

# **Evaluation 1999-2004**

## **Centrum voor Wiskunde en Informatica (CWI)**



# Contents

<b>1</b>	<b>Introduction</b>	<b>5</b>
1.1	Scope and context of this evaluation	5
1.2	The evaluation committee	5
1.3	Data supplied to the committee	6
1.4	Procedures followed by the committee	6
1.5	Aspects and assessment scale	7
<b>2</b>	<b>CWI</b>	<b>9</b>
2.1	Mission	9
2.2	Research	9
2.3	Organizational structure	9
<b>3</b>	<b>Assessment of the Institute</b>	<b>11</b>
3.1	Answers to the Standard Evaluation Protocol	11
3.2	Answers to the questions addressed to the committee by NWO	14
<b>4</b>	<b>Theme Assessments</b>	<b>17</b>
4.1	Theme PNA1 Networks and Logic – Optimization and Programming	17
4.2	Theme PNA2 Advanced Communication Networks	18
4.3	Theme PNA3 Stochastics	19
4.4	Theme PNA4 Signals and Images	21
4.5	Pilot Theme PNA5 Cryptology and Information Security	22
4.6	Theme SEN1 Interactive Software Development and Renovation	24
4.7	Theme SEN2 Specification and Analysis of Embedded Systems	25
4.8	Theme SEN3 Coordination Languages	27
4.9	Theme SEN4 Evolutionary Systems and Applied Algorithmics	28
4.10	Pilot Theme SEN5 Convergent Media Interfaces	29
4.11	Theme MAS1 Non-linear PDEs – Analysis and Scientific Computing	31
4.12	Theme MAS2 Computing and Control	33
4.13	Theme MAS3 Non-linear Dynamics and Complex Systems	34
4.14	Theme INS1 Database Architectures and Information Access	35
4.15	Theme INS2 Multimedia and Human/Computer Interaction	36
4.16	Theme INS3 Visualization and 3D User Interfaces	38
4.17	Theme INS4 Quantum Information and Systems Research	39
<b>5</b>	<b>Conclusions and Recommendations</b>	<b>41</b>
<b>6</b>	<b>Appendices</b>	<b>45</b>
6.1	Curricula vitae of the committee members	45
6.2	Standard Evaluation Protocol 2003-2009	50
6.3	Programme of the site visit	51
6.4	List of PDs and PhDs interviewed	52
6.5	Checklists for internal use by the committee	53
6.6	Current and former CWI staff with full professor appointments	55
6.6	Current and former CWI staff with full professor appointments	55
6.6	Current and former CWI staff with full professor appointments	55



# 1 Introduction

## 1.1 Scope and context of this evaluation

The Netherlands Organisation for Scientific Research (NWO) regularly evaluates the scientific performance of its research institutes. As part of this evaluation scheme, the National Research Institute for Mathematics and Computer Science in the Netherlands (Centrum voor Wiskunde en Informatica, CWI) has been evaluated by an international committee.

The aims of the assessment system are:

- Improvement of the quality of research through an assessment carried out according to international standards of quality and relevance.
- Improvement of research management and leadership.
- Accountability to higher levels of research organizations and funding agencies, government, and society at large.

The committee is asked to produce a reasoned judgement on the mission, strategy and performance of the institute. The evaluation contains retrospective and prospective elements. The assessment is based on the Standard Evaluation Protocol 2003-2009 (SEP), which calls for an evaluation both of the research institute itself and of the research programmes it conducts.

The research institute submits details of the results that have been achieved in each research programme over the previous six years (including quantitative data about staff input, key publications and a list of publications), a short outline of the mission statement of each programme, and details of developments anticipated in the context of the research profile of the institute. Important elements of each review are a site visit, which includes interviews with the management and the programme directors, and a tour of the facilities.

## 1.2 The evaluation committee

The evaluation committee was appointed by the Governing Board of NWO following consultation with CWI and with the NWO Board for Physical Sciences. Its members are:

Frank den Hollander (chair)	Eindhoven University of Technology
Christopher Baker	University of Manchester
Susan Graham	University of California, Berkeley
Wendy Hall	University of Southampton
Kurt Mehlhorn	Max Planck Institute for Computer Science, Saarbrücken

A short curriculum vitae of each of the members is included in Appendix 6.1.

The committee was supported by NWO staff (Ron Dekker, Foekje Grootoink and Els el Idrissi).

All members of the committee declared that their assessment had been free of bias, personal preference or personal interest, and that it had been reached without undue influence from the institute, the programme directors or other stakeholders. Any existing professional relationships between committee members and programmes under review were brought to the attention of the committee. The committee concluded that there were no conflicts of interest.

### 1.3 Data supplied to the committee

The documentation included all the information required by the SEP, as well as answers to the additional questions addressed to CWI by NWO. It included:

- The self-evaluation report by CWI.
- The Annual Report 2003, giving a general overview of CWI's scientific activities and some research highlights.
- A selection of full text papers for each programme.

During the site visit, the following additional information was made available:

- The Scientific Report 2004.
- The Financial Report 2003 and CWI's financial summary for 2004.
- Handouts of all the presentations.

#### 1.3.1 Jargon

CWI uses terms different from those used by NWO (and the SEP):

NWO	CWI
Department	Cluster
Research programme	Theme

In this report we will use the CWI terminology. The expression "management team" refers to the director, the cluster leaders, and the controller.

For convenience, the following abbreviations are used:

PhD = graduate student (aio, promovendus).

PD = postdoctoral researcher.

FTE = full-time equivalent (labour contract of 38 hours/week).

### 1.4 Procedures followed by the committee

The committee proceeded in accordance with the Standard Evaluation Protocol 2003-2009 (see Appendices 6.2 and 6.5). The assessment was based on the documentation provided by the institute, the selected key publications, and the interviews conducted during the site visit on March 23 and 24, 2005. The programme of the site visit is included in Appendices 6.3 and 6.4.

The self-evaluation report, the annual report, the selected papers and an explanatory letter were sent to the committee one month before the site visit. The chair and the secretary of the committee established a timetable for the site visit (see Appendix 6.3) and the committee members divided up the task of reading the full text papers to ensure total coverage. Because of the large number of research themes (17), the committee decided in advance to split up during the interviews with the theme leaders. There were two sessions for the themes with a focus on mathematics (PNA and MAS) and two sessions for the themes with a focus on computer science (SEN and INS). One committee member with broad expertise in both mathematics and computer science switched between the sessions.

The committee met on the afternoon preceding the site visit to discuss and plan the interviews with the governing board, the management team and four heads of support departments. They also decided which PhDs and PDs to interview on the second day of the site visit (see Appendix 6.4).

Prior to the site visit, the theme leaders were informed that their presentation should include a SWOT analysis, and that there would be a separate discussion with the cluster leaders. After each presentation the committee had time for a brief evaluation and initial scoring.

On the morning of the first day, there were interviews with the chair of the board, the management team and the support staff. That afternoon presentations were given by the theme leaders of the PNA and SEN clusters. At the end of the day, the committee had a closed session to evaluate and discuss the various interviews, especially at the institute level.

On the morning of the second day there were presentations by the theme leaders of the MAS and INS clusters, followed by two parallel sessions with PhDs and PDs and an informal lunch with the management team. The afternoon was devoted to a closed plenary session to discuss the results at the institute and theme levels, and to the organization (and allocation) of drafting responsibilities. At the end of the afternoon, the committee informed the management team and the chairman of the governing board of the results and the recommendations for the institute and the themes. In a closing session for the institute's staff, the committee gave a global presentation of the results of the evaluation and its recommendations.

One week after the site visit, all committee members had submitted their texts. The chair and secretary of the committee compiled these to produce a preliminary draft of the evaluation document. The chair then edited this further and a week later sent a first draft to the committee members with a request to provide comments within two weeks. Based on this input, a second draft was prepared by the chair and this was sent on April 28th to the director of CWI to be checked for factual errors. His remarks were received on May 11th and a third draft was then prepared. The report was sent to the Governing Board of NWO on May 22nd. The Governing Board accepted the report on May 25th.

Next the report was presented to the governing board of CWI for its reactions and to the NWO Board for Physical Sciences for its advice to the Governing Board of NWO. Finally, the report, together with the reactions of the governing board of CWI and the advice of the NWO Board for Physical Sciences, will be discussed at a meeting of the Governing Board of NWO.

## 1.5 Aspects and assessment scale

The committee used the scale provided in the Standard Evaluation Protocol, but made slight changes to its interpretation:

### **Excellent**

Work that is at the forefront internationally, and has had and most likely will have an important and substantial impact in the field. The institute is considered to be one of the international leaders.

### **Very good**

Work that is internationally competitive, and has made and is expected to make a significant contribution to the field. The institute is considered to be an international player and to be one of the national leaders.

### **Good**

Work that is competitive at the national level, and has made and most likely will make a valuable contribution to the field, both nationally and internationally. The institute is considered to be internationally visible and a national player.

**Satisfactory**

Work that is solid but not exciting, has added or will add to our understanding and is in principle worthy of support. Nevertheless, it is considered of less priority than the work in the above categories. The institute is nationally visible.

**Unsatisfactory**

Work that is neither solid nor exciting, possibly flawed in the scientific and or technical approach, a repetition of earlier work, etc. Work not worthy of pursuing.

**The committee suggests that the assessment scale should be redefined so as to permit finer distinctions to be made near the top of the scale.**

## 2 CWI

### 2.1 Mission

The “Centrum voor Wiskunde en Informatica” (CWI) is the national research institute for mathematics and computer science of the Netherlands and is funded principally by the Netherlands Organization for Scientific Research (NWO). CWI was founded in 1946 as a mathematics research centre (“Mathematisch Centrum”, MC) and was run by a foundation known as the “Stichting Mathematisch Centrum” (SMC). In 1983, in recognition of the growing computer science component in the MC’s research, the institute changed its name to the “Centrum voor Wiskunde en Informatica” (literally, centre for mathematics and computer science). In 2001 the name of the foundation was similarly changed from “Stichting Mathematisch Centrum” to “Stichting Centrum voor Wiskunde en Informatica”.

CWI has a two-fold research mission:

- 1 to perform frontier research on selected topics in mathematics and computer science;
- 2 to transfer new knowledge in these fields to society in general, and to trade and industry in particular.

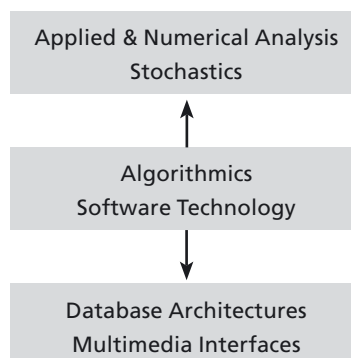
Besides publishing in high-ranking journals, CWI seeks to achieve its mission by being a meeting place for academia and by delivering expertise as well as experts to universities and industry in the Netherlands and abroad. Knowledge transfer to society and industry is achieved by participating in programmes with industry, cooperating with applied research laboratories, starting up spin-off companies, and pursuing patents.

### 2.2 Research

Research at CWI is theme-based. Both pilot and full themes are grouped into research clusters. A cluster typically consists of three to five themes. The cluster is primarily an administrative entity, based on discipline-related and pragmatic considerations. The leaders of the clusters, the controller and the director form the CWI management team.

Core areas are algorithmics and software technology. CWI strives for an algorithmic approach in mathematics and for a mathematical approach in computer science.

#### Research Areas



### 2.3 Organizational structure

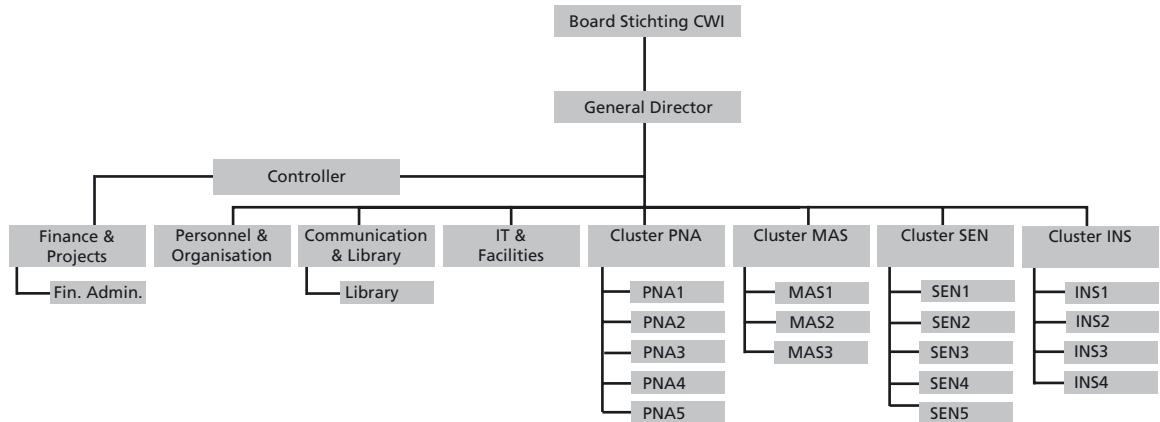
Currently there are four research clusters, together encompassing 17 research themes.

Research clusters and cluster leaders:

- 1 Probability, Networks and Algorithms (PNA) – Prof. dr. A. Schrijver
- 2 Software Engineering (SEN) – Prof. dr. P. Klint

- 3 Modelling, Analysis and Simulation (MAS) – Prof. dr. J.G. Verwer  
 4 Information Systems (INS) – Prof. dr. M.L. Kersten

### Organisation structure



#### 2.3.1 Location

CWI is located at the Science Park Amsterdam. In 1981 it moved to its current building. For the last 10 years, portakabins have served as additional (“temporary”) housing. During the review period (1999 – 2004), CWI has grown by approximately 10%, largely as a result of its success in the BSIK programme and other external funding. The institute expects to expand further (although at a slower rate than in the past six years), due to a continuation of its successful strategy for obtaining additional funding outside NWO. Growth is not a strategy.

#### 2.3.2 Financial matters

The current budget (2005) is M€ 16, of which 64% is basic NWO funding and about 10% comes from NWO-funded projects (competition). The remaining 26% comes from other national and international programmes and contract research. CWI holds a unique intermediate position between academia and more applied laboratories and institutes. In order not to endanger its ability to carry out fundamental and curiosity-driven research, its strategy is to retain the 70%/30% balance in basic/additional funding.

#### 2.3.3 Current staff

Staff on December 31, 2004:

	Tenured		Non-tenured		Total
	Male	Female	Male	Female	
Management team	6 (5.2)*	–	–	–	6 (5.2)
Research	58 (51.2)	6 (5.2)	69 (68.7)	14 (12.6)	147 (137.7)
Support	26 (25.0)	22 (17.9)	5 (4.4)	2 (1.6)	55 (48.9)

\*(FTE)

Of the 64 tenured research staff at the end of 2004, 29 held part-time full professorships at universities (mostly in the Netherlands). Another 73 people holding full professorships at universities have a CWI background (see Appendix 6.6 for a complete overview).

In the Netherlands, there are currently around 80 full professors of mathematics and around 130 full professors of computer science.

## 3 Assessment of the Institute

### 3.1 Answers to the Standard Evaluation Protocol

Evaluation of the institute with respect to	Score
1 Leadership	4
2 Mission and goals	5
3 Strategy and policy	4
4 Adequacy of the resources (€)	5
5 Funding policies	4
6 Facilities (excl. housing)	5
a) Housing	1
7 Academic reputation of the institute	5
8 Societal impact of the institute	5
9 Balance of the strengths and weaknesses of the institute	–
<b>10 Overall assessment of the institute</b>	<b>5</b>

The committee added one item (Housing) under Facilities, and skipped the item 'Balance of the strengths and weaknesses of the institute'. The Standard Evaluation Protocol does not explain how this item is to be judged.

#### 3.1.1 Leadership

The main achievements of the director are that:

- 1 he has ensured that quality and excellence come first;
- 2 he has recruited staff on the Dutch and international market and has attracted two very strong theme leaders for MAS1 and PNA5;
- 3 he has been active in the Dutch funding landscape (e.g. for CWI participation in 2 out of 3 NWO mathematics clusters);
- 4 he is promoting the push for more PhDs within CWI;
- 5 he is engaged with the Human Resource Management problem.

The director did not present a SWOT analysis of the institute in his presentation to the evaluation committee. Within the clusters, there are examples of both good and bad leadership; good management depends on striking a careful balance between conflicting factors and securing the support and involvement of all staff in finding solutions. The management team has not been fully alert to management problems at the theme level. The institute has a tendency to look inwards. This approach works well for the moment, due to successful performance in the past, but there seems to be no strategy for what to do in case of hardship. There is insufficient strategic planning above the theme level.

#### 3.1.2 Mission and goals

Both the scientific mission and the research goals are clear. There is a focus on fundamental research and care is being taken that the institute does not shift towards a more application-oriented mission.

### 3.1.3 Strategy and policy

The current strategy is to aim for quality and excellence. However, strategic planning is minimal and is mainly based on a continuation of good past performance. The governing board needs to appoint a scientific council with a broad outside representation. The management team needs to draw up a strategic plan identifying core topics for the institute and should discuss this strategic plan with the CWI governing board and scientific council. The governing board should reflect more on the overall profile of the institute within the broad spectrum of mathematics and computer science. It should also try to do more to exploit the opportunities that the Science Park offers.

Appointments for tenured positions are made without outside involvement. It would be better for selection committees to include members who are not associated with CWI.

In developing its strategy, CWI should make a decision about its future role in the life sciences. There are many exciting developments in the life sciences which pose questions that are of interest to mathematics and computer science at a deeply fundamental level (besides raising a need for common consultancy and transfer of knowledge). NWO should be aware of this opportunity for CWI, especially since it has made the life sciences one of its central themes.

There could be greater coherence both within and between the research themes. PNA1, MAS2, SEN3 and INS4 are amalgamations of (mostly very successful) sub-themes, but the existence of such amalgamations is no guarantee of continued high quality. Themes should stimulate and help each other in order to enhance the overall impact of the institute.

The current trend towards a larger number of PhDs is welcome. The institute has enough capacity among its tenured staff (approximately 64) to supervise a larger PhD staff than the current turnover of 10 per year.

In its strategy, CWI states that it needs to find short-term research-oriented ICT institutes to cooperate with and also that it needs to find partners interested in and capable of alleviating CWI's software development limitations. The commission doubts whether this is possible. All non-theoretical computer science research institutions have the problem of developing and maintaining the experimental systems on which their research is based. At CWI the INS1 research theme manages the balance really well, but it is hard to get research money to maintain and continue to develop software that was first developed in a previous research project. Production of open source software is one way to proceed but, to quote the SEN5 theme leader, "The myth of the open source software community taking over the development of the core code is just that – a myth". Unless the software is commercially viable (in which case industry will take over the development), the community relies on the originators of the software. Even so, CWI should continue to develop software and maintain it, while at the same time trying to find some way of recognising this as a contribution to research - just as in other engineering disciplines.

### 3.1.4 Adequacy of resources (€)

Since the committee was given neither a detailed financial plan nor a business plan, it is not in a position to say with confidence whether the current funding is adequate. However, it formed the opinion that the funding is GOOD.

Some slight growth (10%) occurred over the review period, and a small amount of further growth is foreseen in the next six years, mainly due to successful recruitment of external funding. The committee recommends that NWO should take this growth into consideration. The funding is vulnerable because of the problem of matching.

### 3.1.5 Funding policies

The 70%/30% rule for basic/additional funding is too rigid and prevents full synergy between themes at the institute level. Small themes could be nurtured by large themes (e.g. MAS1 is strong and could help PNA3).

The institute faces the challenge of recruiting substantial funding from outside the Netherlands, in particular, for computer science.

### 3.1.6 Facilities

The support staff is too large in terms of its budgetary impact. Benchmarking shows that most comparable institutes manage on less. The support staff provides a multiplicity of services, some of which are quite complex. Reduction is difficult and must be carried out with care. The governing board and the management team should develop a strategy for support, especially in relation to the library, the computer department and the communication and publication department.

The library has a national role and provides a number of services. Its importance is perceived differently by mathematics and computer science staff. PhDs and PDs are active and frequent users of the library. The governing board and the director need to redefine the mission of the library. A joint effort with the University of Amsterdam seems the most viable option.

The communication and publication department can play an important role in increasing corporate awareness at the institute and enhancing internal communication. Currently, CWI is well-known internationally for its high quality researchers, but much less so as an institute.

PhDs and PDs are very content with the facilities the institute provides both for computing and for library use. Their communication with supervisors is easy and frequent. They generally do not attend seminars and colloquia above the theme level.

Accommodation is a problem. Space is in short supply. One cluster is housed in a portakabin and therefore physically separated from the three other clusters. It is hard to accommodate part-time and new staff. The ambition to be a meeting place for top researchers cannot be fully achieved. Separate accommodation is also an impediment to cooperation between themes.

### 3.1.7 Academic reputation of the institute

The institute exudes a culture of excellence. CWI researchers have an excellent reputation. Top researchers are eager to join CWI because of the high quality of its research, its lively atmosphere and its thematic focus.

Within ERCIM (the European Research Consortium for Informatics and Mathematics), CWI has a very good reputation. It is a founding member and has been president (twice) in the past.

CWI could be more active in promoting itself as an institute internationally. Many of its individual researchers are well-known abroad, but CWI has a low-profile corporate identity. Within the Netherlands, however, CWI has very high visibility, mostly through its many links with academia and industry.

### 3.1.8 Societal impact of the institute

This is very substantial. CWI acts as a breeding ground for mathematicians and computer scientists, both for academia and for industry. Recently, the director has been asked to act as an advisor/mediator in a conflict at Dutch Railways (NS). Both mathematics and computer science have a heavy impact on other sciences. They have a pronounced role as foundation disciplines in the research-and-development chain. At the same time, they must be careful to avoid sliding into a subservient role in relation to other disciplines and thereby neglecting their internal agendas.

CWI hosts the national office of W3C (the World Wide Web Consortium). Several CWI researchers are on loan to W3C as senior staff members.

### 3.1.9 Balance of the strengths and weaknesses of the institute

The committee did not score this item. The Standard Evaluation Protocol contains no explanation of how it is to be assessed and the committee felt it was a rather dichotomous item to score on a five-point scale.

### 3.1.10 Overall assessment of the institute

The committee is impressed by the high quality of research and staff at CWI. Nevertheless, it feels that there is a need for more staff awareness of an overall strategy and more management involvement in the development of the research themes. This could put CWI in an even stronger overall position, both nationally and internationally. Efforts should be supplemented by an adequate communication policy, with CWI management taking account of the changing roles of its support staff departments.

NWO has reason to be proud of CWI.

## 3.2 Answers to the questions addressed to the committee by NWO

Two sets of questions were put by NWO in addition to the Standard Evaluation Protocol. The first set is general (asked at all evaluations), while the second focuses specifically on CWI.

### 3.2.1 General questions put by NWO

#### 1 What is and what could be the position of the institute in the near future, compared to leading institutes in the world that operate within the same field?

CWI is scientifically very strong. It is expected to maintain this position in the future. Within the Netherlands, CWI is a high-profile institute due to its many links to academia and industry. Outside the Netherlands, it is known mostly through its individual researchers. CWI is not strong on corporate publicity. Unfortunately, the name does little to help.

The heart of CWI is algorithmics and software technology. More could be done to exploit this focus in order to position the institute internationally.

#### 2 Should NWO continue to support the mission of the institute and for what reasons?

Yes, because of its high quality and great relevance. CWI is strong at the intersection of mathematics and computer science. Top talent is eager to spend its research time at a top institute.

Critical mass puts CWI in a strong position to apply for large national and international grants, like those available under NWO's Innovational Research Incentives Scheme (Vernieuwingsimpuls), under the Dutch government scheme for investments in the

knowledge infrastructure (BSIK), from the EU, etc. Its focus on research themes is very transparent for industry and applied research partners.

**3 Are there more effective ways for NWO to support the same type of research and/or facility?**

No, CWI provides critical mass, a good environment to work in and a culture of excellence. A redistribution of human and financial resources would destroy these characteristics.

**4 What is your view of the analyses (made by the management of the institute) of the consequences if these institutional activities were to be discontinued?**

No analysis was provided.

**3.2.2 Questions specific to CWI**

**5 To what extent is there synergy between computer sciences and mathematics at CWI?**

It is a clear advantage to have the two fields together in one institute. There is good synergy, although there is certainly room for more (at Dutch universities the synergy is typically much less). The committee noticed that the style and structure of the self-evaluation report emphasises theoretical work over systems work. This could be more balanced. The institute should find a way to remove this bias in its presentation.

**6 Do current and future housing facilities match the ambition(s) of CWI?**

No (see Section 3.1.6). The current building was already too small soon after its occupation in 1981. Some staff have been in portakabins for the last 10 years. The institute is facing a small expansion due to growth in external funding. In addition, it has the ambition to increase its role as a national and international meeting place. Interestingly, however, during the presentations only one theme leader complained about the lack of space.

**7 What is the importance of CWI's activities (research, facilities, projects, etc.) to the Dutch research community?**

The importance is rated as very high. More than half of the tenured scientific staff hold part-time chairs at Dutch universities. There are many active links with industry, resulting in a high level of innovation. The institute is an attractive place for young researchers.



## 4 Theme Assessments

### 4.1 Theme PNA1 Networks and Logic – Optimization and Programming

Current theme leader: prof.dr.ir. A.M.H. Gerards

Tenured staff: 5 people; 3.8 FTE (1999) – 2.5 FTE (2004).

Theme assessment	PNA1
Quality	5
Productivity	5
Impact	5
Vitality	5
<b>Overall</b>	<b>5</b>

#### 4.1.1 Overall assessment

The quality, productivity, impact and vitality of this theme are rated as EXCELLENT.

The theme started in 1997 and focuses on combinatorics and algorithms, as well as on mathematical optimisation and mathematical logic. It successfully combines ideas and techniques from mathematics and computer science, with algorithmic efficiency as a key line. Some of the work finds its way to applications, most notably to train scheduling and planning of medical student internships at hospitals. Promising future directions are semi-definite programming and algorithmic game theory.

#### 4.1.2 Figures

There are 5 tenured staff members: 4 senior researchers and 1 programmer. The senior researchers are outstanding and high-achieving mathematicians, each following a strong and viable line of research. Two of them have received prestigious awards. Three researchers hold part-time full professorships at Dutch universities and the fourth researcher has received a prestigious VIDI grant from NWO.

The group has produced 183 academic publications, as well as 10 monographs and 3 PhD theses. One monograph is a highly acclaimed three-volume work on polyhedral combinatorics that appeared in 2003.

#### 4.1.3 Recommendations

There is some concern about the theme's "minimalist management approach". Organisationally, the theme is inward-looking, based on its highly successful performance in the past. The SWOT analysis presented to the evaluation committee was inadequate and failed to address some major issues.

It would be advisable for the theme leader to draw up a strategic plan and discuss this with the director and the management team.

The number of PhDs graduated is very low. It seems that the senior researchers are too selective in recruiting PhDs. Correcting this may require a change of culture within the theme.

There are links with PNA2, PNA5 and INS4. It would be worth strengthening these further.

## 4.2 Theme PNA2 Advanced Communication Networks

Current theme leader: prof.dr. M.R.H. Mandjes

Tenured staff: 4 people; 1.7 FTE (1999) – 1.9 FTE (2004).

Theme assessment	PNA2
Quality	5
Productivity	5
Impact	5
Vitality	5
<b>Overall</b>	<b>5</b>

### 4.2.1 Overall assessment

The quality, productivity, impact and vitality of this theme are rated as EXCELLENT.

The theme started in 1997 (under a different name and with a slightly different team of tenured staff). PNA2 graduated from a pilot theme to a fully-fledged theme in 2004 (it has been operating in its current form since 2002). Research focuses on queuing theory with applications in communication networks and related areas. Key words are long-range dependence and heavy tails. Four application domains for the research are cited in the self-evaluation: 1. wireline networks, 2. wireless networks, 3. quality-of-service differentiation, and 4. performance of ICT-systems. These four sub-themes are the core of the research area covered by the theme. A number of the publications selected for reference in the self-evaluation have a high profile (e.g., three have “best paper” awards). The theme has strong internal cohesion and is firmly embedded nationally through nationwide contacts (including regular or frequent visitors to CWI). International contacts are also excellent (both in Europe and in the USA).

### 4.2.2 Figures

There are 4 tenured researchers, all of whom are relatively young. All 4 hold part-time appointments at Dutch universities, 3 as full professor. One is employed part-time in the USA and another was appointed to CWI only a year ago. All are very strong researchers in their field and are highly visible, both nationally and internationally.

There are currently 7 PhDs and 2 PDs.

The theme has produced 146 academic publications, 1 monograph and 2 PhD theses.

The funding is EXCELLENT and comes from a wide variety of sources, including industry. The theme leader has clear views on the strengths and the weaknesses of the theme and on how to develop the theme further.

### 4.2.3 Recommendations

The evaluation committee has no criticism, except for the low number of PhDs. It seems likely that this will improve in the near future.

There are links not only with PNA3 and PNA4, but also with PNA1 and SEN4. It would be worth strengthening the latter two further.

### 4.3 Theme PNA3 Stochastics

Current theme leader: prof.dr. J. van den Berg  
Tenured staff: 3 people; 4.0 FTE (1999) – 2.4 FTE (2004).

Theme assessment	PNA3
Quality	5
Productivity	4
Impact	4
Vitality	3
<b>Overall</b>	<b>4</b>

#### 4.3.1 Overall assessment

The quality of this theme is rated as EXCELLENT, productivity and impact as VERY GOOD, and vitality as GOOD. The latter rating is due mainly to understaffing.

The theme started in 1997, with four tenured researchers and one programmer. Two researchers left, in 2002 and 2003 respectively, and this reduced the range of research topics. Several attempts have been made recently to attract funding for an additional staff member, so far without success.

The research interests of PNA3 include percolation theory and interacting particle systems. These areas, two of the most active ones in modern probability, lie at the interface between probability theory and statistical physics. The research interests also include stochastic analysis, at the interface between probability theory and finance. In the past there was also research on ergodic theory and dynamical systems, as well as on statistics. The theme gives the impression of intellectual excitement. Amongst the topics studied are a number of new branches. These include Self-Organized Criticality, Stochastic Loewner Evolution, spectral analysis of fractional Brownian motion, Saddlepoint/Edgeworth expansions, and estimation of Poisson intensities. The theme has plans to increase its focus on spatial probability.

#### 4.3.2 Figures

The theme has produced 51 academic publications and 6 PhD theses. Almost 80% of the funds come from CWI basic funding. The theme leader holds a part-time appointment as full professor at a Dutch university.

The theme leader is an outstanding probabilist with very high national and international visibility. He recently initiated a national study group on Stochastic Loewner Evolution, which is a hot topic in the area of critical phenomena, combining stochastic analysis with conformal invariance.

#### 4.3.3 Recommendations

In its self-evaluation, PNA3 noted that, despite the 1999 recommendations (and subsequent staff losses), no new senior appointment has been made. This situation needs to be reviewed. Possibly related to this, the theme needs to strike a better balance between quality of research and level of external funding. In order to do so, the theme leader needs to be more responsive to performance criteria set at the institute level, while the director and the cluster leader need to be more responsive to the specific needs of the theme.

CWI is currently strong in stochastic operations research (PNA2), but relatively weak in probability (PNA3) and statistics (PNA4), mainly due to understaffing. Careful thought should be given to the future strategic position of CWI in the latter two areas.

There are links with PNA2 and PNA4. It would be highly beneficial for the theme to forge a partnership with MAS1, where there is a need to get some stochastics on board. Since MAS1 is very strong and has very good funding, perhaps some of this funding can be used to strengthen PNA3.

## 4.4 Theme PNA4 Signals and Images

Current theme leader: dr.ir. H.J.A.M. Heijmans/dr. E.J.E.M. Pauwels

Tenured staff: 5 people; 4.7 FTE (1999) – 4.1 FTE (2004).

Theme assessment	PNA4
Quality	4
Productivity	4
Impact	4
Vitality	4
<b>Overall</b>	<b>4</b>

### 4.4.1 Overall assessment

The quality, productivity, impact and vitality of this theme are rated as VERY GOOD.

The theme started as a pilot in 1997 and became a full theme in 1999. There are three sub-themes: 1. image understanding, retrieval and indexing, 2. image multi-scale analysis and biometrics, and 3. spatial statistics. Research focuses on various aspects of modelling and processing of signals and images, with the current emphasis shifting towards integration of different processing levels.

### 4.4.2 Figures

There are 3 tenured researchers (1 senior and 2 junior) and 2 programmers. The group has produced 117 academic publications, 4 monographs and 3 PhD theses. There are 4 PDs, 1 PhD, and 1 PD vacancy.

The theme is strong on building a bridge between theory and application. It has a high level of innovation and an EXCELLENT track record in terms of funding. It is a (sometimes leading) partner in a number of European and Dutch projects.

### 4.4.3 Recommendations

The management team should assess the future of this theme, in particular since it has recently lost its theme leader (the presentation during the site visit was made by a theme member). This loss presents a threat to the future which needs to be addressed expeditiously. In the period under review, much time was devoted to application and to funding, and this has taken its toll of the fundamental aspects of the research. The members of the theme need to reflect on their scientific mission. The fact that none of them has any link with a Dutch university reduces their national visibility and probably explains why the theme has few PhDs recruited from Dutch universities.

There are links not only with PNA2 and PNA3, but also with INS2. It would be worth strengthening the latter further.

## 4.5 Pilot Theme PNA5 Cryptology and Information Security

Current theme leader: prof.dr. R.J.F. Cramer

Tenured staff: 2 people; 0 FTE (1999) – 0.7 FTE (2004).

Theme assessment	PNA5
Quality	–
Productivity	–
Impact	–
Vitality	–
Overall	–

### 4.5.1 Overall assessment

This theme is a pilot which started less than one year ago. Its performance so far is EXCELLENT on all counts.

The committee decided not to grade the theme because much of its current quality stems from activities undertaken before staff joined CWI. However, future expectations certainly place it at a top level. There are two sub-themes: 1. cryptology, and 2. computational number theory and discrete tomography (The latter sub-theme used to be part of MAS2). Research focuses on mathematical methods underlying digital security, as well as on discrete mathematical algorithms for 3D image composition from 2D projections. A future challenge is quantum cryptography.

The theme has close contacts with academia and industry worldwide, and has attracted visitors and a scientific advisor who contribute to its culture. It has a stimulating research agenda for the future, and external project funding is being sought or planned.

The research on computational number theory has had a wide international impact, e.g. through the “Number Sieve Project” for factoring large integers (while part of MAS2). A factoring code was developed by two PhD students and has been made available to a number of international research groups. It is natural that this work be embedded in the new pilot theme, where it is expected to contribute significantly to the overall symbiosis.

### 4.5.2 Figures

There are 2 tenured staff (both senior) plus 1 vacant tenure-track position. The theme leader holds a part-time full professorship at a Dutch university. There are 2 PDs, 3 PhDs and vacancies for 1 extra PD and 1 extra PhD.

Since it started, the theme has produced 8 academic publications.

The theme is firmly embedded at national level. It is participating in one of the three new NWO mathematics clusters: DIAMANT (= Discrete, Interactive, Algorithmic Mathematics, Algebra and Number Theory).

Funding is GOOD and promising. International visibility is high.

#### **4.5.3 Recommendations**

This is an exciting area which promises to have a considerable impact beyond the limits of its subject and to raise intellectual challenges within it. The director and management team have shown great foresight in starting this theme as a pilot and in recruiting the current theme leader. This is a small but highly dynamic theme which has the potential to grow into a fully-fledged theme of very high quality and vitality.

There are links with PNA1 and INS4. It would be worth strengthening these further.

## 4.6 Theme SEN1 Interactive Software Development and Renovation

Current theme leader: prof.dr. P. Klint

Tenured staff: 5 people; 3.4 FTE (1999) – 3.4 FTE (2004).

Theme assessment	SEN1
Quality	5
Productivity	5
Impact	5
Vitality	5
<b>Overall</b>	<b>5</b>

### 4.6.1 Overall assessment

This theme is very strong and its quality, productivity, impact and vitality are rated as EXCELLENT.

The committee sees no serious weaknesses or concerns. The theme members have a high international reputation. They have made significant contributions to their field, and have produced five PhDs. The plans for future research address important problems and are well-chosen.

SEN1 has been an ongoing theme since 1997. The overall goal of the theme is to develop language-aware methods and tools to facilitate the development, understanding and evolution of large software systems. The group has developed the ASF+SDF Meta-Environment and has enhanced it over the years. The software is distributed and is in use by other research groups. A spin-off company (the Software Improvement Group) deploys the software for commercial use. ASF+SDF includes Generalized LR parsing and parser generation, prettyprinting, static checking, compilation, library functions, user-interface, and connections with the Emacs and Vim editors and the integrated development environment Eclipse.

The researchers have used the ASF+SDF system as a platform for further research. Plans for the coming period include support for domain-specific languages for software development, the extraction and exploitation of information obtained about source code for the purpose of software understanding, and methods for automatic transformation of source code for the purpose of software evolution.

### 4.6.2 Figures

4 senior researchers have been participating in the theme and a fifth was added in 2004. There are also PhDs in the group. 4 senior researchers hold part-time university appointments. 1 researcher is expected to retire during the forthcoming period and 2 are expected to depart for full-time university posts. The group has produced 135 academic publications, 6 monographs and 5 PhD theses during the review period, together with many software releases. It has received a variety of external funding, and has collaborations with both universities and commercial companies.

### 4.6.3 Recommendations

In the light of the possible departure of two senior researchers in the next few years and a third sometime thereafter, the theme leader needs to plan for the recruitment of researchers who will bring new ideas and approaches to the group, while working synergistically with the existing projects.

## 4.7 Theme SEN2 Specification and Analysis of Embedded Systems

Current theme leader: dr. J.C. van de Pol

Tenured staff: 4 people; 3.6 FTE (1999) – 2.7 FTE (2004).

Theme assessment	SEN2
Quality	4
Productivity	4
Impact	3
Vitality	3
<b>Overall</b>	<b>4</b>

### 4.7.1 Overall assessment

The quality and productivity of the group are VERY GOOD. The impact is GOOD to VERY GOOD. The main concern of the committee is the future vitality of the theme, which is GOOD, but needs to be strengthened. Overall, the theme is VERY GOOD.

In its early years, this theme had major senior researchers who did distinguished work and achieved considerable recognition. The theme members have a solid publication record and have graduated eleven PhDs over the review period. However, the more senior researchers have largely departed and the remaining senior researcher, while showing great promise and building his reputation, is at a much earlier stage of his career. This is reducing the impact of the theme at the present time. The reduction of the theme to one senior researcher also threatens its viability, especially since the theme leader has taken on management responsibilities at an unusually early stage.

SEN2 has been a theme since 1997, but has had three theme leaders over that period. The current theme leader took over just six months ago. The research topic of the theme is the study and development of formal techniques for the unambiguous description, design and analysis of systems and software, notably embedded systems, for the purpose of improving their quality.

Theme participants have developed the language mCRL (micro Common Representation Language) and its associated toolset, together with handbooks on process algebra and on term rewriting systems, have worked on distributed model checking, and have obtained a variety of theoretic results. The research results have been applied to various industrial problems.

The current emphasis is on developing high-performance algorithms to reduce the state-space explosion, particularly by the use of symbolic reasoning. Application areas to be addressed include security protocols and traffic control.

### 4.7.2 Figures

For most of the review period, the theme has had 3 senior researchers, along with around 4 other staff, 1 programmer, and 1 PhD. Recently, 2 of the senior researchers have shifted their primary activities to universities, leaving only 1 remaining senior researcher. Over the review period, the group has generated 160 academic publications, 3 monographs and 11 PhD theses. The group has received significant external funding and has had a variety of collaborations with industry.

#### **4.7.3 Recommendations**

This theme shows considerable promise for the future and is addressing important research problems. It is essential that senior research staff be strengthened by additional members in order to broaden and consolidate the research envisaged.

## 4.8 Theme SEN3 Coordination Languages

Current theme leader: prof.dr. J.J.M.M. Rutten

Tenured staff: 6 people; 5.3 FTE (1999) – 5.4 FTE (2004).

Theme assessment	SEN3
Quality	4
Productivity	3
Impact	3
Vitality	4
<b>Overall</b>	<b>4</b>

### 4.8.1 Overall assessment

The quality and vitality of the group are VERY GOOD. However, its productivity and impact are no more than GOOD and are in need of strengthening. The overall assessment of the theme is VERY GOOD.

The quality of the research appears to be high, although the committee was unable to assess it in any depth. The existence of a stable and experienced group bodes well for future viability. However, the production of PhDs is much too low for a group of this size. Furthermore, there is relatively little evidence of major impact, particularly outside the Netherlands.

This is a mature theme that has been active since 1997. The theme is an amalgamation of three related sub-themes, each led by a senior researcher. One of these senior researchers joined the theme at approximately the same time as the retirement of a previous theme member. The theme centres around coordination models and languages for component-based software engineering. The sub-topics are coordination and component-based architectures, formal methods for coordination languages, and co-algebraic models of computation. Theme members have developed the REO coordination model, together with its stream calculus semantics, a rigorous mathematical theory of the correctness of object-oriented programs, and a co-algebraic calculus of streams.

Future research plans include applying coordination approaches for components to systems that are not exclusively software, creation of a programming environment for REO, and further research on formal methods of coordination.

### 4.8.2 Figures

The theme personnel has consisted of 3 senior researchers, 3 to 6 other research staff, 2½ programmers (recently reduced to 1½), and a small number of PhDs. All of the senior researchers hold university appointments. The group has generated 153 academic publications, 7 monographs and 2 PhD theses, and has received external funding.

### 4.8.3 Recommendations

The theme researchers have a very poor record as regards the production of PhDs. At present, they are collectively supervising 11 students. It is important that the group should graduate greater numbers of PhD students. In order to increase their impact, the researchers need to participate in at least some broader and more established conferences, rather than concentrating solely on the more specialized workshops they have created.

There is a link with SEN5. It would be worth strengthening this further.

## 4.9 Theme SEN4 Evolutionary Systems and Applied Algorithmics

Current theme leader: prof.dr.ir. J.A. La Poutré

Tenured staff: 2 people; 1.0 FTE (1999) – 1.5 FTE (2004).

Theme assessment	SEN4
Quality	5
Productivity	5
Impact	5
Vitality	5
<b>Overall</b>	<b>5</b>

### 4.9.1 Overall assessment

The theme is rated as EXCELLENT on every count.

The group studies multi-agent systems with an emphasis on problems in finance and economics. “Intelligent algorithms” (neural networks, evolutionary algorithms, and adaptive algorithms) are used to model the agents in the system. The combination of algorithmic techniques (the theme leader’s background is in algorithms) with multi-agent systems is the strength of the group.

The work of the group is located along two axes. The first axis is to advance the state of the art in neural networks, evolutionary algorithms, and online algorithms. A recent highlight is the work on neurons with timed spikes. The second axis is multi-agent systems and games. Such systems have been studied in AI for a considerable period of time, while the intensive combination with algorithms is novel. Recent highlights are the applications to auction and recommendation systems.

### 4.9.2 Figures

The group is young. It was established in 1999 and has 2 tenured staff, the theme leader and 1 young researcher who was appointed recently and is the recipient of a VENI grant. The group attracts substantial grants. The theme leader holds a part-time full professorship.

The group is well-managed. It has a clear view of its own strengths and weaknesses. It works at the interface between computer science, finance and economics. Expertise in the application areas is introduced in two ways: via 2 PDs and through a consultancy agreement with a professor of economics. We commend the group’s efforts to introduce applications knowledge.

### 4.9.3 Recommendations

There are no specific recommendations, except as regards the group’s proposal to change its name to “Intelligent Algorithms and Multiagent Games”. The committee finds the first half of the proposed name inappropriate. What name would then be given to the algorithms studied in the other groups?

There is a link with PNA2. It would be worth strengthening this further.

## 4.10 Pilot Theme SEN5 Convergent Media Interfaces

Current theme leader: dr. D.C.A. Bulterman

Tenured staff: 1 person; 0 FTE (1999) – 1.8 FTE (2004).

Theme assessment	SEN5
Quality	–
Productivity	–
Impact	–
Vitality	–
<b>Overall</b>	–

### 4.10.1 Overall assessment

The review panel decided that it was too early to give this pilot theme a rating, since it has not had time to establish a track record.

The pilot theme was started in January 2004, when the theme leader returned to CWI after time out as part of a spin-off company, Oratrix, whose technology was based on the SMIL standard previously developed by himself and his team at CWI. He is the only senior researcher in the group, which currently also has three programmers, one senior PD and 2 PhDs.

The group works at the systems level, tackling research issues such as behavioural specifications of presentation scheduling, reconfigurable rendering architectures for 'cPan', and layered models for content sharing and protection. The group evolved out of the INS2 group via a period of commercial exploitation and is now exploring possibilities of working with SEN 3 using the Reo coordination language.

The group is well-known for its work on the SMIL standard(s). It is currently focused on end-to-end 'quality of information', architecture of reconfigurable, distributed temporal clients, and the integration of authoring and interaction at the client. All models are implemented and evaluated on the AMBULANT test bed developed by the group, now available as open source software that is being down-loaded a lot by the research community.

### 4.10.2 Figures

It is too early to judge this theme by the metrics that are available after one year. Currently there is only 1 senior researcher in the group (the theme leader), who seems to be responsible for all the group's publications and fund-raising efforts. The latter have been very successful and the group now has money to hire more research staff. At this stage in its development, the group's emphasis is much more on development than on fundamental research. Its publications are generally about development and standards issues. There is no doubt that the group has the potential to have a significant impact on the standards and applied research community, but it is yet to be seen whether the group can develop a strong research profile.

#### 4.10.3 Recommendations

The director is urged to support the group in continuing to develop state-of-the-art software test beds and taking an active part in the multimedia standards community. CWI can probably afford to develop (at least) one group of this nature, which can also provide software platforms that could be used to support the research of other groups at CWI, such as INS2, as well as the external research community.

The style of the self-evaluation report seems to emphasise theoretical work over systems and standards work. CWI and NWO should review this in order to encourage the development of experimental test beds and membership of standards committees where necessary and/or appropriate.

There are links with SEN3 and INS2. It would be worth strengthening these further.

## 4.11 Theme MAS1 Non-linear PDEs – Analysis and Scientific Computing

Current theme leader: prof.dr. A. Doelman

Tenured staff: 7 people; 8.2 FTE (1999) – 5.5 FTE (2004).

Theme assessment	MAS1
Quality	5
Productivity	5
Impact	5
Vitality	5
<b>Overall</b>	<b>5</b>

### 4.11.1 Overall assessment

This theme started in 1997 and its quality, productivity, impact and vitality are now rated as EXCELLENT.

Since 2000, the research of MAS1 has been directed at non-linear PDEs, as reflected in its current title and that of the related PDE@CWI project group, founded in 2003. The appointment of a new theme leader has involved a shift in focus in the PDE analysis research towards dynamical systems (and away from variational methods).

MAS1 is a large theme, with a strong past and a strong future. Its research is quite broad, covering analytical and numerical aspects of air pollution models, advection-diffusion-reaction equations, cell, functioning, phytoplankton dynamics, as well as atmospheric fluid dynamics. Keywords include: advection-diffusion, adaptive numerical methods, conservation properties, dynamical systems, Hamiltonians, localized solutions, life science, non-linearity, PDEs and integro-PDEs, pre-conditioning, pulse interactions, porous media, and symplectic integrators. Special functions have been a niche area. Future research is intended to include further topics in oceanography and the life sciences.

### 4.11.2 Figures

The theme has 7 tenured staff. Part of the group has branched off to form MAS3. The theme has produced 173 academic publications, 2.5 monographs and 4 PhD theses.

The theme is very firmly embedded and is drawing in strong external funding at the national level. It is participating in one of the three new NWO mathematics clusters, NDNS (= Nonlinear Dynamics of Natural Systems), in which dynamical systems as well as topics from the earth and life sciences are being fruitfully combined.

### 4.11.3 Recommendations

The director and management team have shown great foresight in recruiting the current theme leader.

For a theme of this size, the number of PhDs has been too low in the past. It seems likely that this will improve greatly in the coming years.

The theme is currently drawing stochastics into its arena. It would be good to establish a partnership with PNA3, which would be highly beneficial to both partners.

**MAS1 is making a serious effort in the direction of the life sciences (5 PhDs and 1 PD). Since the committee feels that CWI should contemplate a stronger involvement in the life sciences in general, this part of MAS1 should be used as a source of inspiration for other themes in this direction.**

## 4.12 Theme MAS2 Computing and Control

Current theme leader: prof.dr.ir. B. Koren

Tenured staff: 4 people; 4.5 FTE (1999) – 3.7 FTE (2004).

Theme assessment	MAS2
Quality	5
Productivity	5
Impact	5
Vitality	5
Overall	5

### 4.12.1 Overall assessment

This theme started in 1997. Its quality, productivity, impact and vitality are now rated as EXCELLENT, although vitality is somewhat at risk.

Its research topics have evolved over time, and have included areas such as multi-grid methods, number theory (now in PNA5), singular perturbation problems, and parallel computing. MAS2 now consists of two sub-themes: 1. computing, and 2. control. The first of these focuses on numerical mathematics, fluid dynamics and electrodynamics, while the second focuses on system theory and control theory. The two sub-themes have applications in industry and engineering as their common denominator.

### 4.12.2 Figures

The theme has 3 tenured researchers and 1 programmer. All three researchers are part-time full professors at Dutch universities. One senior researcher, who is a CWI Fellow, is due to retire next year.

The theme has produced 116 academic publications, 1 monograph, and 7.5 PhD theses.

There is a high level of innovation: the group forms a bridge between mathematics and engineering. It has a strong and extensive national network. Computing in combination with control has enormous potential.

The funding of the group is strong.

### 4.12.3 Recommendations

The theme leader should reflect on international ambitions and collaborations.

The two current sub-themes exist side by side, without any true partnership. Both are highly successful. One senior staff member, working in numerical mathematics, will soon retire. It is vital for the theme, as well as for numerical mathematics in the Netherlands at large, that a good successor be found. There is some risk (depending on the direction this succession may take) that the theme may acquire a third sub-theme.

## 4.13 Theme MAS3 Non-linear Dynamics and Complex Systems

Current theme leader: prof.dr. U.M. Ebert

Tenured staff: 2 people; 0 FTE (1999) – 1.8 FTE (2004).

Theme assessment	MAS3
Quality	5
Productivity	5
Impact	5
Vitality	5
Overall	5

### 4.13.1 Overall assessment

This theme started as a pilot theme in 2002 (branching off from MAS1) and has become a full theme. Its quality, productivity, impact and vitality are now rated as EXCELLENT.

The group conveys a high level of excitement and enthusiasm, and has a vision of future directions that it seeks to explore. It is small but highly visible, focusing on specific interfaces between physics and mathematics. Remarkably, it is successfully covering the entire spectrum from experiment via numerics to theory. It has also attracted a high level of publicity.

Research topics include relaxation of fronts in non-linear PDEs, spontaneous branching of spark channels, reptation of polymer chains, and advection-diffusion-reaction equations. Funding has been obtained for research in electric fracture growth (to 2009), multi-rate methods (to 2008) and leading-edge dominated dynamics (to the end of 2005).

### 4.13.2 Figures

Since it became a pilot theme in 2002, the theme has had 2 tenured staff, 4 PhDs and 2 PDs. The theme leader is a part-time full professor at a Dutch university. Both staff members have received prizes for their research.

The theme has produced 52 academic publications, 0.5 monograph (the other 0.5 being attributable to theme MAS1) and 1 PhD thesis.

The theme is participating in NWO's NDNS mathematics cluster (see MAS1). Funding is strong and comes from different sources, as is typical for interdisciplinary research; these include a Dutch-Russian project (NWO-RFBR), an STW project and participation in BRICKS (with a project on hybrid computations). Keeping up this type of funding is demanding.

### 4.13.3 Recommendations

The theme would benefit from closer interaction with applied mathematicians who can help to build bridges between the more physically and the more mathematically oriented aspects of the research. Such interaction could either be integrated into the theme, or else be found outside CWI.

#### 4.14 Theme INS1 Database Architectures and Information Access

Current theme leader: prof.dr. M.L. Kersten

Tenured staff: 4 people; 1.7 FTE (1999) – 5.4 FTE (2004).

Theme assessment	INS1
Quality	5
Productivity	4
Impact	5
Vitality	5
<b>Overall</b>	<b>5</b>

##### 4.14.1 Overall assessment

The overall rating of this theme is EXCELLENT.

This is a very mature theme that started as Database Architectures in 1985 and evolved into its current form in 2004. It currently has 6 senior researchers, 3 programmers, 1.5 PDs and 7 PhDs.

The group has a very strong sense of strategic direction and works very much as a team inspired by the theme leader. Database management remains a key technology for the group and the main mission is to develop next-generation database technology up to a point where it can be effectively used in a real-work application. It is very commendable that the group develops ideas from theory to deployment. This makes the group strong in experimental computer science, but a lot of effort is required to maintain and develop the code needed to sustain the experimental software systems. The group is well-known for its MonetDB system, and has more recently developed XMark (for assessing XQuery engines) and Acoi (for multimedia indexing). Multimedia databases/IR are the key to the group's future direction, and it has set itself a grand challenge to develop self-descriptive and self-organizing database systems.

##### 4.14.2 Figures

The main weakness of the group is its low productivity. For a group of this size and maturity, 100 academic publications is on the low side, hence the lower rating for productivity. The reason for this could be the emphasis on building software systems that can be applied in real-world applications, which is a strength that should be taken into account in future evaluations. During the review period, the group produced 9 PhD theses and attracted a mix of funding. 2 of the senior researchers hold part-time university chairs and members of the group are active in international conference organization.

##### 4.14.3 Recommendations

The group needs to ensure that its publication rate improves over the next review period.

The style of the self-evaluation report appears to emphasize theoretical work over systems work. CWI and NWO should review this in order to encourage experimental work where necessary and/or appropriate. Here computer science is more like physics or engineering than mathematics.

## 4.15 Theme INS2 Multimedia and Human/Computer Interaction

Current theme leader: prof. dr. L. Hardman

Tenured staff: 3 people; 3.7 FTE (1999) – 3.3 FTE (2004).

Theme assessment	INS2
Quality	4
Productivity	4
Impact	5
Vitality	4
<b>Overall</b>	<b>4</b>

### 4.15.1 Overall assessment

The overall rating of this theme is VERY GOOD.

This is a relatively young theme that started in 1997. It currently has 3 senior researchers, 3 programmers, 1.2 PDs and 4 PhDs.

The group's long-term goal is develop knowledge-intensive models and document processing technologies that are able to generate coherent multimedia presentations, tailored to individual users. The aim of the group is to acquire an internationally leading position in understanding how to incorporate design and discourse knowledge into multimedia documents, and in embedding these in Web and Semantic Web technologies. The scientific challenges include making multimedia discourse and design knowledge explicit, expressing re-usable semantics of media assets, and designing architectures for multimedia presentation generations.

The group is well-known for its Web standards work as part of World Wide Web Consortium (W3C) and is internationally one of the few significant groups working in the area of multimedia and the Semantic Web. This area is set to grow substantially as the Semantic Web develops. The group's work is inherently interdisciplinary and this should be encouraged.

### 4.15.2 Figures

The main weakness of the group is its low productivity. The group published only 53 academic papers over the review period, and only 1 paper in 2004. More significantly, the group only produced 1 PhD thesis during the review period. One of the reasons for this is that too much time was spent trying to develop 2 unproductive PhDs. This problem should have been spotted and dealt with earlier. The group has also produced state-of-the-art experimental software, for example the Cuypers system, which is important for the research, but gets no credit in the review. The group has obtained a mix of funding to support its work, and members of the group are active in international conference organization. The theme leader holds a part-time university chair. One of the main problems for the group is finding people with sufficient experience to fill current vacancies. The group will be very vulnerable with 1 of its senior researchers going on secondment to the Rijksmuseum in Amsterdam, and a senior PD coming to the end of his contract.

#### 4.15.3 Recommendations

The group needs to ensure that its publication rate improves over the next review period, and to tighten up its procedures for PhD supervision.

The director is urged to support the group by ensuring that the vacancy created by the secondment to the Rijksmuseum can be filled by a senior PD to help keep up the group's output. The group is currently losing a senior PD because there is no tenured post to which he can be appointed.

The style of the self-evaluation report seems to emphasize theoretical work over systems and standards work. CWI and NWO should review this in order to encourage experimental work and membership of standards committees where necessary and/or appropriate.

There are links with PNA4 and SEN5. It would be worth strengthening these further.

## 4.16 Theme INS3 Visualization and 3D User Interfaces

Current theme leader: prof.dr.ir. R. van Liere  
Tenured staff: 2 people; 1.0 FTE (1999) – 1.8 FTE (2004).

Theme assessment	INS3
Quality	4
Productivity	3
Impact	5
Vitality	4
Overall	4

### 4.16.1 Overall assessment

The overall rating of this theme is VERY GOOD.

The theme started in 2001 as a pilot and was turned into a regular theme in 2003. It has by now grown into a group with 2 senior researchers, 1 PD and 5 PhDs. The theme leader holds a part-time university chair.

The theme is visualization of 3D scientific data (e.g. confocal microscope images of living cells or other data arising in the life sciences and data arising in astronomy) and 3D user interfaces for manipulating 3D visualizations of this data. The approach is experimental.

The criteria for success are publications, convincing software demonstrations, and positive feedback from users in the application areas. The group performs true interdisciplinary research. It has had to invest substantial time in building up its software and hardware base.

### 4.16.2 Figures

The productivity with respect to publications and PhDs is too low. The Personal Space Station (a 3D user interface for manipulating 3D visualizations) is in use in more than 15 institutions and the work on imaging living cells has led to joint publications with biologists. For both lines of research, spin-offs are planned.

The group has been very successful in attracting outside funding (funding is secured until 2008). Its impact is substantial, particularly in the life sciences and astronomy. The group plays a leading role in the national Virtual Reality-effort.

### 4.16.3 Recommendations

The supervision of the PhDs deserves particular attention. Their success will automatically lead to an increased output of publications.

The committee commends the plans for the spin-offs, not so much because of the potential income for CWI, but because they could relieve the group of the routine work of maintaining installations of its systems at other institutions.

## 4.17 Theme INS4 Quantum Information and Systems Research

Current theme leader: prof.dr. H.M. Buhrman

Tenured staff: 3 people; 1.8 FTE (1999) – 2.6 FTE (2004).

Theme assessment	INS4
Quality	5
Productivity	5
Impact	5
Vitality	5
<b>Overall</b>	<b>5</b>

### 4.17.1 Overall assessment

This theme is rated as EXCELLENT on every count.

This theme is very strong. It combines work on quantum information, machine learning and pattern recognition, and algorithms and complexity. The group produced EXCELLENT research, which appeared in top journals and was reported on at top conferences, both in great numbers.

Highlights are new quantum algorithms, a general approach to proving lower bounds for quantum computations, the extension of the Kolmogorov approach to rate distortion in communication and compression, and a new approach to separation of complexity classes.

### 4.17.2 Figures

The senior group members are world-class researchers and the junior members seem to have the potential to achieve similar status. The group's work has been recognised via a number of awards, e.g. Veni, Vidi and Vici grants and a CWI fellowship. The senior group members hold part-time appointments at universities. The group has produced 4 PhD theses over the last 5 years.

The group is well-managed. Each sub-theme has a clear vision of where it wants to go and what it wants to achieve over the next few years, as does the theme as a whole. The goals are highly ambitious but realistic.

### 4.17.3 Recommendations

There are no specific recommendations.

There are links with PNA1 and PNA5. It would be worth strengthening these further.



## 5 Conclusions and Recommendations

The evaluation committee has done extensive preparatory work and has had two days of intensive discussion with the governing board, the director, the cluster leaders, the theme leaders, the controller and the support staff, as well as with PDs and PhDs. As a result, the committee has been able to gain a clear impression both of the research carried out at CWI and of the institute's organizational structure. This has enabled it to reach an assessment of the position and impact of the institute.

The evaluation committee was asked both to assess CWI overall and to review the individual research themes.

### **I Concerning management flexibility, cluster structure and theme interaction the committee wishes to make the following remarks:**

With a large proportion of staff employed on a tenured basis, there are limits to the flexibility with which CWI can be managed in order to respond to new cultural or scientific developments. The committee has not been given any evidence that the funding regime offered by NWO allows for new scientific initiatives or for proleptic appointments [appointments in anticipation of retirements or new initiatives], other than through the competitive grant system. Consequently, the strategy pursued by the management of CWI appears to be largely reactive, with opportunities for a proactive strategy circumscribed by financial realities and employment law. More creativity needs to be shown in finding ways to overcome these constraints; for example, there are ways of expanding the scientific work done at CWI without significantly increasing the institute's costs (visitors on sabbatical leave, INTAS, Marie Curie Fellowships, etc.).

CWI's prospects of achieving its objectives depend upon its ability to operate a business plan and a scientific plan in tandem. The CWI themes already make contributions both to any financial strategy and to the culture and scientific achievement of the institute, but the potential role of the cluster leaders in the management of CWI should not be overlooked, even though clusters are seen mainly as administrative entities. There were clear examples of good leadership amongst the cluster leaders. The cluster leaders might be able to find a stronger role in drawing the attention of the theme leaders to "best management techniques", which are not at present uniformly distributed throughout CWI.

The panel rated the themes as presented in the CWI self-assessment. It is clear that there is more than one acceptable way of sub-dividing CWI into themes and that the results of the review may depend on where the boundaries are drawn between the themes. Suppose, for example, that there are two themes, the first generating income by external development but displaying little scientific excitement and the second operating at the frontiers of knowledge but generating little or no external income. Both may then receive a relatively poor rating, one for financial and the other for cultural reasons. If they were viewed instead as two halves of a single over-arching theme, the impression created would be much more positive. Moreover, a financial management system that is based upon authority delegated to a theme leader provided the theme attains a 70/30 income generation split appears to have limitations. However, it would appear that the CWI researchers are motivated by the possibility of obtaining leadership of a theme, both because of the perceived increase in status and because of the prospect of acquiring the flexibility needed to achieve the objectives of the theme members. The effect of the thematic structure on the life of CWI should be kept under review by the director and the governing board.

The cultural life of CWI depends in part upon communication between staff members. Though there are talks involving the whole of the CWI scientific community, communication appears to be dominated by informal individual interactions and seminar programmes that

are largely of interest only to a particular theme or even sub-theme. The emphasis appears to be on informality. The PhDs and PDs to whom the committee spoke conveyed the impression of easy access to their mentors. However, a number of staff have external activities which must take them away from CWI for certain days of the week. The committee was not informed of any system of "office hours" when research staff are available for interaction with colleagues. Apparently the cafeteria provides a ready meeting point for professional interaction.

As a general rule, the maxim "if it works don't fix it" is a good one. However, CWI does need to engage in preventative maintenance.

## II The main observations and recommendations of the committee are as follows:

- 1 Overall, CWI is a strong research institute with high quality researchers working on highly relevant research themes. The symbiosis it achieves by accommodating mathematics and computer science under one roof and through its careful balance of fundamental and applied research gives it a strong, if not unique, position in the international research landscape. The committee rates 9 themes as EXCELLENT and 6 themes as VERY GOOD. It decided not to award scores to the 2 pilot themes because of their short track record but both seem very promising, albeit for different reasons.
- 2 The committee is impressed by the large number of irons that CWI keeps in the fire. This enhances the impact of CWI research. At the same time, it makes it more difficult for CWI to maintain its leading position, especially within a rapidly developing international research environment in which mathematics and computer science are branching out into a vast number of different areas and disciplines.
- 3 In view of this pressure, CWI must strive to maintain maximum flexibility in order to remain at the forefront of the research areas in which it is currently active and to extend its research into newly developing areas. The committee feels that this can only be done by taking account of the following considerations:
  - a Themes should not be seen as completely autonomous entities that can be left to their own devices so long as they meet the 70% basic / 30% additional funding criterion. More flexibility is needed to redirect resources as required. New themes need to be nurtured. A balance should be struck between themes in which fundamental research is predominant and themes in which applied research is more important. More cooperation between themes is desirable at all levels, from theme leaders to PhDs. Greater overall management control is necessary in order to enhance the organic coherence of the institute's research.
  - b The governing board needs to appoint a scientific council containing outside representatives. This would also give the management team increased authority to take initiatives. The management team needs to draw up a long-term strategic plan for the institute, identifying core topics and specifying how these are to be developed in the years to come. This strategic plan should be discussed with the governing board and the scientific council.
  - c CWI needs to gradually increase the ratio of non-tenured to tenured staff by increasing the number of PhDs and PDs, establishing a transparent tenure-track and career-path system, and encouraging staff to take up appointments at universities or in industry. This is no easy task, but it is a vital one for an institute with a national and subsidiary role like CWI's.
- 4 The committee feels that CWI must reach a clear decision about its future role in the life sciences. CWI is currently embarking on activities in this area of research but these are not yet concerted at the institutional level. If CWI wishes to become engaged in this area of knowledge development, it must reserve a substantial amount of money and manpower for the purpose and it must devise a plan for cooperation with researchers in the life sciences. Decisions need to be based on a careful assessment of the pros and cons compared with those of other opportunities arising from CWI's broad portfolio.

- 5 High priority should be given to solving the problem of accommodation. The current shortage of space is a matter of urgent concern, with one cluster physically separated from the other three, new staff hard to accommodate, and no possibility of achieving the institute's ambition to provide more meeting facilities for visitors. The committee urges NWO to keep up the momentum in the current discussions concerning the enlargement of the institute.
- 6 The library is another delicate issue, influenced by a number of developments that are beyond CWI's control. The library has a national role. It carries a unique collection of journals, acts as an electronic broker, and preserves archives. The importance of the library is perceived differently by mathematics and computer science staff. Interestingly, the committee learned that the PhDs and PDs are active and frequent users of the library. Space, money and impact are competing issues for the library. The governing board and director need to redefine the mission of the library. A joint effort with the University of Amsterdam, once its department of mathematics and computer science has settled at the Science Park, seems the most viable option.
- 7 The committee feels that too large a fraction of the budget is spent on support. It is a very positive sign that researchers at CWI seem to be happy with the current support following the recent reorganization, and many members of the support staff are working very hard. Yet comparable institutes manage with less. The committee fully appreciates that reduction is difficult, especially in view of the multiplicity of support tasks, and must therefore be carried out with care. The necessity of achieving it is directly related to the need to maximise budgetary flexibility in order to enable CWI to remain at the forefront of research.
- 8 In order to increase corporate awareness, theme leaders should be engaged in regular discussions about the overall position and impact of the institute. More generally, internal communication channels need to be improved. A first step might be to ask the theme leaders to read the self-evaluation document and to discuss the evaluation report in a joint session with the management team.
- 9 There is a need for a considerable boost to publicity for the institute as a whole. The Communication and Publication Department must take the lead in mobilising research staff.
- 10 The gender issue requires careful examination. Of the 17 theme leaders, only 2 are female; of the tenured research staff, only 10% are female. It is important that CWI puts/keeps in place processes to recruit, develop and retain talented female staff, and to help them to progress to senior levels through mentoring schemes.

Having listed these observations and recommendations, the committee wishes to stress that CWI is a powerful and vibrant institute with a strong track record and a healthy future. NWO has every reason to be proud of CWI.



## 6 Appendices

### 6.1 Curricula vitae of the committee members

Frank den Hollander (chair)	Eindhoven University of Technology
Christopher T.H. Baker	University of Manchester
Susan L. Graham	University of California, Berkeley
Wendy Hall	University of Southampton
Kurt Mehlhorn	Max Planck Institute for Computer Science, Saarbrücken

#### Frank den Hollander

Scientific Director of EURANDOM (European Institute for Research in Probability, Statistics and Stochastic Operations Research), Professor of Mathematics at Eindhoven University of Technology and Leiden University, The Netherlands.

##### Academic education and degrees

1975 - 1980	Undergraduate, Theoretical Physics, Leiden University, 18/11/1980 M.Sc. (cum laude)
1981 - 1985	Graduate, Mathematical Physics, Leiden University, 25/06/1985 Ph.D. (cum laude)

##### Academic positions

1985 - 1989	PD, Delft Technical University
1989 - 1991	Senior Fellow of the Royal Netherlands Academy of Arts and Sciences (KNAW)
1991 - 1994	Associate Professor, Utrecht University
1994 - 2000	Full Professor, Nijmegen University (Chair of Probability and Statistics)
2000 - 2005	Full Professor, Eindhoven University of Technology (Chair of Probability)
2000 - 2005	Scientific Director of EURANDOM
2005 -	Full Professor, Leiden University (Chair of Probability)

##### Research interests

Probability theory, Mathematical physics, Ergodic theory.

##### Professional activities

Member of the editorial board of several research journals, including Annales Henri Poincaré, Annals of Probability, Bernoulli, Journal of Statistical Physics, Markov Processes and Related Fields.

1996 - 2000	Chair of the Dutch Mathematical Physics Association
1999 - 2004	Member of the Mathematics Advisory Board of NWO
2002 -	Member of the Mathematics Advisory Board of KNAW
2002 - 2006	Chair of the ESF scientific programme Random Dynamics in Spatially Extended Systems
2003 -	Member of the Review Panel of the Isaac Newton Institute, University of Cambridge, UK
2003 - 2007	Member of the Council of the Bernoulli Society
2004 -	Chair of the Bernoulli Society Committee of Stochastic Sciences Institutes
2005 -	Member of the Scientific Council of the Weierstrass Institute, Berlin

##### Awards

2005	Fellow of the Royal Dutch Academy of Sciences
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## Christopher Baker

Emeritus professor, University of Manchester, UK.

Visiting professor, University College Chester, UK.

### Academic education and degrees

1958	Edwin Jones Scholar, Jesus College Oxford
1961	B.A. degree in Mathematics, Oxford University
1964	M.A. and D.Phil. degrees, Oxford University

### Academic positions

1958	Temporary employment, Research Laboratory, BX Plastics Ltd
1964 - 1966	Instructor in Mathematics and Postgraduate Research Mathematician in the Computer Center, University of California at Berkeley
1966 - 1972	Lecturer in Mathematics, Victoria University of Manchester
1972	Visiting Professor, Department of Computer science, University of Toronto
1972 - 1975	Senior Lecturer in Mathematics
1975 - 1989	Reader in Mathematics, Victoria University of Manchester
1976	Visiting Professor, Department of Computer Science, University of Toronto
1989 - 2001	Professor of Mathematics, Victoria University of Manchester
1996 - 1999	Head of Department of Mathematics, Victoria University of Manchester
2001 -	Visiting professor, University College Chester, UK
2001 - 2004	Emeritus Professor, Victoria University of Manchester
2001 - 2004	Research Professor (1/3 FTE), Victoria University of Manchester
2004 -	Emeritus Professor, University of Manchester

### Research interests

Analysis, Numerical Analysis, Bio-Mathematical Modelling.

### Professional activities

Member of the editorial board: Journal of Computational and Applied Mathematics.

Honorary editor: Communications on Applied Nonlinear Analysis. Quondam member of the editorial board of Journal of Integral Equations and Applications (from its inception in 1998 to May 2003) and of the editorial board of Advances in Computational Mathematics (from its inception; resigned 2002).

1992	Mathematics panel member UK RAE
1996	Member of Applied Mathematics panel UK RAE
2001	Chair of Applied Mathematics panel UK RAE
2000 -	Member of EPSRC Peer Review College
2004 - 2006	INTAS Supervisor

## Susan L. Graham

Pehong Chen Distinguished Professor of Electrical Engineering and Computer Science at the University of California, Berkeley, USA.

### Academic education and degrees

A.B. in Mathematics, Harvard University

M.S. and PhD degrees in Computer Science, Stanford University

**Academic positions**

1969 - 1971	Associate Research Scientist and Adjunct Assistant Professor, Courant Institute of Mathematical Sciences, New York University
1971 - 1976	Assistant Professor of Computer Science, University of California, Berkeley
1976 - 1981	Associate Professor of Computer Science, University of California, Berkeley
1981 -	Professor of Computer Science, University of California, Berkeley
1997 - 2000	Chancellor's Professor, University of California, Berkeley
2001 -	Pehong Chen Distinguished Professor, University of California, Berkeley

**Research interests**

Programming language implementation, software tools, software development environments, high performance computing. Compiler code generation and optimisation, building interactive programming environments and high-level interactive software.

**Professional activities**

1978 - 1992	Founding editor-in-chief of the ACM Transactions on Programming Languages and Systems
1983 - 1987	Member of the executive committee of the ACM special interest group on programming languages
1985 - 1990	Member and chair of the ACM Turing Award committee
1992 - 1995	Member of the National Research Council Commission on Physical Science, Mathematics, and Applications
1992 - 1995	Member of the Council of the American Association for the Advancement of Science
1994 - 2000	Member of the [US] President's Committee on the National Medal of Science
1996 - 2001	Member of the National Research Council Computer Science and Telecommunications Board
1997 - 2003	Member of the [US] President's Information Technology Advisory Committee (PITAC)
1997 - 2005	Chief computer scientist, NSF National Partnership for Advanced Computational Infrastructure (NPACI)
2001	Member of the Panel for International Review of United Kingdom Computer Science Research
2001 - 2004	Member of the National Science Foundation Alan T. Waterman Award Committee
2001 - 2007	Member of the Harvard University Board of Overseers
2002 - 2004	Co-chair of the National Research Council study on the Future of Supercomputing

**Awards**

1991	Fellow of the American Association for the Advancement of Science
1993	Member of the National Academy of Engineering
1994	Fellow of the Association for Computing Machinery
1995	Fellow of the American Academy of Arts and Sciences
1997	Fellow of the California Council on Science and Technology
2000	ACM SIGPLAN Career Programming Language Achievement Award

## Wendy Hall

Professor of Computer Science and Head of the School of Electronics and Computer Science, University of Southampton, UK.

### Academic education and degrees

1974	B.Sc. (Hons) Mathematics (First Class), University of Southampton
1977	PhD Mathematics, University of Southampton
1986	M.Sc. Computer Science, City University

### Academic positions

1977 - 1978	Lecturer in Engineering Mathematics, Oxford Polytechnic
1978 - 1982	Lecturer in Mathematics and Computing, La Sainte Union College of H.E., Southampton
1982 - 1984	Senior Lecturer, La Sainte Union College of H.E., Southampton
1984 - 1990	Lecturer, Department of Electronics and Computer Science, University of Southampton
1990 - 1994	Senior Lecturer, Department of Electronics and Computer Science, University of Southampton

### Research interests

Development of web technologies, open hypermedia systems and link services, advanced knowledge technologies, digital libraries, multimedia information management, agent-based systems and human computer interaction.

### Professional activities:

Member of the editorial board of several research journals, including IEEE MultiMedia, The Computer Journal, JoDI.

1996 -	Fellow of the British Computer Society (FBCS)
1998 -	Fellow of the Institute of Electrical Engineers (FIEE)
1995 - 1998	Member of the Technology Foresight ITEC Panel
1997 - 2002	Member of the EPSRC Council
2000 -	Fellow of the Royal Academy of Engineering (FREng)
2001 -	Member of the RAE Computer Science Panel
2002 -	Fellow of the City & Guilds of London Institute (FCGI)
2002 -	Member of the Council of the Royal Academy of Engineering
2005 -	Member of the executive of the UK Computing Research Committee (UKCRC)
2005 -	President of the British Computer Society
	Non-executive director of a number of company boards, including Active Navigation Ltd, Itext Ltd, The Company of Biologists, HERO Ltd and CA Technology Ltd

### Awards

1996 - 2001	Holder of the EPSRC Senior Fellowship
2000	CBE in the Queen's Birthday Honours list
2002	Honorary DSc by Oxford Brookes University

## Kurt Mehlhorn

Director of the Max Planck Institute for Computer Science, Saarbrücken, Germany.

### Academic education and degrees

1968 - 1971	Computer Science and Mathematics at TU München
1971 - 1974	Student at Cornell University, Ithaca, USA
1974	Doctor of Philosophy, Computer Science, Cornell University

### Academic positions

1971 - 1974	Studienstiftung des Deutschen Volkes
1973 - 1974	Cornell University Fellowship Research Associate at Universität des Saarlandes, Department of Computer Science
1975 -	Professor of Computer Science, Universität des Saarlandes
1990 -	Director, Max Planck Institute for Computer Science in Saarbrücken
1995	Co-founder (with Stefan Näher and Christian Uhrig) of Algorithmic Solutions GmbH Awards

### Research interests

Combinatorial optimization, graph algorithms, computational geometry, algorithm engineering, software libraries, computational complexity, data structures.

### Professional activities

Member of the editorial board of several journals, including ACM Transactions on Algorithms, Algorithmica, Computational Geometry: Theory and Applications, Information and Computation, International Journal of Computational Geometry & Applications, Journal of Discrete and Computational Geometry, SIAM Journal of Computing.

1993 - 1999	Member of the Senate, German National Science Foundation (DFG)
1993 - 2000	Member of the Scientific Advisory Board of the Gesellschaft für Mathematik und Datenverarbeitung (GMD)
1993 - 1996	Member of the Scientific Advisory Board, Siemens Corporate Research
1995 -	Member of Academia Europaea
1995 - 1998	Member of the Senate, Helmholtz Gesellschaft der Großforschungseinrichtungen (National Research Labs)
1998 - 2001	Member of the Board of Trustees, International Computer Science Institute, Berkeley
2001 -	Member of Berlin-Brandenburgische Akademie der Wissenschaften
2001	International Review Panel, UK research in Computer Science
2001	Review Committee, Computer Science Department, ETH Zürich
2001 - 2002	Vice Chairman, Chemisch-Physikalisch-Technische Sektion der Max-Planck-Gesellschaft
2002	Chairman, Review Committee, Computer Science Department, Humboldt University, Berlin
2002 -	Vice President, Max-Planck-Gesellschaft
2004 -	Member of Deutsche Akademie der Naturforscher Leopoldina

### Awards

1986	Leibniz-Award, Deutsche Forschungsgemeinschaft
1995	Konrad-Zuse-Medal
2002	Honorary Doctorate Degree, Otto-von-Guericke Universität

## 6.2 Standard Evaluation Protocol 2003-2009

The present evaluation has been prepared in accordance with the Standard Evaluation Protocol (SEP). The institute wrote a self-evaluation report, which was approved by the Governing Board of NWO and then sent to the members of the evaluation committee.

The committee met for a two-day site visit, starting at 5 p.m. on March 22 and ending at 6 p.m. on March 24. The evaluation report was written during and after the site visit. One week after the site visit, all committee members had submitted their texts. The chair and secretary of the committee compiled these to produce a preliminary draft of the evaluation document. The chair then edited this further and a week later sent a first draft to the committee members with a request to provide comments within two weeks. Based on this input, a second draft was prepared by the chair and this was sent on April 28th to the director of CWI to be checked for factual errors. His remarks were received on May 11th and a third draft was then prepared. The report was sent to the Governing Board of NWO on May 22nd. The Governing Board accepted the report on May 25th.

### 6.2.1 Additional questions put by NWO

Two sets of questions were put by NWO in addition to the Standard Evaluation Protocol. The first set is general (asked at all evaluations), while the second focuses specifically on CWI.

#### General questions put by NWO:

- 1 What is and what could be the position of the institute in the near future, compared to leading institutes in the world that operate within the same field?
- 2 Should NWO continue to support the mission of the institute and for what reasons?
- 3 Are there more effective ways for NWO to support the same type of research and/or facility?
- 4 What is your view of the analyses (made by the management of the institute) of the consequence if these institutional activities were to be discontinued?

#### Questions specific to CWI:

- 5 To what extent is there synergy between computer sciences and mathematics at CWI?
- 6 Do current and future housing facilities match the ambition(s) of CWI?
- 7 What is the importance of CWI's activities (research, facilities, projects, etc.) to the Dutch research community?

### 6.3 Programme of the site visit

#### Members of the Evaluation Committee

Frank den Hollander	dH	mathematics
Christopher Baker	Ba	mathematics
Susan Graham	Gr	computer science
Wendy Hall	Ha	computer science
Kurt Mehlhorn	Me	mathematics / computer science

Note: after each interview session there was a 10-minute slot for (closed) discussion

Tuesday, March 22						
17:00 - 19:00	Closed session (synchronising planning & approach, selection of PDs and PhDs for meeting on Thursday)					Hotel NH Tropen
20:00 - 22:00	Welcome Dinner					Hotel NH Tropen
Wednesday, March 23						
8:00	Transport					
8:30 - 9:30	Governing Board					M376
9:30 - 1:00	Director & Management Team					M376
11:00 - 11:45	Support departments					M376
11:45 - 12:30	Tour					
12:30 - 13:30	Lunch (closed session)					Z010
Time	theme; leader	committee		theme; leader	committee	
13:30 - 14:00	PNA2 Mandjes	dH Ba	M376	SEN2 Van de Pol	Gr Ha Me	C001
14:10 - 14:40	PNA3 Van den Berg	dH Ba	M376	SEN3 Rutten	Gr Ha Me	C001
14:50 - 15:20	PNA4 Pauwels	dH Ba	M376	SEN4 La Poutre	Gr Ha Me	C001
15:30 - 15:40	Short Break					
15:50 - 16:10	PNA1 Gerards	dH Ba Me	M376	SEN1 Klint	Gr Ha	C001
16:20 - 16:50	PNA5 Cramer	dH Ba Me	M376	SEN5 Bulterman	Gr Ha	C001
17:00 - 17:30	PNA Schrijver	dH Ba Me	M376	SEN Klint	Gr Ha	C001
17:40	Transport					
18:30 - 21:00	Dinner, Committee and Charles Buys (Governing Board of NWO)					Le Ciel Bleu
21:30 - 23:00	Plenary (closed session)					Hotel NH Tropen
Thursday, March 24						
8:00	Transport					
time	theme; leader	committee		theme; leader	committee	
8:30 - 09:00	MAS1 Doelman	dH Ba	M376	INS1 Kersten	Gr Ha Me	C001
9:10 - 09:40	MAS2 Koren	dH Ba	M376	INS2 Hardman	Gr Ha Me	C001
9:50 - 10:20	MAS3 Ebert	dH Ba	M376	INS3 Van Liere	Gr Ha Me	C001
10:30	Short Break					
10:40 - 11:10	MAS Verwer	dH Ba	M376	INS4 Buhrman	Gr Ha Me	C001
11:20 - 11:50						INS Kersten
12:00 - 12:45	Meeting with PDs and PhDs		M376	Meeting with PDs and PhDs		C001
12:45 - 13:30	Lunch with Director & Management Team					Z010
13:30 - 17:00	Plenary (closed session)					M376
17:00 - 17:30	Plenary with Director & Management Team					M376
17:30 - 18:00	Presentation to CWI					Z011

## 6.4 List of PDs and PhDs interviewed

### Baker and Den Hollander:

**Rachel Brouwer (PNA3):** Random spatial processes with percolation-like aspects, e.g. self-destructive percolation and self-organized critical forest-fire models.

**Mark Huiskes (PNA4):** Content-based image retrieval. Machine learning for data-driven image processing. Models for feature selection and semi-supervised learning.

**Joost Batenburg (PNA5):** Discrete mathematics and algorithms, in particular, discrete tomography.

**Marc van Raalte (MAS1):** Numerical mathematics. Multigrid for discontinuous Galerkin methods. Modelling phytoplankton growth in oceans, which concerns numerical methods for time-dependent PDEs.

**David Echeverria (MAS2):** Numerical mathematics. Computational electromagnetics. Maxwell equations. Space-mapping techniques for the shape optimization of linear actuators.

**Bernard Meulenbroek (MAS3):** Applied PDE analysis. Research on streamer PDE models. Regularization mechanisms for moving boundary problems and stability analysis for ionization fronts.

**Troy Lee (INS4):** Algorithms and complexity.

### Graham, Hall and Mehlhorn:

**Willem-Jan van Hove (PNA1):** Application of operations research techniques in constraint programming.

**Natalia Ioustinova (SEN 2):** Abstraction and static analysis of verifying reactive systems. Automatic test generation and execution for railway systems, in the TT-medal project.

**Nikolay Diakov (SEN3):** Evolution of coordination languages to support real-world applications with the help of software development tools and distributed coordination middleware. Interesting application areas include incident management systems, e-commerce protocols, coordination with performance guarantees for component-based systems, and coordination protocols for systems-on-chip.

**Valentin Robu (SEN4):** Intelligent techniques for negotiation between self-interested agents in multiagent systems, with applications to e-business and logistics.

**Thijs Westerveld (INS1):** Multimedia (Image) Retrieval via probabilistic generating models.

**Joost Geurts (INS2):** Semantic Web, Web, multimedia document processing. Representing and manipulating annotated multimedia on the Semantic Web.

**Jurriaan Mulder (INS3):** 3D visualization.

## 6.5 Checklists for internal use by the committee

How do you evaluate the institute with respect to	5	4	3	2	1
1 Leadership					
2 Mission and goals					
3 Strategy and policy					
4 Adequacy of the resources					
5 Funding policies					
6 Facilities					
7 Academic reputation of the institute					
8 Societal impact of the institute					
9 Balance of the strengths and weaknesses of the institute					
10 Overall assessment of the institute					
Remarks and questions					

5: EXCELLENT, 4: VERY GOOD, 3: GOOD, 2: SATISFACTORY, 1: UNSATISFACTORY

### EXCELLENT

Work that is at the forefront internationally, and which most likely will have an important and substantial impact in the field. Institute is considered an international leader.

### VERY GOOD

Work that is internationally competitive and is expected to make a significant contribution; nationally speaking at the forefront in the field. Institute is considered international player, national leader.

### GOOD

Work that competitive at the national level and will probably make a valuable contribution in the international field. Institute is considered internationally visible and a national player.

### SATISFACTORY

Work that is solid but not exciting, will add to our understanding and is in principle worthy of support. It is considered of less priority than work in the above categories. Institute is nationally visible.

### UNSATISFACTORY

Work that is neither solid nor exciting, flawed in the scientific and or technical approach, repetitions or other work, etc. Work not worthy of pursuing.

How do you evaluate the theme with respect to:	5	4	3	2	1
1.1 Leadership					
1.2 Mission and goals					
1.3 Strategy and policy					
1.4 Adequacy of the resources					
1.5 Funding policies					
1.6 Facilities					
1.7 Academic reputation					
1.8 Societal impact					
1.9 Balance of the strengths and weaknesses					
1.10 Overall assessment of the theme					
<b>Quality</b>					
How do you evaluate the theme with respect to:	5	4	3	2	1
1.11 Originality of the approach and ideas					
1.12 Significance of the contribution to the field					
1.13 Coherence of the theme					
1.14 Publication strategy					
1.15 Prominence of the theme director					
1.16 Prominence of the other members of the research group					
1.17 Quality of academic publications (scientific impact)					
1.18 Quality of other results					
1.19 Overall assessment of quality of the theme					
<b>Productivity</b>					
Considering the number of staff, how do you evaluate the theme with respect to:	5	4	3	2	1
1.20 Number of PhD theses					
1.21 Number of academic publications					
1.22 Number of professional publications					
1.23 Other results (if applicable)					
1.24 Distribution of published output within the group					
1.25 Prominence of the other members of the research group					
1.26 Overall assessment of productivity of the theme					
<b>Impact</b>					
Considering the stated mission of this themeHow do you evaluate the impact of the research with respect to:	5	4	3	2	1
1.27 The advancement of knowledge					
1.28 The dissemination of knowledge					
1.29 The implementation of knowledge					
1.30 Overall assessment of impact of the theme					
<b>Vitality and feasibility</b>					
Considering the present status and future developments (if known) of staff and facilities, how do you evaluate the long-term viability of this theme:	5	4	3	2	1
1.31 In view of the past performance					
1.32 In view of future plans and ideas					
1.33 In view of staff age and mobility					
1.34 Overall assessment of vitality of the theme					

## 6.6 Current and former CWI staff with full professor appointments

1. Aardal, KI (TUE, CWI)
2. Apt, K.R. (UvA, CWI)
3. Arbab, F. (UL, other, WCI)
4. Baayen, P.C. (retired)
5. Back, R.J.R. (other)
6. Baddeley, A.J. (other)
7. Baeten, J.C.M. (TUE)
8. Bakker, J.W. de (retired)
9. Berg, J. van den (VU, CWI)
10. Berg, J.L. van den (UT)
11. Bergstra, J.A. (UvA)
12. Bethlehem, J. (UU)
13. Bezem, M. (other)
14. Blake, E.J. (other)
15. Blokhuis, A. (TUE)
16. Böhm, W. (other)
17. Borst, S.C. (Lucent, TUE, CWI)
18. Boucherie, R.W. (UT)
19. Boxma O.J. (TUE)
20. Brandt Corstius, H (retired)
21. Brouwer, A.E. (TUE)
22. Bruijn, N.G. de (retired)
23. Bruin, A. de (EUR)
24. Buhrman, H.M. (UvA, CWI)
25. Cohen, A.M. (TUE)
26. Cramer, F.J.F. (UL, CWI)
27. Dekker, Th.J. (retired)
28. Dekking, F.M. (TUD)
29. Deursen, A. van (TUE, CWI)
30. Diekmann, O. (UU)
31. Doelman, A. (UvA, CWI)
32. Does, R.J.M.M. (UvA)
33. Doornbos, R. (retired)
34. Duijn, C.J. van (TUE)
35. Ebert, U.M. (TUE, CWI)
36. Eeden, C. van (retired)
37. Eijck, D.J.N. van (UU, CWI)
38. Emden, M.H. van (other)
39. Fabius, J. (retired)
40. Federgruen, A. (other)
41. Fokkink, W.J. (VU, CWI)
42. Gaag, L. van der (UU)
43. Gabrielli, M. (other)
44. Geer, S. van de (UL)
45. Gerards, A.M.H. (TUE, CWI)
46. Gill, R.D. (UU)
47. Grasman, J. (WUR)
48. Groen, P.P.N. de (other)
49. Groeneboom, P.W. (TUD, VU)
50. Groote, J.F. (TUE)
51. Haan, L. de (EUR)
52. Hardman, H.L. (TUE, CWI)
53. Harmelen, F.A.H. van (VU)
54. Hazewinkel, M. (retired)
55. Heesterbeek, J.A.P. (UU)
56. Hemker, P.W. (UvA, CWI)
57. Hordijk, A. (UL)
58. Houwen, P.J. van der (retired)
59. Jacobs, B.J. (RU)
60. Jacquet, J.M. (other)
61. Jager, E.M. de (retired)
62. Jeurig, J.T. (UU)
63. Jonkers, H. (other)
64. Keane, M.S. (other)
65. Kersten, M.L. (UvA, CWI)
66. Klaassen, C.J. (UvA)
67. Klint, P. (UvA, CWI)
68. Klop, J.W. (VU, CWI)
69. Kok, J.N. (UL)
70. Koole, G (VU)
71. Koornwinder, T.H. (UvA)
72. Koren, B. (TUD, CWI)
73. Koster, C.H.A. (RU)
74. Kranakis, E. (other)
75. Kriens, J. (retired)
76. Kruseman Aretz, F.E.J. (retired)
77. La Poutré, J.A. (TUE, CWI)
78. Laan, P. van der (retired)
79. Leeuwen, J. van (UU)
80. Lenstra, A.K. (Lucent, TUE)
81. Lenstra, J.K. (TUE, CWI)
82. Leve, G. de (retired)
83. Liere, R. van (TUE, CWI)
84. Mandjes, M.R.J. (UvA, CWI)
85. Meertens, L.G.L.T. (other)
86. Mei, R.D. van der (VU, CWI)
87. Middeldorp, A. (other)
88. Mill, J. van (VU)
89. Molenaar, W. (RUG)
90. Monfroy, E. (other)
91. Mullender, S.J. (UT)
92. Namen, U. van (other)
93. Nijmeijer, H. (TUE)
94. Oderog, E.R. (other)
95. Oosterhoff, J. (retired)
96. Paalman-de Miranda, A.B. (retired)
97. Palamidessi, C. (other)
98. Peletier, M.A. (TUE)
99. Rem, M. (TUE)
100. Riet, R.P. van de (retired)
101. Roerdink, J.B.T.M. (RUG)
102. Roever, W.P. de (other)
103. Rutten, J.J.M.M. (VU, CWI)
104. Ruymgaart, F.H. (other)
105. Savelsbergh, M.W.P. (other)
106. Schrijver, (UvA, CWI)
107. Schumacher, J.M. (UvT)
108. Schuppen, J.H. van (VU, CWI)
109. Steutel, F.W.
110. Siebes, A.P.J.M. (UU)

- 111. Tanenbaum, A. (VU)
- 112. Tijms, H.C. VU)
- 113. Tucker, J.V. (other)
- 114. Vaandrager, F.W. (RU)
- 115. Velde, S.L. van de (EUR)
- 116. Verduyn Lunel, S.M. (UL)
- 117. Verwer, J.G. (UvA, CWI)
- 118. Vijn, P. (other)
- 119. Vitányi, P.M.B. (UvA, CWI)
- 120. Vliet, J.C. van (VU)
- 121. Vrieze, O.J. (UM)
- 122. Zuylen, M.C. van (RU)
- 123. Zwet, W.R. van (retired)

#### Statistical data

CWI staff	29
Former CWI staff	73
Retired	21
Total	123

#### Numbers per university (retired not included)

UvA	UU	UL	RUG	EUR	TUD	TUE	VU	RU	WUR	UM	UT	UvT	Other
14	9	6	1	3	3	20	12	4	1	1	3	1	24