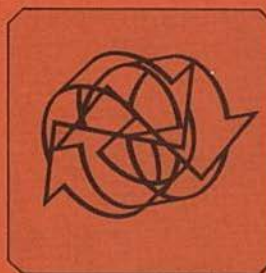




ARCHIEF

**Centrum voor Wiskunde en Informatica**  
Centre for Mathematics and Computer Science

## Facts & Figures



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## **Facts & Figures**





Main entrance of the CWI, situated at  
the Kruislaan in the Watergraafsmeer, Amsterdam



## 0. INTRODUCTION

At an institute like the Centre for Mathematics and Computer Science (CWI) a great variety of activities take place. The present brochure is intended to give insight into its organization and objectives. More detailed information about research performed at the Centre will be presented in separate pamphlets.

Section 1 contains a brief summary of the history of the CWI and the Stichting Mathematisch Centrum (SMC), of which it is a part.

Section 2 gives a description of the actual organization of SMC and of its role in research in mathematics and computer science in the Netherlands. To this purpose the procedures for the preparation of the scientific programme are also described, as well as its evaluation by Dutch researchers in corresponding fields. We then briefly explain the relation and interaction between SMC and SARA.

The next section offers a snapshot of the research activity of CWI, but only its outlines will be discussed: it will be extensively dealt with in a separate booklet.

Doing research is just one of the occupations of CWI. A survey of all other activities may be found in section 4.

Staffing, budget-affairs and computer equipment are mentioned in section 5.

Finally, in section 6, we venture to contemplate a little on future developments as to research in mathematics and computer science and on possible contributions to these fields by CWI.

## 1. HISTORY

The *Centre for Mathematics and Computer Science* is a research institute which is part of the SMC. The history of CWI is therefore inextricably bound up with that of SMC, as this brief survey will show.



CWI in the period 1949-1980 when it was still called  
Mathematical Centre and situated at Boerhaavestraat 49,  
Amsterdam

The foundations for the existence of SMC were laid during World War II, and it was founded officially on 11 February 1946. According to its statutes its aims are: "the systematic cultivation of pure and applied mathematics in the Netherlands, thereby on the one hand raising the level of prosperity and civilization in the Netherlands, and on the other enhancing the contribution of the Netherlands to international culture". As an important means to realize this goal SMC immediately founded an institute. This institute was called by the same name as the Foundation: "Mathematical Centre", until 1 September 1983, the day on which the new name "Centre for Mathematics and Computer Science" was officially introduced. Since 1980 the institute has been situated at the Science Park "Wetenschappelijk Centrum Watergraafsmeer" (WCW), a location which also houses some major research institutes in physics (NIKHEF and AMOLF), the computercentre of the University of Amsterdam, the Free University of Amsterdam and CWI (SARA), and the Biological Centre "Anna's Hoeve".



For almost 35 years nearly all the activities of SMC took place at its institute. The SMC has been sponsored by the Netherlands Organization for the Advancement of Pure Scientific Research (ZWO) as soon as this organization had been established. The research projects concerning mathematics and computer science, carried out at the universities and technical universities, were directly submitted to ZWO for evaluation and financing. From 1 January 1981, at the request of the Dutch researchers represented by the Dutch Committee for Mathematics (set up by the Royal Dutch Academy of Sciences, KNAW), ZWO has delegated the financing of all mathematics projects to SMC. Since then all requests for financial support with respect to research projects in mathematics are handled by SMC, and accordingly it also takes care of the supervision and evaluation of financial projects. In consultation with the Foundation for Technical Sciences (STW) the requests for STW-financing also go through SMC, i.e. SMC takes care of the first-round evaluation of proposed projects and, when financial support is granted, SMC is responsible for the supervision.

From the very first *computer science* has been a major concern of SMC. As a matter of fact, computer science in the Netherlands originated at the Mathematical Centre: the *first computers* in our country were constructed at this institute. This activity was successful to such an extent that (in 1956) a self-reliant company could be formed from the production-group: N.V. Electrológica, which later became part of Philips industries. Closely related to this was SMC's pioneer work in *program-development* and schooling in the fields of hard- and software. Due to these (partially) selfdeveloped computer systems SMC has, for a long time, been able to supply the computer facilities needed by the two Universities at Amsterdam which thus did not have to set up computer centres of their own. Eventually however, the common needs grew to such an extent that SMC, in cooperation with both universities, founded a joint Computer Centre (SARA, 1971).

In 1946 computer science was still innocently viewed as a branch of mathematics. In the meanwhile this subject has come to stand on its own feet, partly as a consequence of the work done at the Mathematical Centre. Recently the Dutch computer scientists have set up an independent research organization for computer science in the Netherlands (SION). In 1982 SION offered its "credentials" to ZWO. From then on ZWO has sponsored research in computer science via SION. SION shares its bureau with SMC and is therefore housed at CWI. The relations between SMC and SION are cordial, which is of great importance, not only for the interface between mathematics and computer science, but also because of their common concern with the Department of Computer Science of CWI.





Chairman's hammer, presented to SMC by the "Nederlands Rekenmachine Genootschap" (1964)

From its very first beginning SMC has been active both nationally and internationally. It played a part for example in the founding of "Nederlands Rekenmachine Genootschap", later to be absorbed by the Dutch Society for Computer Science (NGI). SMC was among the founders of the International Federation for Information Processing (IFIP) and a number of its working committees. Moreover, SMC was one of the founders of the European Association for Theoretical Computer Science and of Eurographics. In 1954 SMC organized the International Mathematical Congress for the International Mathematical Union. In 1978 SMC took an active part in organizing the celebration of the bicentennial of the Dutch Mathematical Society ("Het Wiskundig Genootschap")

1945

Foundation SMC and Institute Mathematical Centre

1950 Foundation Netherlands Organisation for the Advancement of Pure Research (ZWO)

Completion of the first Dutch computer, Automatic Relais Computer Amsterdam (ARRA)

Hydrodynamic studies (Delta Commissie) following the gale disaster in Zeeland IMC Amsterdam; Start research in Operations Research

1955 Delivery Fokker Electronic Computer, type ARRA (FERTA)

Completion 2nd Dutch computer ARMAC; Foundation Electrologica

Completion X1

1960 Report Deltacommissie (Part III: MC); ALGOL-60

MC-tract 1

1965

Completion X8

European Meeting on Statistics etc; ALGOL-68

1970

Independent department Operations Research

Foundation Joint computer centre SARA

MC-25 Computer Science Symposium

Computer department → Numerical Mathematics + Computer Science

1975

Start research Mathematical System Analysis; WG 200

1980

National working communities recognized by ZWO, accommodated at SMC

Institute Mathematical Centre changes its name into Centre for Mathematics and Computer Science

## ADVISING ON SCIENTIFIC RESEARCH

SMC is administered by a *Board of Trustees* consisting of 10 members (see Appendix 1). The members of this Board are selected from both scientific and business circles; one of them is appointed by the Governmental Secretary of Education and Science. All meetings of the Board are attended by the director of ZWO. SMC governs the CWI and 7 national working communities. The actual administration has been delegated to the *Board of Directors* of SMC, which is also in charge of the institute CWI.

At the moment the *Administration of SION* consists of 15 persons. SION heads 6 working communities. Its administrative support is taken care of by the bureau of SMC.

CWI consists of 6 scientific departments and a number of supporting service departments (see Scheme 1). The *Policy Advisory Council* of the institute supports the Board of Directors in developing its policy, in particular with respect to research, consultation and service, and activities of a more educational nature. There are moreover a number of *Advisory Committees* for specific disciplines and a general *Advisory Council*. The advisory committees recommend and supervise the research of the scientific departments and tune in with similar research done elsewhere. Moreover, the general Advisory Council advises on the research plans of the various scientific departments and the overall research policy.

In this context it may be helpful to indicate briefly how the *research* is actually *planned*. Where possible, research at CWI is set up in different projects; these projects are described in full detail in the Scientific Program for the oncoming year and, in more general terms, in a five year plan. Once a year, each scientific department outlines its scientific program, which is then discussed extensively in the corresponding advisory committee, in the presence of the scientific director of CWI. The departmental programs are then collected and, prefaced by a policy-chapter for the institute (including the recommendation of the advisory committees), they are presented to the Advisory Council and to the Policy Advisory Council. In accordance with this process the national working communities correct their policies, put the research projects to be financed to the test and indicate priorities. Based upon the recommendations and priorities of the science committee the Board of Trustees decides on a scientific program for SMC as a whole and then presents this decision to ZWO.

Naturally, the current projects are also frequently put to the test. Concerning university projects, young researchers are offered ample opportunity to report on their results at the annual Dutch Mathematical Congress, organized by the "Wiskundig Genootschap". As to research at CWI, the advisory committees attend a number of lectures on current research of some of the CWI researchers.

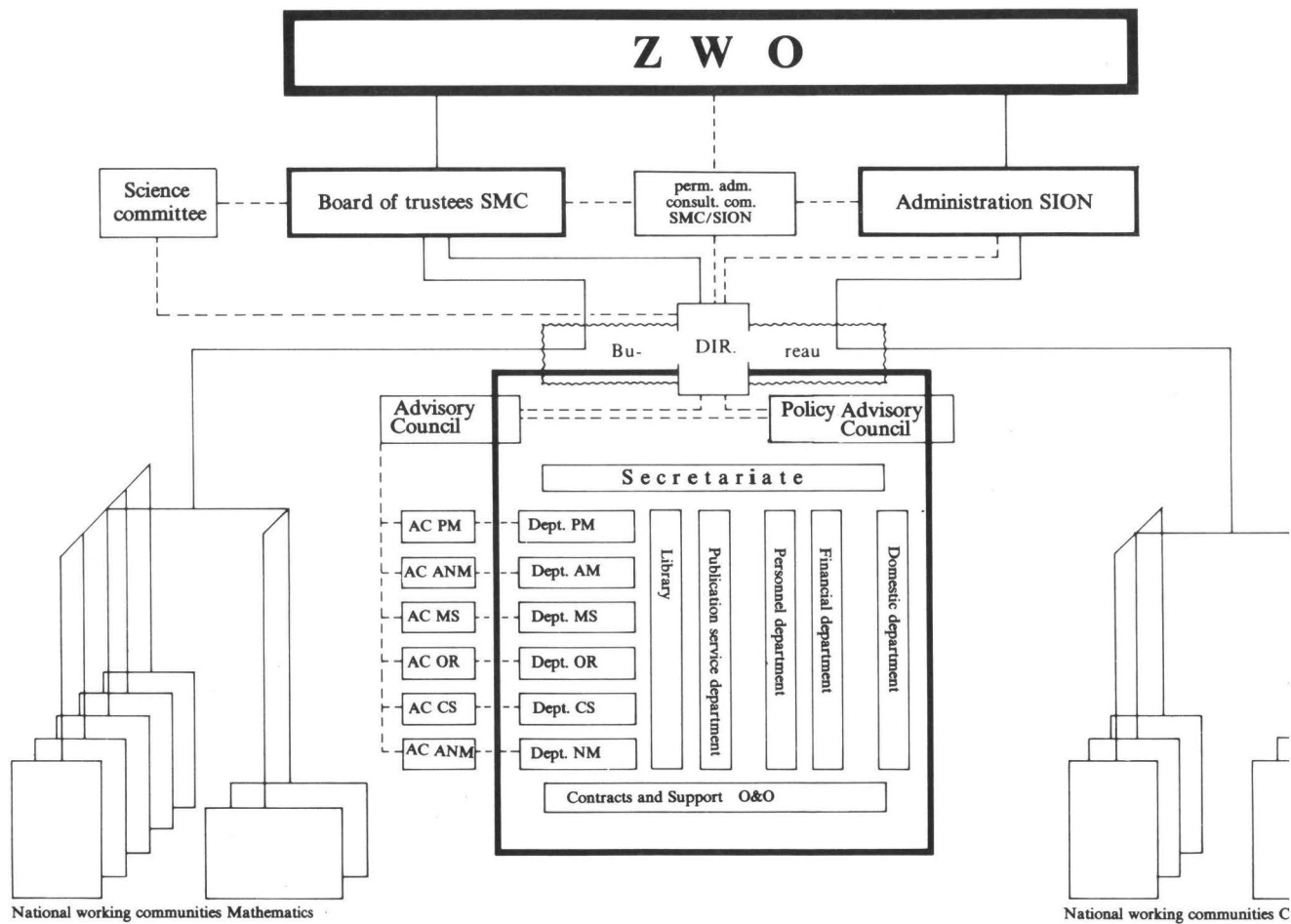
As far as research in computer science is done at CWI, we should add that SION is involved in the consultation about the research in the department of computer science of CWI. At the administrative level this is channelled through a permanent administrative consulting committee SMC/SION. The Board of Trustees has pledged itself to inform ZWO (after careful deliberation) in case any recommendation of SION is overruled.

The participation of SMC in SARA has come into existence in full agreement and collaboration with ZWO. When in-house facilities cannot be used, SARA computer facilities are available.

Besides these ZWO allies, some research groups from business, government and semi-government have, through the mediation of CWI, direct access to SARA, for their mainly statistical and econometric analyses.

The SARA facilities are not only used for research at CWI but also by the service-department of Contracts and Support (O&O) which uses them for clients seeking the services of CWI.

SMC uses about 30 % of SARA's total capacity. Approximately 60 % of that portion is allocated to ZWO and FOM; about 20 % is used for CWI-research and another 20 % for CWI customers.



Centre for Mathematics and Computer Science  
Scheme 1.

## Explanation of Scheme 1:

### SMC

#### National working communities

Numerical Mathematics  
Stochastics  
Discrete Mathematics  
Operations Research  
Analysis  
Algebra and Geometry  
Logic and Foundations of Mathematics

### SION

#### National working communities

Theoretical Computer Science  
Software and Architecture  
Performance analysis, design aids and simulation  
Pattern recognition, incl. artificial intelligence  
Administrative Computer Science  
Interactive systems

### CWI

#### Scientific departments

PM	=	Pure Mathematics
AM	=	Applied Mathematics
MS	=	Mathematical Statistics
OR	=	Operations Research and System Theory
CS	=	Computer Science
NM	=	Numerical Mathematics

#### Advisory Committees CWI

AC PM	=	advisory committee PM
AC ANM	=	advisory committee AM and NM
AC OR	=	advisory committee OR
AC MS	=	advisory committee MS
AC CS	=	advisory committee CS

As already stated in the introduction, a separate booklet about research at CWI is being prepared. In the present brochure only some matters of a more organizational nature have been collected.

The aim of CWI is fundamental and advanced research in mathematics and computer science with special attention to those areas which are of direct importance for applications. By "fundamental" we mean that special attention will be paid to those problems for which as yet no standard methods of solution exist. This means that the development of new methods and techniques is a major part of the research. By "advanced" we mean that it is our aim to do research work that is of a high level nationally and internationally. As one might expect, preference is given to those subjects which, from an international point of view, look likely to have interesting developments.

At present, research at CWI is subdivided into 6 separate departments (see Table 1). This division into these particular 6 fields has been more or less accidental, i.e. based on historic reasons. An expansion of the research in computer science at CWI is in preparation (see also section 6). It is quite possible that this expansion will eventually lead to the formation of a second department of computer science. With respect to the remaining departments some unification or reallocation may come up for discussion. Nevertheless, in the present grouping there exists a definite logical structure.

The subdivision of the research into different departments might give the impression that each of them goes its own independent way. However, in reality there exists considerable collaboration. This is the consequence of deliberate policy, not only in the selection of research topics but also in the selection of the permanent scientific staff. For examples of this cooperation see Scheme 2.

As a matter of fact this Scheme should have been extended by two additional ones: one indicating the relations between research done at CWI and elsewhere in the Netherlands, and another one giving an overall picture of the international contacts of CWI. As it is no easy task to map out all these interrelations, we have confined ourselves to one example. As to the close connections between research done at CWI and in mathematics and computer science elsewhere in Holland we only want to point out that at the Dutch (technical) universities some 45 full professors are employed, who all of them were at SMC for many years, where they thus acquired a good deal of their expertise. Quite a few of them are still in close contact with CWI.



Table 1:

The related activities concerning the projects per department are specified according to the ratio per man/year

## dept. PURE MATHEMATICS

— Discrete Mathematics	2.3
— Analysis and Number Theory	0.6
— Topology and Analysis	0.3
— Algebra	2.2
— Analysis on Lie groups	2.4
— Theta functions	0.8
Consultation etc.	1.2
Projects in other dept's	<u>0.2</u>
Total PM	<u>10.0</u>

## dept. APPLIED MATHEMATICS

— Asymptotics and Applied Analysis	2.6
— Non-linear analysis and biomathematics	3.0
— System theory	0.1
Consultation etc.	<u>1.3</u>
Total AM	<u>7.0</u>

## dept. MATHEMATICAL STATISTICS

	1.0
— Stochastic censoring	1.3
— Stochastic processes and applications	1.7
— Applied statistics	2.0
Consultation etc.	<u>1.5</u>
Total MS	<u>7.5</u>

## dept. OPERATIONS RESEARCH and SYSTEM THEORY

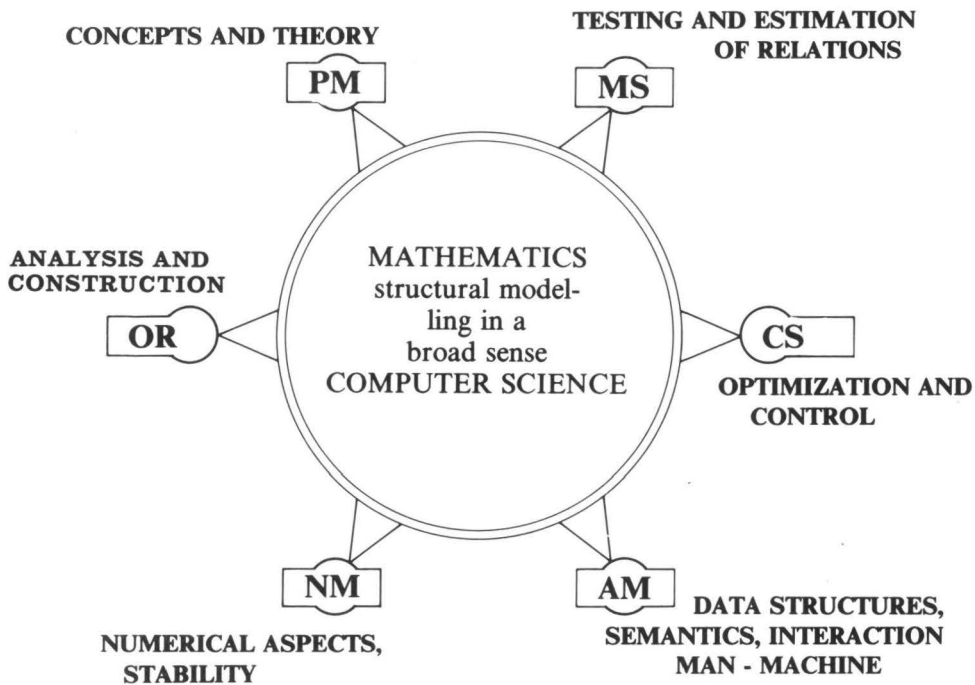
— Combinatorial optimization	2.0
— Analysis and control	1.0
— System theory and -analysis	3.0
— Software	0.0
Consultation etc.	<u>2.0</u>
Total OR	<u>9.0</u>

## dept. NUMERICAL MATHEMATICS

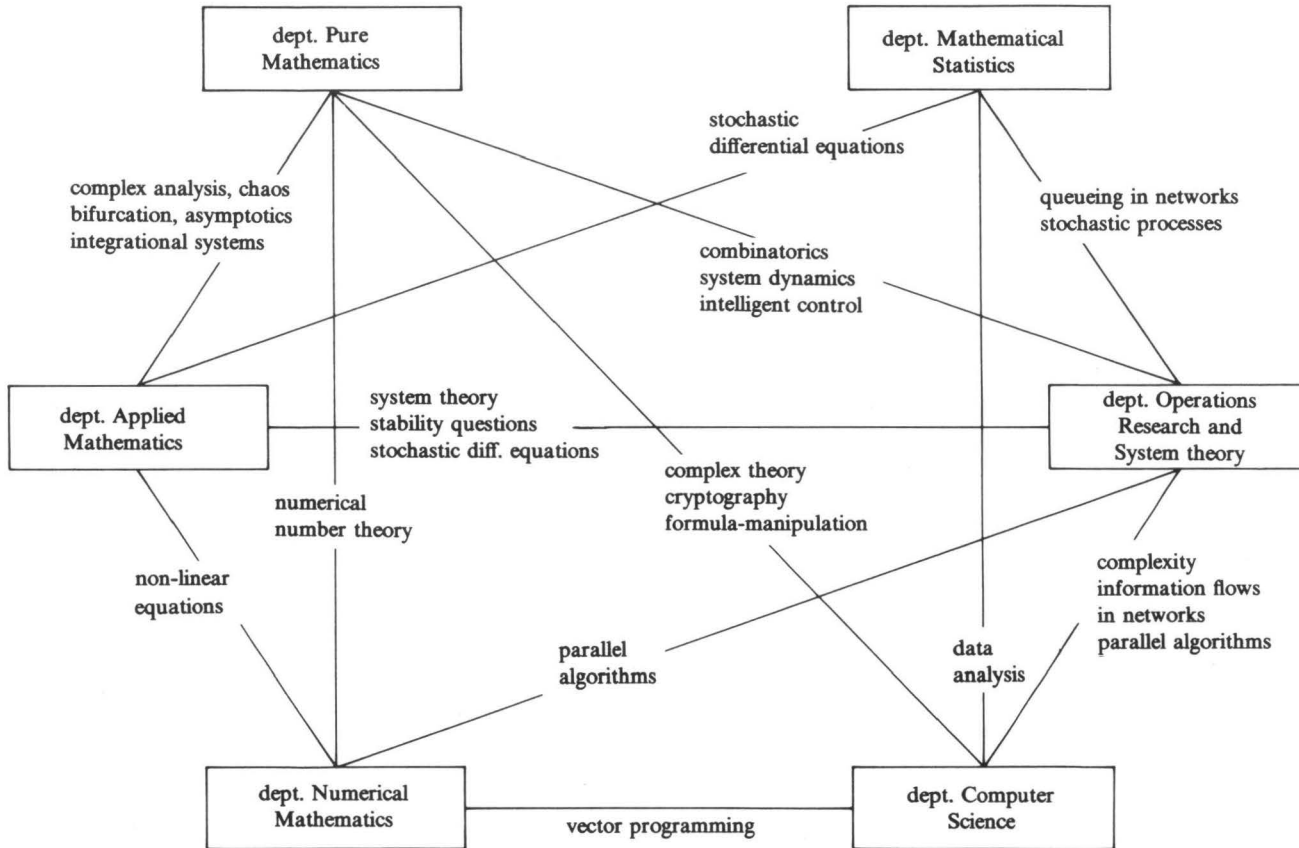
— Initial value problems	2.0
— Boundary problems	2.0
— Number theory	p.m
— Software	0.0
— Volterra-integral equations	1.0
Consultation etc.	<u>0.0</u>
Total NM	<u>8.0</u>

## dept. COMPUTER SCIENCE

— Complexity	1.0
— Theory and methodology of programming	1.0
— Language implementation and computer architecture	3.0
— Software design	1.0
— Interaction	1.0
Consultation etc.	<u>1.0</u>
Total CS	<u>11.0</u>



Scheme 2.





VANCOUVER



HIROSHIMA  
KYOTO



CORNELL  
MINNEAPOLIS  
TUCSON  
CHICAGO  
VANDERBILT  
BETHESDA



STRATHCLYDE  
OXFORD



HEIDELBERG  
TÜBINGEN



CWI AMSTERDAM



TRENTO  
ROME  
BARI

An example of international collaboration: We have here displayed a number of locations where, in excellent cooperation with CWI, first-rate research is being done in mathematical biology.

Every year a number of national as well as international courses and seminars are organized. On the one hand their aim is to stimulate research in the relevant fields both at CWI and at other Dutch institutes concerned. On the other hand advanced courses are given in order to pass on acquired insight and knowledge. Below we list a selection of some regularly recurring educational events.

#### CREST courses (summer, period of 2 weeks)

1. Advanced course on Programming Languages and Data structures, 1972 (A. van Wijngaarden)
2. Advanced course on the Foundations of Computer Science I, 1974 (J.W. de Bakker)
3. Advanced course on the Foundations of Computer Science II, 1976 (J.W. de Bakker)
4. Advanced course on the Foundations of Computer Science III, 1978 (J.W. de Bakker & J. van Leeuwen)
5. Advanced course on the Foundations of Computer Science IV, 1982 (J.W. de Bakker & J. van Leeuwen)

#### PAO Computer Science courses

1. Interactive computer graphics
2. Modern techniques in software engineering
3. Interactive computer graphics

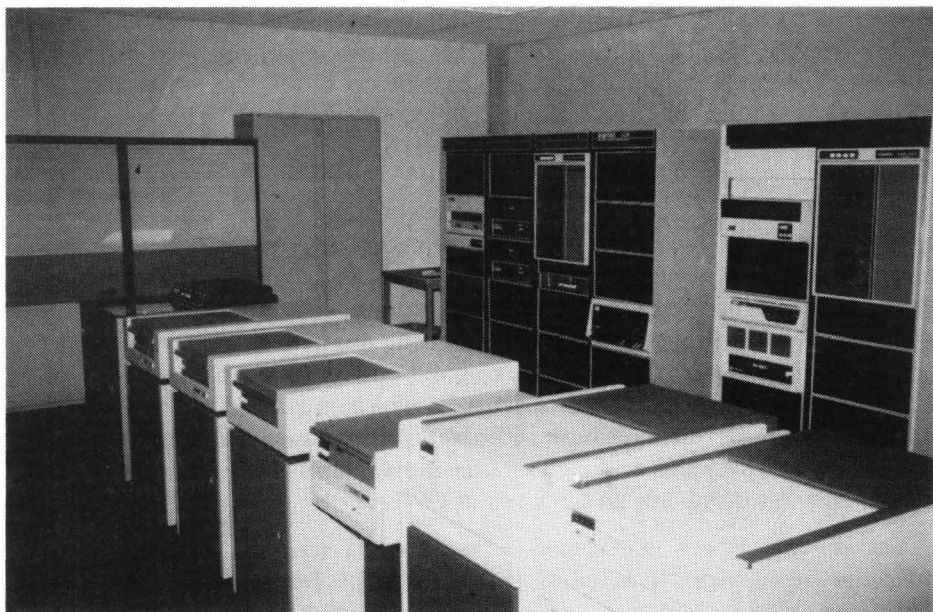
## TOPICS OF THE SUMMER COURSES FOR TEACHERS (organized since 1946)

1946	Mathematics and didactics of mathematics
1947	Modern algebra and discussion on the didactics of mathematics
1948	Foundation problems
1949	Group theory
1950	Probability, foundations and applications
1951	Mathematics and various applications
1952	Mechanics
1953	Some domains of pure and applied mathematics
1954	--- no course, on account of IMV-congress in Amsterdam
1955	Concept-syllabus for mathematics 1954
1956	Scientific foundation of elementary mathematics
1957	History and methods of geometry
1958	History and methods of algebra
1959	Vectors
1960	Mathematical education of tomorrow's secondary schools
1961	Modern algebra
1962	Innovation in mathematical education in secondary schools
1963	Topology
1964	Applied analysis (two analytical methods of applied mathematics)
1965	Number theory
1966	Saddlepoints
1967	Operations Research
1968	History of mathematics until ca. 1900
1969	Statistics and Probability
1970	Computers and education
1971	Development of mathematics in the past 25 years
1972	Graph theory and its applications
1973	Abstract computer science
1974	Algebraic equations
1975	Discrete mathematics
1976	Functional analysis
1977	Logic
1978	Geometry - past and present
1979	New applications of mathematics (economics, social sciences, biomathematics, and linguistics)
1980	Number theory
1981	Orientations in computer science
1982	Mathematics in the open - wave phenomena
1983	Complex numbers

## TOPICS OF THE TEACHERSCOLLOQUIUM (organized since 1970)

1970/71	Computer Science
1971/72	Functions theory
1972/73	Differential equations

1973/74	Linear algebra
1974/75	Geometry and its relation to algebra
1975/76	Boolean algebra and model theory
1976/77	Graph theory
1977/78	Geometry of surfaces (Griffiths)
1978/79	Number theory
1979/80	Group theory
1980/81	Finite geometry
1981/82	Geometrical theory of differential equations
1982/83	Game theory



CWI Computer equipment



From the day of its foundation one of the objects of CWI has been to put to work all fundamental and advanced research to the benefit of governmental, semi-governmental and business institutions.

To this end CWI has at its disposal a service department O&O. This department has a supporting task for the entire institute, for example with respect to automation of data handling regardless of the question whether the data are of a scientific nature or whether they are from the financial administration, the publication department, or the library. Moreover, O&O gives support to the scientific departments in carrying out consultation projects for clients. Finally, O&O also accepts assignments directly, although in carrying them out it frequently calls in the expertise available at the scientific departments. Besides supporting the researchers in making their pure research applicable, research is also continually backed up by various other means. CWI is, for example, equipped with a well-stocked *library*. While housed in the CWI, its collection is in fact of national importance. In particular we mention its extensive collection of (research) journals which was largely acquired through a great variety of exchange contacts. The exchange material consists on the one hand of CWI research papers (e.g. reports) and on the other of "*Indagationes Mathematicae*", a reprint of the mathematical "*Proceedings A*" of the Royal Dutch Academy of Sciences (KNAW). The latter item has (for this purpose) been put at the disposal of CWI at advantageous conditions. This has enabled us to build up a considerable collection of mathematics and computer science journals which is unique in the Netherlands. Especially by the exchange with scientific institutes and other learned communities all over the world, this collection contains many journals which in the Netherlands are only to be found at CWI.

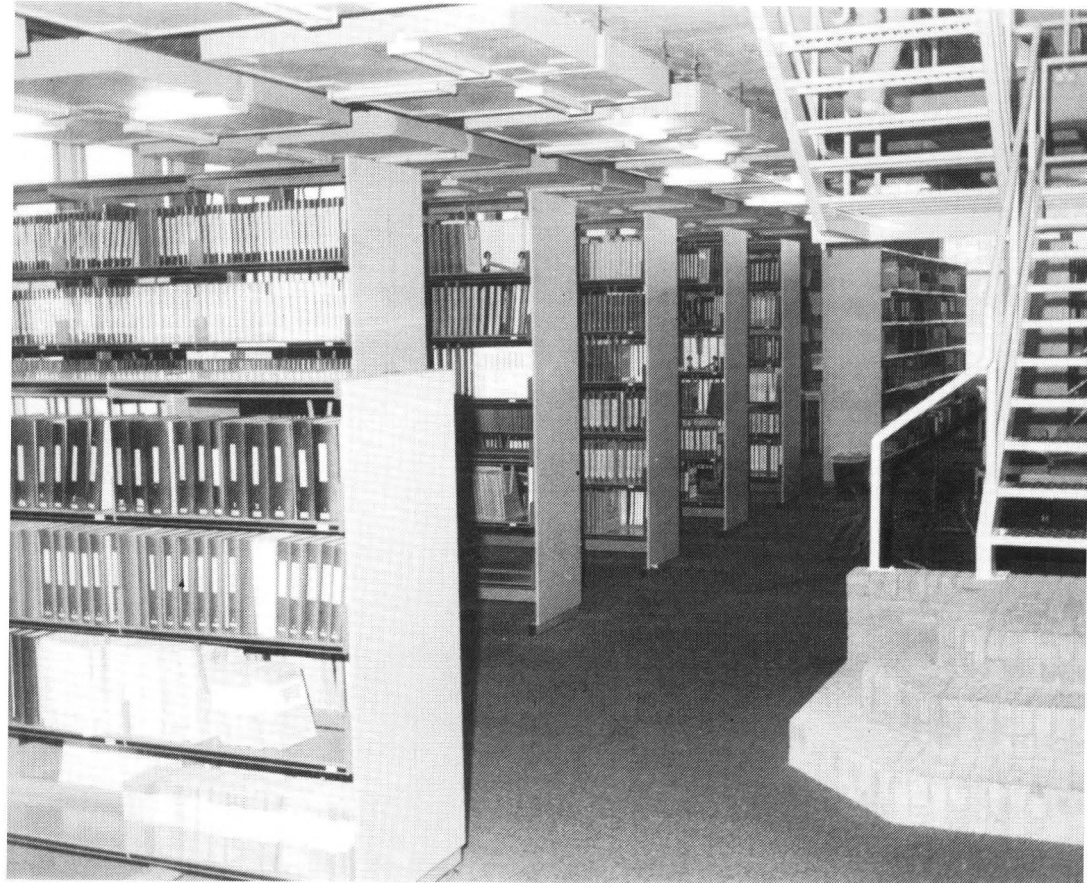
Yet another service department supporting the scientific research is the *publication department* (typesetting and printing). Besides the undeniable importance of a prompt publication of research results these CWI publications play an important role as exchange material for the library, as we already mentioned above. The printing division also carries out a good deal of work for the other scientific institutes located at WCW.

A short survey of the numbers and types of publications produced at CWI since 1970 is presented in Table 2.

year	MC reports	vols. in MC TRACT series	vols. in MC SYLLABUS series	publ. in journals	theses	misc.
1970	57	5	3	8	4	1
1971	87	6	5	9	2	6
1972	71	4	1	28	4	3
1973	86	7	7	20	2	3
1974	76	8	1	24	4	
1975	117	4	2	31	3	
1976	106	9	13	42	4	
1977	119	10	6	54	4	
1978	95	10	3	56	6	
1979	102	19	4	58	6	
1980	114	16	4	71	2	
1981	125	14	9	76	3	
1982	123	6	4	104	9	4

Table 2a: PUBLICATIONS OF CWI since 1970

	total	PM	OR/SA	MS	AM	NM	CS
<i>MC-publications</i>							
Tracts	6						
Theses	9	2	1	1		2	3
Syllabi	4	1	1				2
W-reports	113	12	23	13	11	27	27
N-reports	10	1	2		1	4	2
Contributions to tracts	3	1					2
contributions to syllabi	11	5	1				5
<i>other publications</i>							
books	1		1				
editorship books	10						
journal articles							
articles in proceedings	104	25	21	8	9	17	24
contributions to books							
reports	14	9	1	1	1		2
miscellaneous	7		4				3



The library has an extensive collection of books, journals, and reports on mathematics and computer science. It contains about 30,000 books, 960 current journals and 35,000 reports and every year more than 3,500 reports are acquired.

## 5. SOME DATA CONCERNING PERSONNEL, STAFFING, BUDGET AND COMPUTER FACILITIES

### *Personnel*

On 1 September 1983, CWI had 151 employees, 47 of which were in part-time positions so that the total staffing expressed in full-time equivalents amounts to 134.5.

Of these 151, 77 are employed at the scientific departments in close contact with research and development and pre-development activities. For direct support of research and development 36 are employed at the department O&O and the library.

More than half of all those employed at the scientific departments have a temporary appointment. Some occupy (after having obtained their doctorate elsewhere) a post-doctoral position at the CWI, others are given the opportunity to do research work at CWI in order to obtain their doctorate. See Table 3.

	number of CWI employees that obtained their doctorate	number of CWI employees leaving the institute
1970	3	6
1971	2	5
1972	4	10
1973	2	5
1974	3	5
1975	3	5
1976	4	4
1977	4	9
1978	5	9
1979	6	6
1980	2	9
1981	3	10
1982	8	11
	49	99

Table 3: Survey of the number of employees that obtained their doctorate during their period of research at CWI and the number of research employees

The SMC budget for 1983 amounts to about Dfl. 15.3 million. Of this amount Dfl. 1.85 million is allocated to research by the national working communities, whereas the contribution of SMC to SARA amounts to about Dfl. 2 million. CWI's own budget amounts to about Dfl. 12.5 million. Of this sum 84 % is allocated by ZWO and the remaining 16 % is obtained as revenues out of work done for clients.

### *Computer equipment*

The computer equipment of CWI is managed by the Computer Laboratory of O&O. The interrelation between the various components is indicated in Scheme 4. The computer equipment originates largely from Digital Equipment Corporation:

*VAX 11/780*: this system is generally used for computer science research. This is CWI's most powerful computer (1MIPS). The VAX configuration regulates the UNIX network for Europe through the Auto Call Units, the port selector (IPS) of SARA (for connections with the Free University of Amsterdam and SARA's PDP 11/70) and its own port selector (MICOM) for connections with our own PDP's and the system of the NIKHEF institutes.

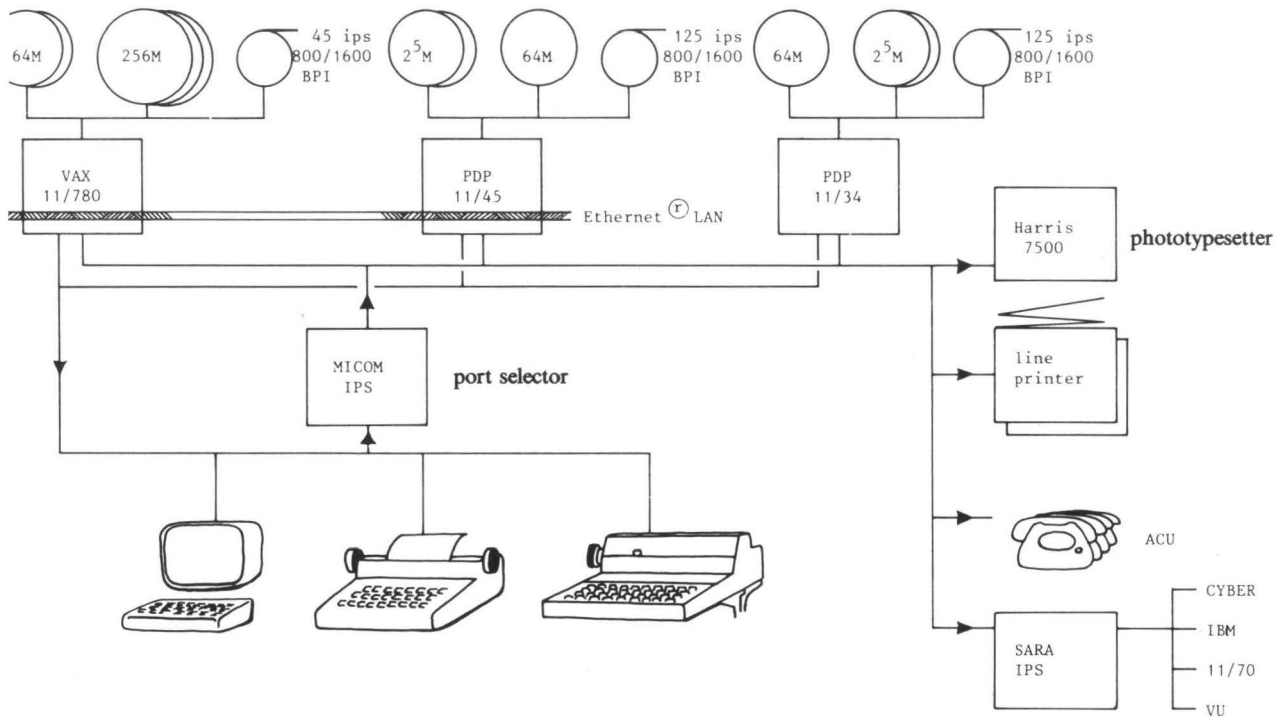
*PDP 11/34*: used for administrative purposes: administration (department of personal and financial department), library, publication department and data entry. The machine is not actually used for computational work.

*PDP 11/45*: this computer is used for graphical output through, for example, the laser plotter (HRD/1) and data entry systems. Also spelling programs, text analysis programs and lay-out/typesetting programs are executed on this machine.

*Peripheral systems*: all these can, generally speaking, be reached from all other CWI computers. In this way these systems can be handled by all users in an easy and efficient manner. For example, data entry output can be printed, without any changes in its lay-out indication, from any machine on any other system in accordance with the user's quality requirements (line printer, daisy wheel printer or even the HARRIS 7500 photo typesetting system).

*MICOM*: the present Intelligent Port Selector. At the same time it is the pivot of all computer connections. At any terminal one may choose which computer one wants to use (VAX 11/780, PDP or SARA's port selector). This portselector also enables every computer to reach any other one or its peripherals such as line printer or phototypesetter.

*Ethernet*: the VAX 11/780 and PDP 11/45 have until now been the only two computer (-systems) connected via Ethernet. Shortly the PDP 11/45 will be replaced by a number of micro-systems which are also connected via Ethernet. When that is effective, CWI will have a Local Area Network. At present Ethernet is in a test and development phase at CWI. The Computer Laboratory hopes to complete this experiment early 1984. By then the user will not be aware anymore on which computer he is actually working.



*"Strength in science and technology is essential to the welfare of our nation for reasons of both economics and national security. Mathematics is an important component of science and technology. Scientific computing, statistical analysis and a theoretical understanding of nonlinear equations will be vital topics for science for at least the remainder of the twentieth century. Progress at the frontiers of mathematics is part of the forward thrust of Science". \**

Mathematics and computer science together form the *structure-sciences* (so termed by Carl Friedrich von Weizsäcker, 1971). In this vision, mathematical statistics, system theory, game theory, and part of computer science and cybernetics are included in the term mathematics. The founders of SMC had a clear vision of the great importance of these structure-sciences for science in general and for technology. This vision was one of the driving forces of the founders of SMC and it made them lay down in the articles of foundation that the systematic cultivation of pure and applied mathematics (including computer science) will contribute to raising the level of prosperity and civilization in the Netherlands.

Since the forties mathematics has undergone a tempestuous development. At times a definite divergence could be seen: mathematics seemed to explode as a consequence of specialization and increasing abstraction. After a number of years, however, some convergence could again be observed: many separate disciplines are interacting again and reciprocally stimulating new developments. New applications of mathematical techniques are drawing our attention. To mention just one example, we see that results from non-linear analysis are applied to various areas, from epidemiology to nuclear reactor technology. It is most exciting to be able to witness all this. At CWI the application of mathematical methods and techniques have always been considered of great importance. In contrast to the sixties and early seventies, when the rapid growth of some mathematical disciplines led to extensive new theoretical research, research arising from mathematical problems from the outside world is getting a great deal of attention again. Contacts with various institutions, where the emphasis is on applications, are taken up again (e.g. with Philips, dr. Neher Laboratory, Dutch Railways, Dutch software industry and many other government sponsored research institutes. These contacts yield important problems which stimulate fundamental as well as applied research.

In view of the applications of research done at CWI, the Operations research and System Theory Groups have been expanded. Other subjects

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\* From an address by James Glimm, chairman of the Advisory Subcommittee for Mathematical Sciences of the National Science Foundation, U.S.A. See SIAM News 16, January, 1983), p.1.





The research policy of CWI still bears the stamp of prof. dr. ir. A. van Wijngaarden, managing director of the Mathematical Centre (CWI) from 1961-1980. Appointed in 1946 as one of the first staff members, he initiated computer science in the Netherlands in the post-war years. He gave guidance to very important developments, in the field of computer frameworks as well as in the field of software (language development, ALGOL).

tics, stochastic processes, queueing problems, risk-analysis, finite (discrete) systems and cryptography.

We cannot pass by the *education* of the researchers, an aspect which has always been considered of great importance. Especially in the fifties and early sixties many researchers received their research education at CWI. Most of them now occupy important positions in the Dutch community (among them quite a number of full-professors at the Dutch universities). This aspect will also be paid attention to in the future.

The *computer science division* at CWI will be considerably expanded in the next few years, when the necessary structural possibilities will have been created. Computer science at CWI has always had an important pioneer function: as mentioned above, the cradle of Dutch computer science stood at CWI. In the years ahead - the universities being overwhelmed by great numbers of students and, at the same time, being understaffed - CWI can take up a task similar to the one it used to perform in earlier years: as a research centre, its influence will radiate towards universities and commercial institutions, and as a centre where scientific staff is educated it will involve younger students in current research. In view of this CWI will have to reinforce its own staff. In view of the current "market capacity" in the Netherlands, inviting foreign guest-researchers will most probably be an important means to accomplish this prospect. Fortunately, CWI has an excellent reputation as a research institute so that it may easily attract foreigners to come and work at CWI.

The research program of the computer science department has to be extended. This implies in particular to applied research, development and pre-development. The means to start this are available: CWI has always incorporated research of an applied nature as well as fundamental research in fields such as complexity theory or programming language design and implementation. Also of great importance is the embedding of computer science in a much wider spectrum of research. In particular, at the department Operations Research and System Theory (though not only there) research is done which is indispensable to a centre for computer science. An important new field such as vector programming (directed towards supercomputers) could be explored efficiently in good cooperation between numerical mathematics and computer science. Another example: in the field of current interest such as computer networks, CWI has already acquired considerable practical know-how. In the future this will be a field of research in which computer scientists and experts in the fields of the analysis and direction of information flows in networks will complement each other.

In cooperation with SION a policy of much wider scope is in preparation. In accordance with SION, CWI holds the view that an enlargement of scale concerning fundamental research and development-directed computer science is of the utmost importance for computer science in the Netherlands and for

a proper participation in the European strategic program for research and development in the field of computer science (ESPRIT; see Table 5 for CWI participation in the pilot phase of the ESPRIT program). This widening of the research, however, will be feasible only if ZWO provides the necessary means.

From 1 September 1983 the institute MC presents itself as CWI. This change of name is more than just a peripheral matter: SMC and SION thereby express their confidence that this institute continually takes part in the most recent developments and that in the future it will contribute to the growth of the structure-sciences: mathematics and computer science.

## ESRAT PROJECTS

### *Formal Specification and Systematic Program Development*

#### *(Software Technology)*

co-applicants: Philips - Natuurkundig Laboratorium (prime contractor)  
SGE - Laboratoire de Marcoussis  
COPS

### *Design Rules for Computer Integrated Manufacturing Systems / CIM*

#### *(Computer Integrated Manufacturing)*

co-applicants: British Leyland Systems, UK (prime-contractor)  
UvA, department computer science, CWI } (sub-contractors)  
British Leyland Technology LTD, UK }

### *UNIX-based Information Exchange System with Open Systems Interconnection*

#### *(Information Exchange System)*

co-applicants: CII Honeywell Bull  
Siemens  
General Electric  
ICL  
CWI (sub-contractor)

## ADA PROJECT

### *Guidelines for the Design of Large Modular Scientific Libraries in ADA*

co-researcher: National Physical Laboratory, UK.

Table 4: Projects in EC-connection, in which CWI is involved

## Appendix 1

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drs. J. Nuis

## Abbreviations

CREST	Committee on Research and Education in Science and Technology
CWI	Centre for Mathematics and Computer Science
ESPRIT	European Strategic Programme of Research and Development in Information Technology
EUR	Erasmus University Rotterdam
FOM	Foundation for Fundamental Research on Matter
IFIP	International Federation for Information Processing
KHT	Catholic University Nijmegen
MC	Mathematical Centre
NGI	Dutch Society for Computer Science
O&O	CWI service department Contracts & Support
PAO	Post-doctoral education
RUG	University of Groningen
RUL	University of Leiden
RUU	University of Utrecht
SARA	Foundation Academic Computer centre Amsterdam
SION	Foundation for Research on Computer Sciences
STW	Foundation for the Technical Sciences
THD	Delft University of Technology
THE	Eindhoven University of Technology
THT	Twente University of Technology
UvA	University of Amsterdam
VUA	Free University of Amsterdam
WCW	Science Park Watergraafsmeer
ZWO	Netherlands Organization for the Advancement of Pure Scientific Research

The abbreviations denoting scientific departments of the CWI can be found in the explanation of Scheme 1







**Stichting Mathematisch Centrum**

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**Centrum voor Wiskunde en Informatica**  
Centre for Mathematics and Computer Science

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