.

(4) NSOR members probably fulfil linking-pin functions, transmitting OR into their firms/organizations (Tables 4, 7). For economies of scale, it would be preferable if their co-operators could

be induced to become members themselves.

(5) Some NSOR members are not actively engaged in OR, hence, 'marginal' members or interested 'outsiders' (Table 8). This number could be multiplied if the society took account of this fact in its publication and contribution policy.

(6) The link between OR and computers is strong (Tables 10–12). It is good for society executives, conference organizers and journal editors to realize this.

(7) Many people are willing to perform activities for the society, specifically refereeing and reviewing, if only they are asked (Table 3).

(8) A questionnaire by telephone is time-consuming but rewarding. The aims have been achieved. It is recommended that other OR societies establish a similar contact with their membership.

(9) An OR society is probably like the visible tip of an iceberg: members representing their firms/organizations and many people performing operations research under different, fancy names without knowing. Nevertheless, this survey was deemed representative for OR in the Netherlands. For further research, it is recommended that a careful survey of national surveys be made to determine the common ground of current operations research.

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