

# **Computer Science**

**Revised Edition**

**December 2004**

Quality Assurance Netherlands Universities (QANU)

Leidseveer 35

P.O.Box 8035

3503 RA Utrecht

Netherlands

Phone : +31 (0) 30 236 38 00

Telefax : +31 (0) 30 236 38 05

E-mail : [info@qanu.nl](mailto:info@qanu.nl)

Internet : <http://www.qanu.nl>

Quality assessment of education and research in Dutch universities was until recently carried out by the Quality Assurance department of the VSNU. In 2004 the activities of this department were transferred to QANU.

© 2004 QANU

Text and numerical material from this publication may be reproduced in print, by photocopying or by any other means with the permission of QANU if the source is mentioned.

## Table of Contents

<b>Preface</b>	5
<b>1 Scope and Goals of the Assessment</b>	7
1.1 The Dutch System for Quality Assessment of Research	7
1.2 The Review Committee for Computer Science	7
1.3 Scope of the Assessment	8
1.4 Procedure Followed by the Committee	9
1.5 Assessment Criteria	10
1.6 The Five-Point Scale of the Standard Evaluation Protocol	11
1.7 Clarification of the Assessment Aspects	11
<b>2 Structure and Funding of Computer Science in the Netherlands</b>	13
2.1 Flow of Funds	13
2.2 Graduate Schools	13
2.3 Societal Relevance of Computer Science	14
<b>3 Comments on Computer Science in the Netherlands</b>	15
3.1 General Comments	15
3.2 Comments on Subdisciplines	17
<b>4. Assessment of Institutes and Programs</b>	19
4.1 Technische Universiteit Eindhoven	19
4.2 University of Nijmegen	25
4.3 University of Maastricht	29
4.4 University of Amsterdam	33
4.5 Vrije Universiteit Amsterdam	39
4.6 Utrecht University	43
4.7 University of Groningen	49
4.8 University of Twente	55
<b>Appendices</b>	
A. Official Note of the Appointment of the Review Committee for Academic Research in Computer Science	63
B. Curricula vitae of the Members of the Review Committee for Computers Science	65
C. Discipline Protocol for the Members of Computer Science (with Annex)	69
D. Scientific Input per Program	75
E. Checklists for Internal Use by the Committee	79
F. Graduate Schools for Computer Science	81
G. Grades for the Programs According to the SEP Scale	83
H. Grades for the Programs According to the VSNU Protocol 1998	87
I. Abbreviations and Nomenclature	89
J. Addendum/Erratum	



## Preface

Over the past year, the staff of computer science departments of Dutch universities, the VSNU staff and the Review Committee have worked intensively to produce a quality assessment of research in computer science in the Netherlands over the period 1996-2001. I want to thank everybody for their dedication to this very difficult task and I am proud to present the results of this work here.

The evaluation activities of the Review Committee started from the self-descriptive reports of the 43 research programs spread over eight universities. The reports were produced in accordance with the instructions of the VSNU *Protocol 1998* for research assessments, and the universities have included, on a voluntary basis, some elements of the new *Standard Evaluation Protocol 2003-2009 for Public Research Organizations*.

The main conclusion of the Committee is very clear: computer science research in the Netherlands is generally good, often very good, and in some cases excellent. We therefore congratulate all researchers for this result. Given the tremendous importance of computer science for reaching excellence in all scientific domains and the importance of information technology for practically all areas of society, the Committee recommends that the positive trend in increased funding and better organizational support for computer science be sustained without hesitation. We already see a clear improvement with respect to the previous assessment, in terms of a balancing of applied and theoretical work and a better positioning of computer science in many universities with respect to other disciplines.

In addition, the report suggests that there is a need to put more emphasis on creativity and high-risk research that could lead to significant breakthroughs. It also suggests that actions be taken to increase the participation of women and to improve organizational support for the many tasks that computer science departments are trying to achieve. More detailed comments on institutes and research groups are presented in this report. The Committee has done its utmost best to be balanced and fair, without shying away from clear judgments. All remarks are intended to be constructive and we hope that they will encourage research excellence.

Although the effort to survey computer science for the whole country is substantial, there is nevertheless great value in doing so and it is therefore regrettable that the assessment does not include the Delft and Leiden universities. Nevertheless, I believe that this report contains information not only for specific institutes and research schools, but also for the state of computer science in the Netherlands as a whole.

Luc Steels

Chairman of the Review Committee for Computer Science

This **revised edition** of the report Computer Sciences was necessitated by the following reasons:

- the faculties concerned have expressed the desire to add an overview of the scores according to the (old) VSNU-scale. The reason for this is that this report is published in a period of transition from the VSNU-protocol to the Standard Evaluation Protocol (SEP), and a confusion between the two different scales of these protocols should be avoided as much as possible. This means that this revised edition now contains overviews of the scores according to both protocols (see Appendices G and H)
- after publication of its report, the Review Committee was informed by the Executive Board of Groningen University that they wish to object to the assessment of programme RUG 3 “Computing and Imaging”. The committee has seriously studied the arguments and objections, and has found that there are grounds for an addition to and a revision of the assessment of this programme (see Appendix J)
- Groningen University has pointed out that they had not opted for partial application of the Standard Evaluation Protocol. For that reason they have asked to delete the overall programme scores and the scores for Institutes in the RUG section of the report.



# 1. Scope and Goals of the Assessment

## 1.1 The Dutch System for Quality Assessment of Research

Since 1993, the Dutch universities, under the auspices of the Association of Universities in the Netherlands (VSNU) have developed a common system for assessing the quality of university research. An international Review Committee of experts assesses research programs per discipline or scientific area ('peer review'). Each Committee assumes responsibility for scrutinizing the research in a certain discipline or scientific area carried out over the preceding five years. The Committee is also asked to comment on the structure and the research profiles of the participating faculties in each university and on the development of the research in these fields in the Netherlands as a whole. The general rules of the assessments are laid down in a general Protocol (the *VSNU Protocol 1998*), which is subsequently further elaborated in a *Discipline Protocol*.

The most important functions of this assessment system are:

- Quality assurance
- Accountability

The aims of the assessment system are described as follows in the VSNU Protocol:

- assessment of the quality of the research programs on the basis of self-evaluations prepared by faculties or institutes; appraisal of how the work is related to the group's mission, as well as to the mission of the faculty or the institute of which the group's program is a part. This will enable the Committees to place the activities of the group within the context of the group's environment;
- evaluation of the missions of faculties or institutes, as well as of the group's own mission;
- appraisal of the state-of-the-art in the discipline or academic area concerned.

Until 2003, assessments were carried out per discipline, over a period of five years, by means of peer review. The Royal Academy of Arts and Sciences (KNAW) advises on the constitution of these Committees. Every Committee finishes the assessment with a public report.

It must be noted that from January 2003 the evaluation system changed on a number of important organizational and material points. The traditional system of assessing a discipline on a national level by the VSNU was abandoned in favour of a more flexible model, which offered universities more options regarding the scope and nature of the assessment. At the same time a new *Standard Evaluation Protocol 2003-2009 for Public Research Organizations* replaced the *VSNU Protocol 1998*.

This new Protocol introduces a greater emphasis on evaluation of the management of a research program. Evaluators are explicitly asked to judge not only the performance of an institute's research and researchers, but also its leadership, strategy and policy, and research organization. If applicable, the quality questions may also refer to the socio-economic impact of research and to multi- and interdisciplinary research. The new evaluation system is a combination of *retrospective* and *prospective analysis*. The relationship between retro- and prospective evaluation is to some extent the result of acquired confidence for the future based on insight in the past. In other words: discussions about the future require knowledge of the past. The emphasis will be on the prospective analysis.

In the computer science review, some elements of this new Protocol are incorporated on a voluntary basis, as indicated in an Annex to the *Discipline Protocol* (Appendix C).

## 1.2 The Review Committee for Computer Science

In February 2003, the Discipline Subcommittee for Computer Science provided a list of proposed Committee Members, which was approved by the KNAW on March 31. The fact that it took a total of eight months to complete the composition of the Committee has led to some delay in the procedure.

This Committee consisted only of international experts, which complicated the planning of the site visits. Many factors had to be taken in account: the short notice on which the site visits had to be planned, which sometimes interfered with other long-standing commitments of Committee Members, and the need to match the expertise of the reviewers with the research programs of a specific department. Finally, a schedule was arranged that was demanding both for the Committee and for the departments, but that allowed all departments to be visited by the majority of the Committee.

By decree of 19 September 2003, the Chairman of the VSNU appointed the Chairman and Members of the Review Committee for Computer Science.

- Prof. dr. Luc Steels, Free University of Brussels, VUB (Chairman), Belgium
- Prof. dr. Ralph-Johan Back, Abo Akademi University, Finland
- Prof. dr. Alberto Del Bimbo, University of Florence, Italy
- Prof. dr. David Harel, Weizmann Institute of Science, Israel
- Dr. Gilles Kahn, INRIA, France
- Dr. Carl Kesselman, University of Southern California, United States
- Dr. Johan de Kleer, Palo Alto Research Center, United States
- Prof. dr. Gordon Plotkin, University of Edinburgh, United Kingdom
- Prof. dr. Arne Sølvberg, Norwegian University of Science and Technology, Norway

Drs. Bas Bauland, staff member of the VSNU, was appointed as secretary of the Review Committee.

For the official notice of the appointment, see Appendix A. A short curriculum vitae of each Member is included in Appendix B.

### **1.3 Scope of the Assessment**

The universities participating in the assessment were:

- Technische Universiteit Eindhoven (TUE)
- University of Nijmegen (KUN)
- University of Maastricht (UM)
- University of Amsterdam (UvA)
- Vrije Universiteit Amsterdam (VU)
- Utrecht University (UU)
- University of Groningen (RUG)
- University of Twente (UT)

Initially, the universities of Delft and Leiden, cooperating closely in computer science, were to be included in this national evaluation. Later they decided to make use of the options of the new system of research assessment and organized a separate review.

The Committee has only obtained a partial view of computer science research in the Netherlands. This is because:

- two universities were not included in this assessment (Leiden and Delft);
- important related work takes place in non-computer science departments;
- some research is carried out in non-academic research institutes, such as CWI, the Telematica Instituut (Institute for Telematics) and TNO.

It would have been better for a balanced and more complete view if this research could have been incorporated in the assessment. Moreover, the Committee sees value in comparing different universities by one committee (despite the hard work involved) and therefore regrets that this system is now being abandoned.

In the period 1996-2001, ten new programs started in the departments, assessed in this review:

- 1996: Software Technology (University of Nijmegen)  
Information Retrieval and Information Systems (University of Nijmegen)
- 1998: Information Systems (University of Twente)  
Intelligent Media and Language Technology (University of Twente)

- 2000: Language and Inference Technology (University of Amsterdam)  
Decision-support Systems (Utrecht University)  
Large Distributed Systems (Utrecht University)  
Software Engineering (University of Groningen)
- 2001: Artificial Intelligence and Cognitive Engineering (University of Groningen)  
Application Protocol Systems (University of Twente)

As stated before, in this review some elements of the new Protocol are incorporated on a voluntary basis, as indicated in an Annex to the *Discipline Protocol*. The reports are compiled in accordance with the 1998 Protocol of Quality Assessment and the *Discipline Protocol* for the review of computer science of April 2002. This Protocol allowed for the addition of an annex and four institutes had done so. This annex deals with aspects of the new Protocol, such as:

- Organizational structure
- Steering mechanisms
- Future perspectives

In those cases where an annex has been added (Universities of Maastricht, Utrecht, Eindhoven and Nijmegen), the Committee was asked to consider this annex. The *Discipline Protocol* and Annex are included in Appendix C.

The Review Committee received the following data from the participating faculties: a report *Research Assessment 1996-2001*, including a profile and key data of the Faculties, documentation for each of the 43 research programs with input and output data and a list of publications issued in the assessment period; a set of five key publications for each research program.

Some key data of the reports are compiled in Appendix D.

During the site visits, some universities provided data on research input and output over 2002. This additional information served to deepen the Committee's understanding, but it was not taken into account in the numerical evaluations.

#### **1.4 Procedure Followed by the Committee**

Each member of the Committee received the complete set of documentation in September 2003. Each member was asked to complete a preliminary assessment form (see Appendix E) as first or second reviewer for a number of the 43 research programs, in accordance with their specific expertise. The preliminary assessments, the documentation and the procedure of the assessment were discussed in two Committee meetings in Eindhoven on October 12, and Amsterdam on October 26, 2003. The Committee felt that the reports and the key publications served well as a preparation for the interviews, but it provided in general no solid foundation for making detailed judgments, without having talked to the program leaders, other researchers and the management of the departments.

During the site visits in October the Committee had meetings with the Faculty Board, Ph.D. students (aio's and oio's) and the program leaders or their representatives of all programs. The Committee also visited facilities and demonstrations. On request of the Vrije Universiteit, the Committee also met a newly appointed professor in bioinformatics, prof. P. Heringa. The University of Groningen made a similar request. There, the Committee had an interview with prof. R.C. Jansen of bioinformatics. It must be stressed that these interviews were not formal assessments. They only provided background information. The first round of site visits took place on October 13-15, 2003. The Committee visited the Technische Universiteit Eindhoven, the University of Nijmegen, and the University of Maastricht. The second round of site visits took place on October 27-31, 2003. The Committee visited the University of Amsterdam, the Vrije Universiteit Amsterdam, Utrecht University, the University of Groningen, and the University of Twente.

The Committee was impressed by the open manner in which these conversations were conducted and by the frankness with which all questions were answered. The discussions took place in a friendly atmosphere, with genuine effort from the researchers and managers to highlight the relevant issues in computer science, both at departmental and at national level.

After each interview, the Committee discussed the conclusions and agreed upon the final scores and comments on the programs.

In December 2003, the VSNU sent a draft report to the universities for factual corrections and comments on the reviews. The comments received were carefully considered and led to a number of adjustments in the text.

In all cases the conclusions presented in this report are supported by the entire Committee and are the sole responsibility of the Committee.

### **1.5 Assessment Criteria**

For the preliminary assessment the Committee used the forms provided by the VSNU, which specify the separate aspects for assessing the programs and the management, strategy and organizational aspects of the institutes.

The assessment criteria for an institute as a whole and those for the research programs are similar, but differ in scope and depth. The institute assessment puts emphasis on strategy and organizational aspects, expressed in an overall grade, whereas the program assessments focus on the results, on quality of the scientific research and on the future.

The institutes were assessed on:

- Leadership
- Mission and goals
- Strategy and policy
- Adequacy of the resources
- Funding policies
- Facilities
- Academic reputation
- Societal relevance
- Balance of the strengths and weaknesses

This report will only give one overall grade for each institute.

Each research program has been evaluated along the same criteria as the institutes, but also on several aspects of:

Quality (international recognition and innovative potential)

Productivity (scientific output)

Relevance (scientific and socio-economic impact)

Vitality and feasibility (flexibility, management, and leadership)

Together the criteria represent a comprehensive picture of the performance of an institute or research group in any given field, and of its potential. For a complete list of all elements of the assessment, see the forms in Appendix E.

### 1.6 The Five-Point Scale of the Standard Evaluation Protocol

The Committee has expressed the scores in words: *excellent*, *very good*, *good*, *satisfactory* and *unsatisfactory*. It must be noted that the *VSNU Protocol 1998* and the new Standard Evaluation Protocol 2003-2009 differ in the numerical values attached to these verbal scores. *It is important for the reader to realize that numerical grades of the VSNU assessment cannot be compared directly to the SEP scores.* For convenience, both numerical scales are presented below. In the text, the grades are only expressed in words.

	VSNU Protocol 1998	SEP 2003-2009
<b>Excellent</b> <ul style="list-style-type: none"> <li>• Work is at the forefront internationally</li> <li>• Work will most likely have an important and substantial impact in the field</li> <li>• Institute is considered an international leader</li> </ul>	5	5
<b>Very good</b> <ul style="list-style-type: none"> <li>• Work is internationally competitive, nationally at the forefront in the field</li> <li>• Work is expected to make a significant contribution</li> <li>• Institute is considered an international player, national leader</li> </ul>	n.a.	4
<b>Good</b> <ul style="list-style-type: none"> <li>• Work is competitive at national level</li> <li>• Work will probably make a valuable contribution in the international field</li> <li>• Institute is considered internationally visible and a national player</li> </ul>	4	3
<b>Satisfactory</b> <ul style="list-style-type: none"> <li>• Work is solid but not exciting, will add to our understanding and is in principle worthy of support</li> <li>• Work is considered of less priority than work in the above categories</li> <li>• Institute is nationally visible</li> </ul>	3	2
<b>Unsatisfactory</b> <ul style="list-style-type: none"> <li>• Work is neither solid nor exciting, flawed in the scientific and or technical approach, repetitions of other work, etc.</li> <li>• Work not worthy of pursuing</li> </ul>	2	1
<b>Poor</b>	1	n.a.

### 1.7 Clarification of the Assessment Aspects

#### *Overall score of institute and research programs*

The overall scores for the institutes and research programs are an innovative aspect of the Standard Evaluation Protocol 2003-2009. They closely relate to the annexes that were provided by some institutes on a voluntary basis. However, the Committee felt that these aspects were highly relevant for all departments and programs. Therefore, leadership, goals, strategy, and the other topics were addressed in all interviews, as was a SWOT analysis on the department and program level. The Committee had the impression that this procedure was very beneficial in raising the important issues for the institutes and for Dutch computer science in general. The Committee carefully weighted the several items that are listed in Appendix E, before determining the overall score.

### *Quality*

In order to assess a program's quality, the Review Committee Members had the opportunity to read the five key publications, provided by each research group. Together with the program descriptions and the lists of publications, this was a very important element in the assessment.

### *Productivity*

The Committee defined productivity strictly as the publication output, calculated as output / input. It must be emphasized that the grade for productivity does not include a judgment on the scientific value of publications or the quality of the research.

Output was defined as:

- Ph.D. theses (weight factor 2)
- Academic publications (weight factor 1)
- Conference proceedings (weight factor 1)
- Chapters (weight factor 1)
- Books, excluding edited books (weight factor 2)
- Items of scientific software (weight factor 1)

Input was defined as full time equivalents in research (not counting Ph.D. students). According to the format of the available data, which for most part of the assessment period only differentiated between Ph.D. students and 'others', postdocs were included in the research input.

Professional publications were not counted for productivity. In computer science, technical reports are a clear example of professional publications.

To calculate the total output of a program, the number of each type of output was multiplied by a factor as indicated above.

In the future, it might be better to differentiate in the documentation between different types of books, e.g. monographs, edited books, reprints and translations.

### *Relevance*

When assessing the relevance, the Review Committee took into account:

- Advancement of knowledge
- Dissemination of knowledge
- Implementation of knowledge

It was not always easy to distinguish this aspect from the academic quality. As much as possible, arguments for the one or for the other aspect were kept separated during the discussions.

### *Vitality and feasibility*

When assessing long-term viability (considering the available staff and facilities), the Review Committee took into account:

- Past academic performance
- Future plans and ideas
- Staff age and mobility

In these assessments, the future funding prospects and the planning of the replacement of retired personnel played a major role. The Committee specifically considered the continuity of a group in case of a 'generation change'. The size of the group was also a critical element.

## 2. Structure and Funding of Computer Science in the Netherlands

### 2.1 Flow of Funds

Scientific research in the Netherlands is funded from several sources. The universities, which generally carry out the research, identify the following three 'flows of funds'. The first flow of funds comes directly from a government ministry to a university. The second flow of funds is allocated by the Netherlands Organization for Scientific Research (NWO), on a competitive basis to research groups or individual researchers at a university. The third flow of funds is derived from contract research carried out for clients in both the private and public sector, and is paid directly to the university research group carrying out the research. The third flow also includes funds from the Ministry of Economic Affairs and European funds. NWO promotes scientific research at Dutch universities and research institutes and seeks to raise the quality of that research. Innovation is a key element in this endeavor.

To help it achieve these aims NWO receives funding of around 450 million euro from the government. Most of this funding comes from the Ministry of Education, Culture and Science, though other ministries, like the Ministry for Economic Affairs, also contribute. NWO research funding is allocated through a stringent selection process based on the quality of the research proposals submitted each year, as well as through the provision of support to individual researchers. Within NWO, the Technology Foundation STW has a special position. STW research projects can stem from any of these fields, although most grant applications belong to science and technology. Every other section of NWO cooperates with the Technology Foundation as soon as applications come into sight.

In a survey from 2001 (by the NOAG-i, see section 2.3), it was estimated that there were 850 computer scientists working in the Netherlands in research and education (among them 75 full time professors and 470 Ph.D. students and postdocs), at ten universities and the CWI. The budget for research and education was about 50 million euro, 35 million via the universities and 15 through NWO.

In September 2003, NWO announced an extra investment in computer science of ten million euro over the period 2004-2007. After 2007, the budget for computer science would be raised with five million euro structurally. The extra funds would allow for more than a hundred extra researchers.

Also significant for computer science are the Bsik Funds (benefits from the Dutch resources of natural gas). The goal of this subsidy is to provide more usable knowledge and research capacity in the Netherlands. In November 2003, the government decided to allocate substantial Bsik Funds (215 million euro) to several projects in information and communication technology in general. About 100 million euro of these funds will be invested directly in computer science.

Finally, the EU funds are important for the funding of computer science in the Netherlands. A recent survey by the Ministry of Economic Affairs showed that the Netherlands participated above average in the theme User-friendly information Society (IST) of the fifth Frame Program (1998-2002). The Netherlands participated in 805 of 18.114 projects. The Dutch participations were funded with an estimated 176 million euro. Of the Dutch proposals, 32% was funded, well above the European average of 25%. In the theme IST of the sixth Frame Program (2003-2006), the Dutch participation seems to be somewhat lower.

### 2.2 Graduate Schools

In general, research in the Netherlands is organized in graduate schools (onderzoeksscholen): consortia of researchers from several universities. In some cases, a program is affiliated with two research schools. For this assessment the following research schools are relevant, each focusing on a specific field of computer science:

SIKS:	Information and Knowledge Systems
IPA:	Programming Research and Algorithmics
ASCI:	Computing and Imaging
OZSL:	Logic Research
TGS:	Telematics Graduate School

All graduate schools are accredited by the KNAW. For more information on the graduate schools, see Appendix F.

### 2.3 Societal Relevance of Computer Science

In the past years, the Dutch government initiated several investigations to stimulate the research in computer science and its application to the benefit of the Dutch economy and society. The report of one of these committees, *Taskforce ICT en Kennis* (Taskforce ICT and Knowledge), commissioned by the Ministries of Education and Economic Affairs resulted in the foundation of the *Informaticaonderzoek Platform Nederland* (Forum for Computer Research in the Netherlands), in which participated NWO and the graduate schools. In 2001, this platform defined a new research agenda for the period 2001-2005, called the NOAG-i 2001 (Nationale Onderzoeksagenda Informatica), with seven research themes that were considered scientifically challenging and relevant for society:

- Parallel and Distributed Computing
- Embedded Systems
- Software Engineering
- Multimedia
- Modeling, Simulation and Visualization
- Intelligent Systems
- Algorithms and Formal Methods

The NOAG-i concluded that Dutch investments in ICT research, public and private, remained far below those of the leaders in the field. The NOAG-i urged that by 2005 the research budget for computer science be doubled, leading to the employment of 650 computer scientists extra. It is unlikely that these ambitions will be realized. However, in September 2003 NWO announced an extra investment in computer science, mentioned in section 2.1. In line with the NOAG-i, NWO has formulated a number of key objectives for computer science for the period 2002-2005:

- to develop broad-based thematic programs which transcend the boundaries of the individual disciplines and connect the physical sciences as a whole to other NWO research councils;
- to achieve far-reaching cooperation between the various disciplines within the field, enabling a more flexible allocation of structural resources among the disciplines;
- to devote specific attention to strategic research in informatics;
- to develop and apply an effective policy whereby research groups' human resources problems may be resolved.

Several special programs were started to support research-items mentioned in the NOAG-i. *Jacquard* is an NWO-program to support research in software engineering; *Progress* is a similar program for embedded systems. There are several other initiatives to support and stimulate research in computer science. One of these is the *ICT-Forum*, also proposed by the Taskforce ICT and Knowledge. The participants in this Forum are: NWO, the Ministry of Economic Affairs and several companies.

## 3. Comments on Computer Science in the Netherlands

### 3.1 General Comments

The quality of computer science research in the Netherlands is generally good, often very good, and in some cases excellent. It rests on a tradition of excellence, based on close cooperation with mathematics and logic. Since the last review, computer science in the Netherlands has increased its application orientation. For example, there is an increased emphasis on information systems; there are theory groups focusing on application of formal methods to real systems; there is increasing attention to interdisciplinary matters, such as bio-informatics. All these are positive and healthy developments. There are also clear signs that the funding situation has improved, for example by the doubling of NWO money for computer science, the availability of special funds (such as through the Bsik funds) and more balanced personnel allocation inside universities. This is very positive and offsets funding difficulties in some areas (such as telecommunications) due to the economic downturn.

There are many very motivated and dedicated researchers, working inside dynamic departments. The Committee has seen very impressive groups that are competitive on an international level. In general, department heads and program leaders are clearly concerned with advancing their groups and seeking the best possible management structures.

The Ph.D. students are generally good, well-trained and well-motivated, which indicates that the research schools are functioning well, providing not only graduate education at a national level but also fulfilling the important role of enabling students to form networks of like-minded colleagues.

Besides the generally positive observations, the Committee sees a number of concerns:

#### 1. *Scattering of research activity*

In some cases, there seems to be a scattering of research activity across several departments and faculties other than computer science. It would be better if these activities, which have often grown up separately for historical reasons, were brought together. This would help to achieve critical mass in more groups, get better coverage across the disciplines, and make the most effective use of the limited financial and human resources available. In 2002, the Review Committee for Education made a similar observation regarding the courses in computer science. The Committee encourages consideration of these issues at a national level, particularly because some disciplines, which are critical for the field, for industry, or the knowledge-based society, are not covered adequately. Security, networking, hardware, ubiquitous computing, or programming languages come to mind.

#### 2. *More emphasis on experimental computer science and systems engineering*

There needs to be more emphasis on experimental computer science and systems engineering. A large part of the research investigation addresses theoretical and methodological issues, although several groups have developed high quality applied research with strong relationships with industry. In any case, applied research should also be developed in those universities where a tradition exists in the theoretical and methodological direction. One way to alleviate this problem might be to provide faculty and appropriate infrastructural support for these types of research agendas to be successful, such as vehicles for carrying out larger projects, stable programming staff, or support for long-term large-scale projects with industry. This may be important for helping to bootstrap or improve software related industrial activities in the Netherlands.

### 3. *Financial structure*

Some groups do not have a healthy financial structure despite the presence of large numbers of students. The Committee recommends that funding of computer science should generally be along the same lines as other engineering disciplines. Many groups, particularly those who have a strong industrial relevance, increasingly depend on contract research, but the effort required to obtain this money is considerable. This needs to be taken into account in the evaluation of the faculty involved.

One suggestion is that the graduate schools (IPA, SIKS, etc.) be given a considerable amount of additional funding, partly to enlarge the Ph.D. coordination efforts, but mostly in order to upgrade these to centers where coordinated Dutch EU applications could be made with full time professional staff. This would encourage the research groups to form bigger alliances (also including other countries) in order to raise EU funding, and might provide the nucleus for a professional organization for coordinating EU projects.

### 4. *Decrease of Dutch students*

There has been a dramatic decrease of Dutch students in computer science, particularly at the graduate level. This is offset by a greater influx of foreign students. However, it seems that this may be an important danger for the future of the knowledge economy in the Netherlands, particularly because most of the foreign students leave after their studies. Urgent action to make advanced computer science attractive to Dutch students is needed. This is not only a matter of more government money. Dutch computer science needs to reinvent itself to be attractive and this is under way in several universities.

### 5. *Few female scientists in Dutch computer science*

The Committee noted the lack of women in computer science at all levels: undergraduate, postgraduate and junior and senior faculty. This is indeed an extremely well known problem, not only in computer science but also in other sciences and engineering disciplines, and not only in the Netherlands but also world wide, including Europe and the United States and Japan. NWO has initiated several programs to stimulate the career perspectives of women in science. The *Meervoud-programma* funds assistant professor positions for women in postdoc positions. *Aspasia* is a general program for women in humanities and sciences, financing associate professor positions for women.

The problem clearly demands, and receives input on a national and institutional scale, but the Committee would recommend that something also be done at departmental levels, possibly in a context of a national cooperation. One, minimal possibility would be the production of a best practice guide (like, for example, the one written by the Scottish Higher Education Funding Council) that would be made available to all higher education institutions. It may be a good idea for the government to finance its own 'women in science and engineering program' at one or two universities (to be decided competitively) along lines similar to the ones at the Carnegie-Mellon University, suitably adapted to the Netherlands context; should such a pilot scheme work, the lessons learned could be applied more widely.

### 6. *More investment in software production needed*

The Netherlands seems to be lacking strong investments in software production. There should be a general reflection on how to improve this situation.

The tradition of the country as a trading nation, as opposed to a manufacturing nation, is not helpful. Moreover, the government itself, as an important user of computer applications, could stimulate development of software for its own use, which might then have a multiplicative effect. Many funding programs by the Ministry of Economic Affairs are indeed designed for stimulating Dutch industry only. Industrial cooperation should not necessarily be stimulated inside the Netherlands, a European, if not global, view is necessary. In other words, universities should be able to obtain funding for cooperation with companies outside the Netherlands.

### 7. *Stimulate creativity and novelty*

Although the quality of research is generally good, sometimes very good, the Committee has seen relatively few attempts to achieve real breakthroughs by carrying out very risky research, without losing sight of applicability. Some thought is needed on how to stimulate creativity and novelty. Although there is surely a need for research coordination (as argued in 1), it is important to leave enough room for exploration and curiosity-driven research. Senior researchers could take a much more pro-active stance and be more involved on an international level in shaping new research fields.

NWO may wish to specifically consider the ‘blue skies’ elements of research proposals when evaluating them (that has been done by the UK EPSRC, which is also concerned about this problem). Such a scheme should reward adventurous grants, though not exclusively so – grants making regular scientific and technological progress are still, evidently, necessary and very much to be desired.

### 8. *Publication habits of computer science*

The field of computer science has its own customs that need to be accepted. In particular, conference publications in many subdisciplines (such as software engineering) often have the same value as important journal publications. This should be recognized in evaluation of researchers, and has been done so by the Committee. In addition, the construction of software artifacts and their widespread distribution is viewed as very important and has been taken into account.

## 3.2 **Comments on Subdisciplines**

It is not so obvious to segment computer science into specific subdisciplines, and new subdisciplines are constantly formed. This was one of the reasons that the Dutch computer science community needed so much time to propose members for the Committee, as mentioned in section 1.2. The Committee follows here the separation along the *onderzoeksscholen*, or graduate schools.

### 1. *Information and knowledge systems*

This discipline concerns all types of applications in the form of information systems and knowledge systems. The Committee sees a very healthy activity, particularly as managed through the SIKS graduate school, which is organizing a steady stream of events for doctoral students and integrates many groups, which are outside the computer science departments. The VU Amsterdam and the University of Utrecht play key roles in this school. The emphasis is on building practical applications and exchanging experience about methodology and tools. This activity is of major importance for the economy of the nation.

### 2. *Programming research and algorithmics*

This discipline focuses on algorithms, software engineering and programming language research, and takes a fundamental, ‘scientific’ approach to tackle issues related to reliability, efficiency and flexibility. The discipline is well developed in the Netherlands and is taking various initiatives to promote computer science to industry and the public at large. The TU Eindhoven takes a leading role in the organization of the graduate school IPA. There are strong international connections with other graduate schools. It is of great relevance to keep this foundational research at the highest level of excellence.

### 3. *Computing and imaging*

This discipline covers advanced, large-scale and high-performance computer and imaging systems, in which media-oriented applications play a central role. The applications are particularly oriented to support scientific research (e.g. visualization of chemical reactions) and, more recently, multi-media technologies. A link with local consumer electronics industries is obvious. Since the Technical University of Delft, which was not included in this assessment, mainly carries the ASCI graduate school, it is difficult for the Committee to assess the area.

4. *Logic research*

Logic research is a traditional strength of Dutch university research and thanks to this tradition computer science in the Netherlands has been able to build up a strong reputation in formal methods and proof theory. This discipline covers many additional areas of interaction between logic and disciplines like philosophy, linguistics or artificial intelligence, which are becoming increasingly important in areas like the semantic web. The University of Amsterdam is a major driving force in the related research school Logica.

5. *Networking and telecommunication*

The graduate school TGS is located at the University of Twente, where it is integrated into CTIT. There is a close collaboration with the Telematica Instituut, also located on the campus of Twente. This gives Twente a leading role in the Netherlands in the area of (large-scale) networking, telecommunication, and their applications.

## 4. Assessment of Institutes and Programs

### 4.1 Technische Universiteit Eindhoven

*Division of Computer Science*

Assessment 1996	Assessment 2001
Formal Methods prof. dr. J.C.M. Baeten, prof. dr. L.M.G. Feijs, dr. ir. C. Hemerik, dr. R.P. Nederpelt	Formal Methods prof. dr. J.C.M. Baeten
Programming Methodology prof. dr. R.C. Backhouse, dr. ir. C. Hemerik	Software Construction prof. dr. B.W. Watson
Parallel Systems prof. dr. M. Rem, prof. dr. E.H.L. Aarts, prof. dr. P.A.J. Hilbers dr. J.J. Lukkien	Parallel Systems prof. dr. P.A.J. Hilbers, dr. J.J. Lukkien
Computer Graphics dr. C.W.A.M. van Overveld	Visualisation prof. dr. ir. J.J. van Wijk
Distributed Real-time Systems prof. dr. D.K. Hammer, dr. P.D.V. van der Stok	System Design and Analysis prof. dr. ir. J.F. Groote
Information Systems prof. dr. K.M. van Hee, dr. ir. W.M.P. van der Aalst, dr. P.M.E. de Bra, dr. L.J.A.M. Somers	Information Systems prof. dr. P. de Bra prof. dr. K.M. van Hee

The Division of Computer Science studies the design of efficient reliable software systems. It seeks design methods that yield reliable qualitative and quantitative statements about such systems.

The institute has two main goals:

- the scientific foundation of software engineering with theoretical approaches to software construction and verification;
- the construction of embedded systems, implemented through the presence of the Embedded Systems Institute. It has a staff addressing both topics and a strong growth of students.

A strength of the department is a strong tradition in rigorous methods for software engineering. A weakness is that these activities appear removed from practice. The creation of a Laboratory for Quality Software seems to be an important improvement in this respect.

Over the last years, the Division of Computer Science has continued to move from a knowledge-driven, mono-disciplinary approach to a more society-driven, multi-disciplinary way of working. This has led to increasing cooperation with other departments of the University. Indeed some of these departments have ventured into application areas developed in computer science, and have even taken over research activities and staff of the Division.

In the 1996 quality assessment two research programs obtained a less than satisfactory viability score: Programming Methodology and Computer Graphics. As a matter of research policy, new leaders were appointed during the current assessment period and the direction of both programs was redefined. They were renamed as: *Software Construction* and *Visualisation*.

During the period 1996-2001, the number of students in computer science has increased substantially, with consequent growth in the division. Following on the previous assessment, research was revitalized and several new chair holders appointed. In this period, these were Groote, Watson, Van Wijk and Van Hee.

In June 2000, the Division of Computer Science selected a number of areas, as a focus for the development of its scientific competence, along with a number of application areas that will serve both as an inspiration and as a touchstone for the research in the coming years.

The focus areas are:

- software engineering (research programs: Formal Methods, Software Construction);
- computational engineering (research programs: Parallel Systems, Visualisation);
- systems engineering (research programs: System Design and Analysis, Information Systems).

The application areas were selected for their academic and innovative nature, with a scientific (competence) base within the department, and in accordance with the general research profile of the TUE.

They are:

- embedded systems (cooperation with Electrical Engineering);
- business information systems (cooperation with Technology Management);
- biomedical applications (cooperation with Biomedical Engineering and Mathematics).

The implementation of this strategy is well under way. However, given the recent transfer of an entire group from the research program Parallel Systems to the Department of Biomedical Engineering, the biomedical applications area has to be reconsidered. A possible new area is information security, in which there is already cooperation with the Division of Mathematics.

#### *Recent developments*

Although it is outside the scope of this assessment period, it is worth mentioning that in the fall of 2002 the TUE started an Algorithms group, with prof. M. de Berg as professor and Dr. O. Cheong as associate professor. The group focuses on fundamental research in computational geometry, dealing with spatial data. It is connected to other areas of algorithms research and to combinatorial geometry, and it has applications in computer graphics and virtual reality, CAD/CAM, geographic information systems (GIS), and robotics. The group's ambition is to develop a theory of geometric algorithms that is closer to practice. This is done by performing a more refined analysis of the algorithms and data structures, taking the shape and distribution of input objects into account; in this way the analysis give an improved prediction of the performance of an algorithm on realistic inputs.

As mentioned before, an important innovation is the start of the Laboratory for Quality Software, for methods of design, verification and validation of high quality software systems. The laboratory has formulated the following goals:

- to generate new research through empirical studies;
- to improve internal cooperation;
- to improve education through student participation in large-scale system development projects;
- to achieve mutually beneficial knowledge exchange with industry through hands-on experience.

One of the activities in the laboratory will be the development and maintenance of a toolset that supports the methods the department produces. The toolset will contain design tools and tools for verification and validation. Experiments will be set up to test these methods in practical environments and to verify and validate concrete software systems. The Laboratory will publish evaluations of methods, quality software systems and software patents. Certification of industrially designed or developed software will be one of the sources of income for the laboratory. It is expected that in the next four years the laboratory will grow to fifty permanent fte researchers and a number of Ph.D. students. All groups of the department will be involved in this laboratory. The director of this laboratory has a background in industry. The coupling of formal methods to real software process needs more emphasis and this laboratory is an excellent move in that direction.

Overall score for the institute: very good

## **TUE1: Formal Methods**

program leader: prof. dr. J.C.M. Baeten  
research input 2001: 14.70fte

research program: very good  
quality: very good  
productivity: good  
relevance: very good  
vitality and feasibility: very good

The area of Formal Methods concerns fundamental research and considers system constructions in computer science. These constructions are described precisely in a formal syntax and are supplied with a formal semantics whenever appropriate. The practice of computer science inspires the choice of research topics. The tools that are developed are intended for use in practice. For the reporting period, the main areas of interest are: process theory, theorem proving and type theory, verification and testing and specification languages.

This group has a clear vision and is ambitious. Under energetic and encouraging leadership, they follow their own course, getting the maximum out of process algebra. Their international reputation is strong. They are aware who their competitors are. The group has a good record in Ph.D. recruitment. One of the problems of this group could be its small size in comparison to the many topics it has to deal with. The director is conscious of this imbalance. They play a very positive role in the formation of the Quality Software Laboratory, which is very positive.

## **TUE2: Software Construction**

program leader: prof. dr. B.W. Watson  
research input 2001: 2.80 fte

research program: good  
quality: good  
productivity: very good  
relevance: good  
vitality and feasibility: good

In March 2001, the Programming Methods group was dissolved and a new group on Software Construction was constituted – coinciding with the appointment of prof. B.W. Watson. The discontinuity in the research is significant. Only two research themes have been retained: the work on taxonomies, toolkits and component-family-architectures; and the work on type systems and lambda calculi.

The current program director has inherited a troubled group but is doing a good job in reshaping it. The Committee appreciates the broad spectrum covered by this program. While the group inherited a strong scientific tradition, they should also be open to complementary inputs from other traditions. The tools this group develops are used in industrial contexts and technology transfer is encouraged. The group has successfully identified important niches where formal methods can be applied in practice on an industrial scale. In addition, a taxonomy-based composition (such as XML) could be applied; the group should look at composition in commercially sized systems.

The grade for productivity relates to the current situation, which has improved considerably in comparison to the past.

### **TUE3: Parallel Systems**

program leaders: prof. dr. P.A.J. Hilbers, dr. J.J. Lukkien  
research input 2001: 11.10 fte

research program: good  
quality: good  
productivity: very good  
relevance: very good  
vitality and feasibility: good

Until 2001, the research themes of this group were delay-insensitive systems and VLSI-programming, large-scale scientific computing and heuristic search. Over the past years, there have been many personnel changes in this group. Prof. dr. C.H. van Berkel from Philips Research has joined the group as a part time professor, working on VLSI programming. Prof. P.A. Hilbers has been active in building a strong group around large scale scientific computing, in particular in Chemistry and Biology, where they had a very strong reputation. Currently, in the absence of a full professor, Dr. J.J. Lukkien is head of the group. Profs. Van Berkel and Aarts work 0.2 fte for this group.

With the transfer of prof. Hilbers to Biomedical Engineering, the focus of the Parallel Systems group will move in the direction of system architecture and networks, and a new chair for the group will be recruited from this area. The research in VLSI programming and scientific computing has been phased out.

This group is involved in several national and international research programs, funded mainly by NWO and STW. A significant amount of work was funded through industrial channels in cooperation with companies such as Philips, TNO, VDO/Dayton and others.

In the next years, the major research themes for this group will be system architecture and networking. With regard to system architecture, this includes exploration of the design space of hardware/software systems at architectural level, in particular with respect to non-functional requirements (timeliness, energy consumption and area). The emphasis will be on embedded software, and they remain especially interested in the penetration of high-level techniques into hardware design. In networking, the group studies embedded intelligence: the automatic and autonomous cooperation of networked devices sharing resources in a transparent manner.

The Committee concludes that this group is very active with a high publication rate. However, the scope is too wide and the new focus is not yet clear. On embedded systems, other groups have already done a large amount of work. The added value of this particular group is not clear. That can also be said for this group's work on real-time networking and networked systems.

### **TUE4: Visualisation**

program leader: prof. dr. ir. J.J. van Wijk  
research input 2001: 2.80 fte

research program: satisfactory  
quality: good  
productivity: good  
relevance: good  
vitality and feasibility: satisfactory

The mission of the former Computer Graphics group of the Faculty of Mathematics and Computer Graphics has dramatically changed in the period 1996-2001. In June 1998, prof. J.J. van Wijk succeeded the previous research director, Dr. C.W.A.M. van Overveld, first as an associate professor, and, since October 2001, as full professor. The previous research program focused on animation and geometric modelling. The university considered this a highly competitive field with limited direct applications in the Netherlands. The new director started a new research program, based on his own knowledge and experience and changed the name of the group to Visualisation.

The program leader is doing high quality research in the domain of visualization, although its scientific focus is not clear. There have been publications in important conferences like Siggraph, but more publications in journals are recommended. Although the productivity of the group as a whole is good, considering its size, this is mainly due to the program leader. The productivity of other members of the group is significantly lower. However, there are clear signs that this situation has improved since 2001. The leadership could be improved; the program director is focusing on his own research, but is not so keen on expansion. Perhaps this is the reason that the group has difficulties in attracting external funding. Presently, the group is too small and needs to expand to reach critical mass. Its cooperation with other groups is a positive factor. The group needs a stronger interaction with application groups, leading to external validation. The group should develop its methodology in the context of applications.

### **TUE5: System Design and Analysis**

program leader: prof. dr. ir. J.F. Groote  
 research input 2001: 7.30 fte

research program: good to very good  
 quality: good  
 productivity: good  
 relevance: very good  
 vitality and feasibility: good

In 1996, the focus of the System Design and Analysis group was object orientated design, real time operating systems, off- and on-line scheduling, and formal description and design techniques. After approximately one year, research on real-time operating systems was terminated because various systems became commercially available. Around 1998, object-oriented design techniques were succeeded by the higher-level concept of component wise design and structural architecture. In 2000, prof. J.F. Groote succeeded prof. D.K. Hammer. By now, virtually the whole staff has been refreshed over the years. Consequently, a shift towards the analysis of the behavioural aspects of architecture has taken place.

This group now has a strong energetic leadership with a clear mission and strategy; however, it should be noted that the task of leading a group can be delicate. The group is working on an ambitious project and the concreteness of the application projects tackled is very good. Their interest in legacy software and software renovation is also positive. The participation of the program leader in the new Quality Software Lab is seen as a very positive contribution to the department.

The use of formal methods should be integrated with the design practice and design process, which may include investment in interfaces, methodology and tools. To be successful the group needs to be pragmatic and look at the intersection of formal methods and the practice of software engineering. They are on the way to this goal and the Committee would wish to encourage them. The Committee hopes that the increased scientific personnel will also lead to increased publication output.

## TUE6: Information Systems

program leaders: prof. dr. P. de Bra, prof. dr. K.M. van Hee  
research input 2001: 9.10 fte

research program: very good  
quality: good  
productivity: very good  
relevance: very good  
vitality and feasibility: very good

Until 1996, the research in the Information Systems group consisted of a single program led by prof. dr. K.M. van Hee, in which prof. dr. P. de Bra participated as associate professor. In 1994, Van Hee started the SMIS subprogram. In 1996, Dr. Ir. W. van der Aalst, a former Ph.D. student of Van Hee, was appointed as associate professor and he became the leader of the SMIS subprogram. At the same time in 1996, De Bra was appointed as full chair in the Information Systems group on Databases and Hypermedia, and he became the formal leader of the AWIS subprogram (Adaptive Web-Based Information System Design). In 2000, Van der Aalst was appointed as full professor in ICT in the department of Technology Management and to a part-time position (0.2) in the department of computer science where he continues his work on the SMIS subprogram. In 2001 it was agreed that Van Hee will gradually extend his activities as professor and will be a full-time professor again in 2004, renaming the SMIS chair into Architecture of Information Systems.

This group provides solutions for business-oriented problems with formal frameworks, such as petri-nets, business processes and web-based systems.

The group has a clear vision. There is strong cooperation between the two professors. They have good view of competitors and other research groups. There is a good balance in the funding of the research projects. The group knows when to apply what. The Committee suggests that they might get involved in standardization and keeps track of developments, particularly in web services.

The research has led to a good output of papers and downloadable tools. Their widening of the scope of formal methods is refreshing. The Committee hopes that they continue these joint projects (merging of tools for workflow and web) and encourages cooperation with the planned Quality Software Lab.

## 4.2 University of Nijmegen

*Nijmegen Institute for Computing and Information Sciences*

<b>Assessment 1996</b>	<b>Assessment 2001</b>
Computers and Mathematics prof. dr. H.P. Barendregt, prof. dr. O.A.H. Axelsson, prof. dr. W.H.M. Levelt	Foundations prof. dr. H.P. Barendregt
Software Engineering prof. C.H.A. Koster dr. ir. H. Meijer, prof. dr. ir. M.J. Plasmeijer, dr. ir. Th. P. van der Weide	
	Software Technology prof. dr. ir. M.J. Plasmeijer
	Information Retrieval and Information Systems prof. dr. ir. Th. P. van der Weide
Informatics for Technical Applications prof. dr. F.W. Vaandrager	Informatics for Technical Applications prof. dr. F.W. Vaandrager

Partly in reaction to the last quality assessment of computer science research, the faculty decided to realign the research activities within the department. Another important reason for reorganizing the research activities was the joining of the faculty of Science and the faculty of Mathematics and Computer Science. In 1996, there were six research lines in computer science that were organized in three programs, one of which was interdisciplinary with Mathematics. It was decided to reduce the number of research lines from six to four; each line becoming a separate research program. The department seems to have overcome these organizational difficulties, and it has emerged much strengthened.

From the 1996 program Software Engineering, consisting of the three research lines Functional Programming Languages, Information Systems and Programming Methodology; the first line has developed into the program Software Technology, the second line into Information Retrieval and Information Systems (recently renamed *Information and Knowledge Systems*). The third line has been phased out. In 1996, the program Informatics for Technical Applications (ITA) consisted of two research lines: Experimental Informatics for Technical Applications and Theoretical Informatics for Technical Applications. ITA was reorganized into two new subprograms: *Real-Time and Hybrid Systems* and *Security of Systems*. From the multi-disciplinary program Computers and Mathematics (with Mathematics), the part that was already residing in the computer science sub-faculty was turned into the program Foundations.

The Nijmegen Institute for Computing and Information Sciences (NIII) is developing and exploring formal methods for various areas of software technology. The institute is showing outstanding internationally recognized work in fundamental areas of theoretical computer science, such as work on the lambda calculus and term-rewrite systems. It also shows very effective use of formal methods in embedded systems and security. The issue of security is strategically very important and well chosen. The work is of a high quality and deserves a higher profile. Although the research deals with interesting topics, the department has problems in attracting Ph.D. students. The institute is not doing too well in external funding. This situation might be improved by increasing the efforts in recruitment and in external communication of the research topics to other faculties.

*Recent developments*

A prominent change has been the introduction, in 2001, of a new curriculum in Information Science, which aims at bridging the gap between technology and the environment (organizations, users) in which it functions. It was decided not to erect a separate research program in Information Science, but to place this research within the existing programs Information Retrieval and Information Systems (IRIS) and Software Technology (ST). To emphasize the broadening of education and research into Information Science, the sub-faculty Computer Science was christened NIII in 2001.

Overall score for the institute: good to very good

## **KUN1: Foundations**

program leader: prof. dr. H.P. Barendregt  
research input 2001: 7.08 fte

research program: very good  
quality: excellent  
productivity: satisfactory  
relevance: very good  
vitality and feasibility: good

The group is world leading in lambda calculus and term rewriting systems and is very strong and original in theorem proving aspects. This is a very strong research program with high visibility internationally. The leadership of Barendregt is outstanding. Since his Spinoza award, he has given up his management and educational tasks, to be able to devote all his time to research, including the supervision of junior researchers and the directing of research; he will remain program director. Presently, a new professor is sought, as managing director. The program has a strong tradition and has translated this into clear mission and goals. There is a clear ambition to produce results that have a long-term impact. The group has focused on quality instead of quantity.

The work of this group is highly relevant not only for the mathematical foundations of computer science, but also in applications. Results are being widely used by many other groups in theoretical computer science and programming languages. The expectation is that the ties between this group and the researchers from computer algebra, in the Mathematics Department, will be strengthened.

## **KUN2: Software Technology**

program leader: prof. dr. R. Plasmeijer  
research input 2001: 3.57 fte

research program: satisfactory  
quality: good  
productivity: satisfactory  
relevance: good  
vitality and feasibility: satisfactory

This program deals with functional programming. This research is of high value but may be too narrowly focused. The relevance of the research program should be improved by broadening the scope beyond the specific functional programming language considered in the group. Perhaps the group should have more links with other theoretical groups in the department, maybe even merge, so that they could broaden the scope of theoretical inputs and contribute. It may be important to look for serious applications and make contact with new communities where these techniques could be applied. There is a high quality work on implementation, but techniques and approaches developed in the implementation of functional programming could be carried over into other widely used programming frameworks.

The group has been underperforming in terms of scientific publications, which puts it at risk for the future. There should be more emphasis on high quality publication, particularly in journals.

### **KUN3: Information Retrieval and Information Systems**

program leader: prof. dr. T. van der Weide  
research input 2001: 2.77 fte

research program: good  
quality: good  
productivity: very good  
relevance: good  
vitality and feasibility: very good

Information retrieval is a very important area. The research of this group centers on the theme of knowledge-intensive systems drawing upon ideas, methods and techniques from information systems and artificial intelligence research. The areas of application range from business and information technology to biomedicine. These areas can also offer a basis for empirical validation of some of the research ideas. This is the case with this group's research on architecture and research alignment. Questions from the IT industry guide this research. In other cases, there is collaboration with biomedical and clinical researchers, who play an essential role in choosing the right research focus. The group seems to be in a transition phase but is currently positioning itself in the area of knowledge-intensive information systems. The general direction is good, although the research seems to need more focus. This lack of focus is the consequence of the recent influx of new staff members and measures are taken to increase the convergence in research. The group has been relatively successful in fundraising and in making contact with IT companies: the last couple of years the group has doubled. These are clear signs of the group's vitality. Still, large-scale empirical validation is needed, as is implementation. The group has a well-thought out scheme for supervision of doctoral students resulting in a high completion rate. The quality of scientific publications is good. A large variety of papers is being published. The productivity is high with respect to the staff.

### **KUN4: Informatics for Technical Applications**

program leaders: prof. dr. F. Vaandrager, prof. dr. B. Jacobs  
research input 2001: 11.52 fte

research program: excellent  
quality: very good  
productivity: satisfactory  
relevance: excellent  
vitality and feasibility: very good

This program is divided into two subprograms:

- Real-Time and Hybrid Systems
- Security of Systems

Both are very important area where formal methods can make an important difference. Security is obviously a key critical area of computer science today and this group is making significant contributions to it. The quality of the research is very high. There is a combination of mastery of formal methods and excellent application down to practical use. The program manifests strength and vitality. This is a strongly-focused group with good balance between external funding and internal research. The group participates actively in European research programs and has a strong academic reputation. There are opportunities for leverage, for instance the work on security could be expanded to cover more aspects of security. The Committee invites the group to play a more active role on any national initiative related to security issues in the Netherlands and in any case expects the group to play a significant role internationally.

### 4.3 University of Maastricht

*Institute for Knowledge and Agent Technology*

Assessment 1996	Assessment 2001
Computer Science prof. dr. H.J. van den Herik, prof. dr. P.T.W. Hudson, prof. dr. H. Visser, dr. P.J. Braspenning	Knowledge and Agent Technology prof. dr. H.J. van den Herik

The Institute for Knowledge and Agent Technology (IKAT) at the university of Maastricht is a department with one research program divided into four subprograms:

- Agent Technology (AT)
- Neural Networks and Adaptive Behaviour (NNAB)
- Search and Games (S&G)
- Knowledge Management (KM)

The goals of this institute are:

- to be recognized as a top institute in these areas;
- to be the best institute for education in knowledge engineering in the Netherlands;
- to have an extensive national and international network;
- to be recognized by the public sector;
- to be 'a source of inspiration'.

The research in the AT group emphasizes the specification of intelligent agents. The NNAB group focuses its research on intelligent robots and intelligent systems for knowledge discovery and data mining. The S&G group develops and applies intelligent search techniques to a wide variety of games. Finally, the KM group disseminates the techniques and knowledge gained in the other three groups to society.

Right from the beginning in 1987, the research profile of the department of computer science in Maastricht was in the domain of artificial intelligence. The focus was on research on computer games (chess). Program leader Van den Herik launched a second line of research, applying neural-network research to games. This research has been raised to a higher level of biologically inspired adaptive behaviour. The third line in artificial intelligence research deals with the question of computers acting as legal agents.

The research program of IKAT originated from the NOAG-i theme *Knowledge Disclosure* as defined in 1997. IKAT's present research program is best characterized by the novel NOAG-i theme Intelligent Systems. Hence, the program development follows the development of themes as defined by the NOAG-i, 2001. The study, development, and applications of artificial-intelligence techniques are now a common theme in all four research groups.

The department has a *Public-Services group*, involved in applied research for societal institutions and companies. It aims at the dissemination of knowledge and raising external funding.

There is a strong leadership in this department and very clear management.

The group has excellent quality and leadership in the domain of games, which it is trying to apply also in other areas. A lot has been done with limited resources due to strong research focus. For future growth, it is desirable to diversify more aggressively in new areas and create additional leaders that can autonomously explore new areas.

The department suffers from being at a university that is not strong in other Natural Sciences; computer science is quite small due to a small influx of students. Recently, there have been some organizational difficulties, which now seem to have been overcome. Contacts with medical, legal or other departments inside the university are further encouraged. It may be interesting to bring together all computer science of the university into one department.

The attraction of outside funding is very good, which points to a good societal relevance of research. Particularly applications in public services and knowledge management are of great importance.

Overall score for the institute: good to very good

## UM1: Knowledge and Agent Technology

program leader: prof. dr. H.J. van den Herik  
research input 2001: 8.37 fte

research program: good  
quality: very good  
productivity: excellent  
relevance: very good  
vitality and feasibility: good

Neural Networks and Adaptive Behaviour aims at gaining a deeper understanding of natural intelligence (i.e., visual perception, memory, and action), by developing and studying adaptive models that serve as part of artificial sensory-motor systems. The research also aims at applying machine learning to tasks that require natural intelligence. The group deals with the fundamentals of neural networks and machine learning, novel neural networks and machine-learning structures and applications. Since 2001, the research is focused on situated-agent and machine-learning research. In the future, the group hopes to apply the results of their research in commercial computer games and to continue with fundamental and applied research in machine learning.

This is a strong research program in the field of games. The research in adaptive behaviour has a clear theme and already concrete research results.

The Agent Technology group focuses on communication and coordination among agents. Over the past years it has dealt with:

- reasoning processes of communicating agents;
- ability of an agent to collect information on behalf of its users;
- formalization of the behaviour of collaborating and communicating agents;
- evolution of an agent language within a group of communicating agents;
- the repair of infringed schedules.

Current research is about interoperability, diagnosis and repair and agent-based information retrieval.

The subprogram Knowledge Management aims at gaining understanding of methods of management and exploitation of knowledge. The group also works on facilitating enterprises with knowledge management strategies, and applying new solutions, tools and technology. Together with DSM, a multinational life-sciences company, they have worked on e-collaboration and are now working on automatic categorization and personalization. Other projects deal with the exchange of knowledge between actors in a supply-demand chain and the implications of ICT in legislation. There is a strong continuity in these themes for the next years.

Areas like Agent Technology and Knowledge Management are developing, but have not yet reached the same level of excellence. They need to be cultivated and matured. The cooperation with other universities in the Netherlands appears to be very strong. Activities in knowledge management have the potential for cross coupling between programs and stronger links with other faculties of the university, such as economics.

Search and Games deals with:

- developing new techniques, in particular intelligent search techniques, for complex state spaces in the domain of games;
- combining search-based techniques with machine-learning techniques;
- investigating and solving particular games.

During the last years, the group has worked on the development of intelligent search techniques, on obtaining perfect and heuristic knowledge and mathematical game theory. For the future, they are looking for a combination of machine learning and intelligent search. They will also do research in imperfect-information games, multi-player games and complexity steps in games.

In general, the research could be pushed more strongly towards innovation and originality, particularly in the subprograms not concerned with games. The potential of expertise on computer games is immense, but the group seems to be too small to benefit from this. The vitality of the group depends critically on the strong leader.

## 4.4 University of Amsterdam

*Department of Computer Science*

<b>Assessment 1996</b>	<b>Assessment 2001</b>
Algorithmics and Complexity prof. dr. P. Vitanyi	Algorithmics and Complexity dr. P. van Emde Boas
	Constructive and Intensional Logic prof. dr. J.F.A.K. van Benthem, prof. dr. D.H.J. de Jongh
Intelligent Autonomous Systems prof. dr. F.C.A. Groen	Intelligent Autonomous Systems prof. dr. F.C.A. Groen
	Language and Inference Technology dr. M. Masuc, dr. M. de Rijke
Methods for Parallel Computing dr. P.M.A. Sloot	Computational Informatics prof. dr. P.M.A. Sloot
Programming Environments prof. dr. P. Klint	Programming Methods and Environments prof. dr. J.A. Bergstra, prof. dr. P. Klint
Intelligent Sensory Information Systems prof. dr. ir. A.W.M. Smeulders, prof. dr. M.L. Kersten	Intelligent Sensory Information Systems prof. dr. ir. A.W.M. Smeulders
Parallel Systems Architecture prof. dr. L.O. Hertzberger	Advanced Computing Systems Engineering prof. dr. L.O. Hertzberger

A leading conception structuring the research at the University of Amsterdam is the view that informatics is a unifying paradigm between the Humanities, the Natural and Social Sciences. This leads to a broad spectrum of potential research and areas of application. The computer science department covers eight major research areas, positioned in two institutes: the Informatics Institute (II) and the Institute for Logic, Language and Computation (ILLC). The subjects show a broad variety but, disparate though these activities are, there is inter-group and inter-institutional collaboration. Since 1998, several activities have been embedded in multidisciplinary centers – project driven organizations that are financed by several research institutes and the Cognitive Science Center Amsterdam.

### *Informatics Institute*

The central theme of the institute is complex information systems. The research is organized in five groups, each with their own focus and program. The size of each group is relatively small (generally 1 full professor, 2.5 associate/assistant professors and 1 Ph.D. student). External funds are necessary to create sufficient momentum. In some of the groups only 10% of the income are university funds. Recently the groups in the institute have been clustered into two laboratories (Computing System Architecture and Programming, or CSP and Multimedia and Intelligent Systems, or MMIS). The intention of this is to strengthen the coherence in the scientific programs of the institute.

Prof. P.M.A. Sloot is head of the laboratory on CSP. This laboratory consists of the research groups:

- Computer Architecture and Parallel Systems
- Computational Science
- Programming Research

The focus of this laboratory is on complex system architectures. Main themes are the integration of data modules, the integration of architectures of computer systems, the integration of parallel and distributed computation models and the integration of software systems. Part of CSP will be the Virtual Laboratory, a new project, funded by Bsik. In this project, the Advanced Computing Systems Engineering Program is developing a hardware and software reference architecture and laboratory framework to enable scientists and engineers to work on their problems via experimentation, making use of modern information technology. To that end, three virtual laboratory domains are being developed: for experimental physics, for bio-informatics and laboratory framework to enable scientists and engineers to work on their problems via experimentation, making use of modern information technology. To that end, three virtual laboratory domains are being developed: for experimental physics, for bio-informatics and biomedicine and for systems engineering. Prof. L.O. Hertzberger will be scientific director. CSP is also involved in two other Bsik projects: MultimediaN, on multi-media (scientific director prof. A.W.M. Smeulders) and ICIS, in cooperation with the University of Delft.

Prof. A.W.M. Smeulders heads the laboratory of Multimedia and Intelligent Systems, which consists of the research groups:

- Intelligent Sensory Information Systems
- Intelligent Autonomous Systems
- Internet Information (still under construction)

The focus of this laboratory is on complex data- and information structures. Primarily questions about integration of information, levels of representation and interaction between components and the real world are addressed. Main themes are the integration of different information modules, integration of different information sources and integration of information acquisition and information based action.

A third laboratory is being developed in the Informatics Institute: the SWI (Social Science Informatics). This laboratory, headed by prof. B.J. Wielinga, will be transferred from the Faculty of Social and Behavioural Sciences to the Faculty of Science.

#### *Institute for Logic, Language and Computation*

ILLC's research is interdisciplinary. Its scientific mission is to study formal properties of information, viz the logical structure and algorithmic properties of processes of encoding, transmitting and receiving information, and the use of information in classification and reasoning. Researchers pursue these goals in close interaction with neighbouring disciplines in which the same or similar concepts play a central role. The research is organized in five projects:

- Algorithmics and Complexity Theory
- Constructive and Intensional Logic
- Language and Inference Technology
- Theory of Interpretation
- Cognitive Systems and Information Processing

The last two are outside the scope of this assessment.

The department has a great diversity of research topics and has achieved a very high reputation in several of them. This diversity makes hard to identify the central vision of the department for the future of computer science. However, the diversity also leads to great success in attracting outside funding, which has provided the opportunity to enter two new areas: multi-media and virtual laboratories (e-science). However, this creates the risk that the externally controlled financing pushes the department too much in the direction of application-oriented research, which puts theoretically founded or innovative pure research at risk.

There is strong interaction with the Dutch National Research Institute for Mathematics and Computer Science (CWI), which gives the department a competitive advantage, compared to other universities; specifically it distorts to some extent productivity measures.

The Committee sees value in simplifying the structure of the department to push leadership and strategy closer to the research levels and reduce overhead. An organization of groups into laboratories seems a good way to achieve this. The Committee encourages breaking barriers between the institutes, for example combining efforts of the Intelligent Sensory Information Systems group and the Language and Inference Technology group into the MMIS, or the Computational Informatics and Algorithms and Complexity group into the Virtual Laboratory.

On the other hand, the Committee observes a somewhat excessive fragmentation of research into small research groups. Following this trend can be, in the long term, a potential risk for the quality of research. In fact this can make research activity within individual groups self-referential and reduce the exchange of ideas and know-how between the researchers. It also reduces the capability of impact, especially for applied research activities.

Overall score for the institute: very good

### **UVA1: Algorithms and Complexity Theory**

program leader: dr. P. van Emde Boas  
research input 2001: 1.54 fte

research program: good  
quality: very good  
productivity: excellent  
relevance: good  
vitality and feasibility: satisfactory

The general themes of the Algorithmics and Complexity Theory project are algorithmic methods and complexity analysis. Specific subjects are quantum information processing, computational learning (in cognition and artificial intelligence), network algorithms, computational complexity theory, descriptive complexity theory and its applications, and computational game models. The goal of this group is to focus on algorithms and complexity including quantum computation. They act as a facilitating group that has many interactions with other groups in the department. It contains a number of strong researchers and has a lot to contribute. Inspired by the vision of Informatics as a unifying paradigm, their activities range from theoretical work on complexity to practical applications including in a variety of domains such as language learning and biological processing. The group is small with many part-time researchers. A new leader could guarantee its vitality in the future. The group could benefit from a stronger integration, on one location, with the main body of computer science in the Informatics Institute.

### **UVA2: Constructive and Intensional Logic**

program leaders: prof. dr. J.F.A.K. van Benthem, prof. dr. D.H.J. de Jongh  
research input 2001: 2.90 fte

research program: very good  
quality: very good  
productivity: good  
relevance: good  
vitality and feasibility: good

The Constructive and Intensional Logic group has a long-standing excellent reputation in the field of pure and applied logic, with applications in a wide range of fields, including natural language. They deal with mathematical logic and the foundations of mathematics, in particular constructivism and proof theory. The second theme is a broad study of modal

and dynamic logic. Both themes meet in research on provability logics of arithmetic and modal logics of information and information flow. There have been some fine recent achievements, including recent work in fragments of first order logic. The group has a wide network of international contacts. Only part of its activity has a direct connection to computer science. The group has a wide perspective on logic and its application and this is reflected in the attitude towards Ph.D. students, encouraging them towards strong independence. The group seems in a transitional phase but has a good strategy to manage the transition.

### **UVA3: Intelligent Autonomous Systems**

program leader:            prof. dr. ir. F.C.A. Groen  
 research input 2001:      6.18 fte

research program:        good  
 quality:                    very good  
 productivity:              good  
 relevance:                 very good  
 vitality and feasibility:   good

This group studies methodologies to create intelligent autonomous systems, which obtain their information from sensors and use that information to generate intelligent, goal-directed actions. They may be single entities or cooperating multi-agent systems, and they must operate in the real world, inhabited by humans and other agents. The research focuses on new methods that inherently incorporate this real-world structure, in order to produce data processing and modeling that is robust to noise and computationally efficient.

This group is focusing on very specific topics in the domain of intelligent autonomous systems, with the goal of having them capable to learn and adapt to the environment and to solve problems by coordination in a multi-agent system. The group has clear strength in some areas such as appearance models and coordination graphs. Success in the Robocup is an indicator of the effectiveness of these research results. The group has strong external funding. This has steered them into focused applications, however a better balance with fundamental research may be desirable. The research cooperation with TNO gives the group an interesting competitive advantage.

### **UVA4: Language and Inference Technology**

program leaders:         dr. M. Masuc, dr. M. de Rijke  
 research input 2001:     9.67 fte

research program:        good  
 quality:                    good  
 productivity:              excellent  
 relevance:                 very good  
 vitality and feasibility:   good

The Language and Inference Technology group researches intelligent information retrieval which uses inference and language technologies: representational and algorithmic aspects of computational linguistics and computational logic, with a strong emphasis on mechanizing and evaluating language processing and inference methods. They explore new applications for automated reasoning and language technology and comparing and refining existing methodologies.

There seems to be a major change between the review period working on broader topics and the current period, with a narrower focus. The group seeks an interesting balance between theory, experiment, and application. It has become a very coherent team. The group has strong external funding but lacks sufficient permanent staff. A full professor is

required. Although this group is located within the ILLC, there would be value in integrating this group geographically and organizationally with other groups in the Informatics Institute, particularly in the MMIS-laboratory (Multimedia and Intelligent Systems).

#### **UVA5: Computational Informatics**

program leader: prof. dr. P.M.A. Sloot  
research input 2001: 7.10 fte

research program: very good  
quality: very good  
productivity: very good  
relevance: very good  
vitality and feasibility: very good

The research deals with the question how macroscopic processes emerge from local microscopic rules and interactions. It is inspired by the paradigm of complex systems. This group focuses on cellular automata models. It addresses issues of how physical and biological problems can be formulated in this framework and how they can be mapped on distributed architectures and grid computers. The applicability of this research is validated through the development of high-performance problem solving environments for asynchronous natural processes. The group has adequate resources to explore parallel computing. It has a clear vision and strong contacts with the outside world. It takes a very proactive stand, also with respect to the new e-science Virtual Laboratory. The work has a strong theoretical foundation as well as strong coupling to applications.

#### **UVA6: Programming Methods and Environments**

program leaders: prof. dr. J.A. Bergstra, prof. dr. P. Klint  
research input 2001: 3.48 fte

research program: good  
quality: good  
productivity: good  
relevance: good  
vitality and feasibility: good

This group consists of two subgroups: Programming Methods and Programming Environments. The first one deals with the design and systematic use of algebraic methods in specification languages, modeling of processes, and program transformations. This project primarily aims at the transfer of results to the scientific literature and education. The second subgroup, Programming Environments, concentrates on the generation of programming environments from a formal language definition, in particular generic user-interfaces and implementation and integration of distributed, interactive systems. This project has produced several systems that have been distributed to the computer science community. Most of the people of the Programming Environments subgroup have left the UvA in 1999. The corresponding research activities are continued at the CWI, and at a small scale, at the UvA. Two scientists with an excellent record of accomplishment lead the programs. From 1998 until 2000, there was a third subprogram, Life Cycle Enabling, with the aim of developing tools and methods to support the software life cycle. More specifically, it concentrated on the development of a process for the introduction and employment of tool support for automated modification of legacy systems. This program was led by Dr. C. Verhoef until he became professor at the Vrije Universiteit in 2000. Since then, this research has been discontinued.

Despite the importance of this field for computer science and its applications, it has been difficult to attract external funding. It also has been difficult to attract a new generation of students. This suggests that the group needs to reposition itself with respect to the Dutch context and with respect to the field of software engineering as a whole.

### **UVA7: Intelligent Sensory Information Systems**

program leader: prof. dr. ir. A. Smeulders  
research input 2001: 11.48 fte

research program: very good  
quality: very good  
productivity: excellent  
relevance: excellent  
vitality and feasibility: excellent

The main goal of this group is to bridge the semantic gap between pictorial data and the interpretation of the data. They do so in two ways: (1) based on the image driven interpretation by computer vision, as well as based on the knowledge about the image, designing algorithms of image analysis, experimenting on visual data, and (2) learning from (very) large image databases. The research ranges from the theory of computer vision to applications in digital document structure analysis, video analysis, colour image analysis and picture search engines.

They have built up a good reputation and achieved clear successes, such as the VLDB Best Paper Award in 1999. They are now exploring new challenges in the interaction between language and computer vision with great vitality.

The group has taken a leadership role in the new multi-media laboratory (MMIS) and in setting up multi-media research in the Netherlands. The group has been very successful in raising external funding and has a good strategy for mobility and overcoming the rigidity of the Dutch employment system.

### **UVA8: Advanced Computing Systems Engineering**

program leader: prof. dr. L.O. Hertzberger  
research input 2001: 8.50 fte

research program: good  
quality: good  
productivity: satisfactory  
relevance: good  
vitality and feasibility: good

The underlying theme of this research is to derive inspiration from problems that are relevant to society. The methodology applied is to identify relevant problems that give rise to challenging research questions. Collaboration with industry and government agencies is therefore essential for this group. In their research, they restrict themselves to methods and tools for complex, typically parallel/distributed, computing systems design and realization. The research activity comprises two major tracks: *Methods* and *Tools* for (embedded) computing system design concentrates on modeling and simulation of complex computer-based systems with the aim to predict performance. *Advanced Information Management System Support* focuses on the design and the prototypical development of database systems to support the classification and manipulation of the information handled within advanced and complex data-intensive applications.

This group has made important contributions into different application areas and some of the work is picked up by industry. The group is now moving into managing large-scale information systems for experimental science. The group is in a transition period: activities are progressively being transferred to other groups, particularly into the Virtual Laboratory.

## 4.5 Vrije Universiteit Amsterdam

### *Department of Computer Science*

<b>Assessment 1996</b>	<b>Assessment 2001</b>
Design Methods for Knowledge Based Systems prof. dr. J. Treur	Artificial Intelligence prof. dr. J. Treur
Software Engineering	Information Management and Software Engineering prof. dr. J.C. van Vliet
Computer Systems prof. dr. A.S. Tanenbaum	Computer Systems prof. dr. A.S. Tanenbaum
Theoretical Computer Science prof. dr. J.W. de Bakker, prof. dr. J.W. Klop	Theoretical Computer Science prof. dr. J.W. Klop
Information Systems prof. dr. R.P. van de Riet, dr. W. de Jonge	

Since 1996, there have been two reorganizations of the embedding of computer science at the Vrije Universiteit. Since 2002, the Department of Computer Science has been part of the Faculty of Sciences; therefore, it is the unit for this assessment. The most noteworthy changes in the Department of Computer Science have been the forming of new groups in Parallel Programming (headed by prof. H.E. Bal of Computer Systems), Business Informatics (headed by prof. J.H.M. Akkermans of Information Management and Software Engineering), Intelligent Interactive Distributed Systems (headed by prof. F.M. Brazier of Artificial Intelligence), and Computational Intelligence (headed by prof. A.E. Eiben of Artificial Intelligence). Furthermore, the professor of Information Systems, prof. R.P. van de Riet retired. His successor is prof. C. Verhoef (Information Management and Software Engineering). In addition, prof. J.W. de Bakker of Theoretical Computer Science has retired. His successors are prof. W. Fokkink and prof. J. Rutten.

In 2000, a Bioinformatics unit was established within the department. This unit is part of the Integrative Bioinformatics Institute VU (IBIVU), founded by the Faculty of Sciences and the Faculty of Earth and Life Sciences. The research of IBIVU is interdisciplinary in nature, guided the needs of the participants. Head of both IBIVU and the Bioinformatics unit in the Department of Computer Science is prof. J. Heringa. This group has become operational as of September 2002 and is currently developing methods to analyze sequence data and predict protein structure and function. Other subjects for research are tool creation and optimization, data/method/model integration and comparative genomics/ gene prediction.

In order to rejuvenate the department, the management has paid serious attention to achieving diversity in personnel ages, and a harmonious cooperation among the staff. There is a healthy management structure, which promotes communication.

The research of the Department of Computer Science aims at a better understanding of the foundations, mechanisms, and technologies that are needed to develop and deploy information and computing systems that are characterized by their complexity. Much of the research concentrates on Internet-based information and computing systems, and involves questions related to multi-agent systems, semantic web, e-business, grid computing, and scalable middleware. Another field of research activities, and which partly overlaps the previous one, is that of large-scale information systems in which research is concentrated on methods to improve the development and deployment of such systems, as in re-engineering, software architectures, human-computer interaction and scalable verification methods. In all cases, the inherent complexity of the problems investigated plays a key role and is a source of inspiration. Much of the research has a multidisciplinary approach.

The current main strength of the department is in Computer Systems and Artificial Intelligence. There is extensive industrial cooperation with service industries and government agencies. The department is also strong in multi-disciplinary activities across other departments inside and outside the faculty. This is most notably true for research related to application domains such as e-business or bio-informatics, but also holds for projects in human-computer interaction and agent technology (cooperation with psychology), software asset management (cooperation with economy) and scientific visualization (cooperation with physics).

The budget of the department strongly depends on students, which makes it vulnerable to fluctuations in the number of students. The department compensates for this fluctuation by obtaining external funding. The capability of attracting funds from industry has been definitely very good, although it is present only in some research groups. On average, the amount of contract research per staff member in 2001 is good: The income is largely allocated to permanent staff positions so that to avoid unbalance between educational pressure and research activity of the staff. Also, the human resource policy appears to be good especially in the attention dedicated to PH.D. students. The staff has grown in a balanced way in the different areas.

There is a lack of effective administrative support at the faculty and university level for large-scale external projects – which is really necessary to meet the current funding demands. The department has insufficient control of their IT infrastructure.

There is some discrepancy between the different research programs in the achievement of goals and objectives. In particular, both productivity and quality of research does not appear to be uniform in the different research programs. In some of them quality should be improved by changing the strategy of publication and increasing the presence of the researchers in top journals.

Overall score for the institute: very good to excellent

### **VU1: Artificial Intelligence**

program leader:	prof. dr. J. Treur
research input 2001:	12.30 fte
research program:	very good
quality:	excellent
productivity:	very good
relevance:	excellent
vitality and feasibility:	very good

The group's research is well founded in logic and adaptive techniques with subgroups focusing on various aspects of symbolic and non-symbolic intelligence and its applications. It has a large number of multi-disciplinary connections. It has achieved considerable success particularly in the area of ontologies, agent design methodologies and evolutionary computing. Ontologies are of growing importance in the web or in fields like medical protocols, and in agent applications. Their focus on knowledge representation in distributed faulty environments is on a key problem and is well chosen.

The group has a young and energetic staff. It has critical mass in the field and is very dynamic. The general infrastructure supporting the group for contract research could be improved, such as in the field of secretarial and financial services, particularly for doing large-scale EU projects, or in computational services, such as wireless internet technologies.

### **VU2: Information Management and Software Engineering**

program leader: prof. dr. J.C. van Vliet  
research input 2001: 11.10 fte

research program: good  
quality: good  
productivity: very good  
relevance: very good  
vitality and feasibility: good

This group is headed by prof. J.C. van Vliet and is concerned with making software development more predictable, in particular the early phases of systems development. In 1998, from this group a new research group for Business Informatics has been created, headed by prof. J.M. Akkermans. He is introducing knowledge engineering techniques (such as ontologies) into business informatics and bringing multi-disciplinary elements together into systems development. This group's research approach involves an iterative cycle of problem analysis, research definition, idea generation, theoretical and empirical investigation, answer formulation and validation. For the purpose of this assessment, the two groups are considered as one program. Business Informatics is a welcome extension and has brought improvements of focus, dynamism and interdisciplinarity.

Because of its strong embedding in business applications, Business Informatics provides a wealth of application opportunities, but there is high pressure due to the relatively small staff. A high influx of students presents an additional pressure and the group requires additional staff. The group has been able to raise significant external funding from local industries. Both the faculty and the university have difficulties in providing effective (financial) management necessary to engage in large-scale external projects, even though this is required for this type of funding.

### **VU3: Computer Systems**

program leader: prof. dr. A.S. Tanenbaum  
research input 2001: 11.60 fte

research program: very good  
quality: excellent  
productivity: good  
relevance: very good  
vitality and feasibility: very good

The group seeks a deeper understanding of writing software systems for computer systems, particularly for globally distributed large-scale systems. It has the strategy of defining and carrying out long-term research projects, which is clearly paying off, although the Committee suggests diversifying goals somewhat to foster innovation. They have already done so by considering visualization. Since 2003, the group is furthermore conducting research in new areas such as distributed agent technology, very large decentralized (peer-to-peer) networks, and parallel applications in bioinformatics. They have a very strong, long-standing reputation, which allows them to attract people and funding and set up interesting international collaborations. The group appears in strong control of their destiny and have a solid stable technical staff and technical infrastructure. It is of great importance to keep this alive. The turnover in key personnel has been well managed. The group's work could have a more significant commercial impact if there were a stronger tradition of software development in the Netherlands.

#### **VU4: Theoretical Computer Science**

program leader: prof. dr. J.W. Klop  
research input 2001: 2.30 fte

research program: good  
quality: very good  
productivity: good  
relevance: good  
vitality and feasibility: good

The group is developing theory in the domain of term rewriting and algebraic methods and its applications. The succession of the group head was well managed. A strong interaction is starting with the Computer Systems group and with CWI, leading to interesting challenges. The interaction could be extended to other areas such as artificial intelligence. There is a long recognized tradition in this group in semantics and term rewriting with high quality output. They are world leader in semantics of programming languages. The Committee is concerned that the focus of the group was too narrow and not forward looking enough, but recently measures have been taken to improve this situation.

## 4.6 Utrecht University

*Institute of Information and Computing Sciences*

<b>Assessment 1996</b>	<b>Assessment 2001</b>
Algorithms & Complexity prof. dr. J. van Leeuwen	Algorithmic Systems prof. dr. J. van Leeuwen
	Decision-Support Systems prof. dr. ir. L.C. van der Gaag, dr. ir. D. Thierens
Applied Algorithms prof. dr. M.H. Overmars	Geometry, Imaging and Virtual Environments prof. dr. M.H. Overmars
Formal Methods in Science of Programming and Artificial Intelligence prof. dr. J.-J. Ch. Meyer, dr. ir. L.C. van der Gaag	Intelligent Systems prof. dr. J.-J. Ch. Meyer
	Large Distributed Databases prof. dr. A. Siebes
Software Technology prof. dr. S.D. Swierstra, prof. dr. G.L.T. Meertens	Software Technology prof. dr. S.D. Swierstra, prof. dr. G.L.T. Meertens
Developmental Research of Mathematics and Computer Science Education prof. dr. J. de Lange	

Computer science research in Utrecht is ambitiously focusing on software for complex information systems, with activities in software technology, large distributed systems, algorithmic systems and agent technologies. This is a top class internationally recognized computer science program; particularly strong parts are algorithms and decision support systems, which is carrying over to other areas. A strategic option of the institute is to seek a good balance between theory and application. By starting new programs in Information Sciences and emphasizing their societal impact, the department hopes to attract more students.

From 1996 and 2001, the Institute of Information and Computing Sciences of the University of Utrecht went through a turbulent period, with many changes, both in organizational structure and in size. In 1996, it was a relatively small institute, fully responsible for computer science research, teaching the computer science curriculum, and participating in the Artificial Intelligence curriculum. After some changes had been made in the curriculum, the number of freshmen rose. The research became concentrated in four research centres, each with its own master program:

- Algorithmic Systems
- Geometry, Imaging and Virtual Environments
- Software Technology
- Intelligent Systems

The organization of research activity around centers that include enough large research groups is a good solution to avoid fragmentation and improve penetration of research outputs into society. It also favours the exchange of ideas and promotes the development of new interdisciplinary research. These centers are equipped with very good facilities. The faculty appears to have very good contacts with industry but contract research in the last year has been not particularly important. This deserves attention. It would perhaps be interesting to have industry involved in the advisory boards of the centers.

Because of the increase of the number of students, the department got permission to create two new chairs, each with their own research program. Prof. L.C. van der Gaag is one of those chairs, the other one that of prof. A. Siebes. The chair of prof. Van der Gaag was in fact detached from the research group Artificial Intelligence, headed by prof. J.- J. Ch. Meyer. This led to a shift of focus of Meyer's research team; it concentrated more on agent technology, and less on artificial intelligence in general and logic.

More associate professors are needed to back up this growth. The independence of the Faculty of Mathematics and Computer Sciences seems to have worked well so far and allows computer science to work across all other faculties of the university. The Committee considers the 'benches' where several professors take joined responsibility for a research direction a good approach. The increasing importance of computer science in the research of other departments should be reflected in a more visible place of the department in the research organization, which could allow integration of other natural partners such as Artificial Intelligence.

The number of technical reports has been extraordinary high in the period under assessment, but these were not counted for the publication output.

There is a somewhat unbalanced distribution of resources between the different programs. In the long term, this might penalize important research areas and make their contribution marginal. This situation deserves further study and corrective action.

Overall score for the institute: very good to excellent

## UU1: Algorithmic Systems

program leader: prof. dr. J. van Leeuwen  
research input 2001: 5.00 fte

research program: very good  
quality: excellent  
productivity: good  
relevance: good  
vitality and feasibility: good

Until January 1999, the research director was only partially available, because he also was dean of the Faculty of Mathematics and Computer Science. As he has been appointed to a second term as dean, the group needs to find another leadership arrangement. Expanding the group, possibly with a senior research position, should compensate this, given that algorithmics is so important in computer science in general and that the group is internationally recognized for this work.

During 2000-2001, the direction of the group was changed to its current form. Areas like parallel and distributed computation were de-emphasized. The research in the area of combinatorial optimization was re-focused to the field of planning, scheduling and simulation. Research in integer line planning was de-emphasized. The research in the area of networks and graphs was extended, to include a more application-oriented component (in close cooperation with the group Decision-Support Systems). The new research in intelligent algorithms was initiated in 2001, partly influenced by similar developments in industry (viz in contacts with the Philips Research Laboratories). In 2001, it was also decided to change the name of the program to Algorithmic Systems, to more accurately reflect the new directions in the program. In December 2001, the new Center for Algorithmic Systems was founded. An almost entirely new set of Ph.D. students joined the group.

This group is focusing on algorithm design, particularly graph and network algorithms, planning and on-line scheduling algorithms with connections to the optimization domain. They have done fine work in these areas and their proposal to look at intelligent interactive algorithms is intriguing. There might be more intensive contact with other communities, such as the constraint-based planning and scheduling community. The group is strong and has a very well established international reputation.

## UU2: Decision-Support Systems

program leaders: prof. dr. ir. L.C. van der Gaag, dr. ir. D. Thierens  
research input 2001: 4.70 fte

research program: very good  
quality: very good  
productivity: very good  
relevance: very good  
vitality and feasibility: very good

In the Decision-Support Systems research program the use of concepts and techniques from statistics for decision support is being studied in two main research themes: decision making under uncertainty and evolutionary computation. The two main themes have so far been pursued rather independently. Until then, the two senior researchers in the program, Van der Gaag and Thierens, had participated in different programs, Intelligent Systems and Geometry, Imaging and Virtual Environments respectively. The Decision-Support Systems research started in May 2000 with the appointment of Van der Gaag as a full professor.

The goal of the group is to build a new generation of decision support systems based on concepts of statistics so as to handle problems where uncertainty plays a significant role or where there is a large size in the data sets involved. Example applications are easily found in the medical field, which is one of the main application areas of the group. A key idea is to synergistically combine probabilistic networks with genetic algorithms. This is a good research program, which is being carried out well. The group is young and has many new Ph.D. students. It is important that this program can continue and grow in the future.

### **UU3: Geometry, Imaging and Virtual Environments**

program leader: prof. dr. M.H. Overmars  
research input 2001: 13.29 fte

research program: very good  
quality: very good  
productivity: good  
relevance: good  
vitality and feasibility: very good

During the past six years the group Geometry, Imaging and Virtual Environments (GIVE) extended its strengths in the application domains. In this, the institute followed one of the recommendations of the previous research assessment that stated that computer science in the Netherlands should strengthen applied research.

This group focuses on various areas where computational geometry can be applied, including imaging and virtual environments. Now, there is a focus on motion particularly for CAD/CAM, robotics, spatial planning, gaming, etc. The group is very strong in both theory and application and has a wide network of international contacts. They have been successful in obtaining external funding. However, this introduces a risk because companies sometimes rapidly shift attention. The group has attracted many new students. They are proactive in exploring new application domains of their fundamental theoretical work.

### **UU4: Intelligent Systems**

program leader: prof. dr. J.-J. Ch. Meyer  
research input 2001: 5.50 fte

research program: very good  
quality: very good  
productivity: very good  
relevance: good  
vitality and feasibility: very good

The group works on aspects of agent technology to bridge the gap between theory and application, specifically formal definition of agents, programming languages for agents, semantics, etc. The group has focused on theoretical work but the recent emphasis on more application-oriented research could prove the viability of the agent-based approach, including issues of security and process algebra. They are in a good position to put agent philosophy on a sound computer science footing.

### **UU5: Large Distributed Databases**

program leader: prof. dr. A. Siebes  
research input 2001: 1.90 fte

research program: satisfactory  
quality: good  
productivity: good  
relevance: good  
vitality and feasibility: good

This group focuses on modern scale data sets (like bio data and semi-structured data). Traditional data base techniques are inadequate to handle such large data sets. This group's activities are connected to specific application areas, including in the bio-informatics field, but the Committee did not perceive a clear research vision, although the group claims to be focusing on the development of algorithms for efficient relational mining of mixed type data. The group is young and expanding quickly. There is an imbalance between availability and external resources and research advisory capability in the group. The Committee recommends that the group develop a focused agenda with clear research goals.

### **UU6: Software Technology**

program leaders: prof. dr. L.G.T.L. Meertens, prof. dr. S.D. Swierstra  
research input 2001: 11.00 fte

research program: very good  
quality: good  
productivity: good  
relevance: good  
vitality and feasibility: good

This group focuses on language design in support of software technology, particularly for making functional programming language tools more easily usable by computer scientists. The research program is coherent and grounded in good software engineering practice. The work is internationally recognized. While it is good to show the applicability of these methods to their own software development, it is important to show the applicability of their techniques also in more challenging and realistic large applications, e.g. by establishing relations with large science projects or business applications. The group depends critically on external funding, which makes it sometimes difficult to ensure continuity of the research.



## 4.7 University of Groningen

*Institute of Mathematics and Computing Science  
Department of Artificial Intelligence and Cognitive Engineering*

<b>Assessment 1996</b>	<b>Assessment 2001</b>
	Software Engineering prof. dr. J. Bosch
Fundamental Computing Science prof. dr. G.R. Renardel de Lavalette prof. dr. W.H. Hesselink	Fundamental Computing Science prof. dr. G.R. Renardel de Lavalette, prof. dr. W.H. Hesselink
High Performance Computing & Imaging prof. dr. N. Petkov dr. J.B.T.M. Roerdink, dr. G. Vegter	Computing & Imaging prof. dr. N. Petkov, dr. J.B.T.M. Roerdink, dr. G. Vegter
Systems Technology prof. dr. ir. L. Spaanenburg dr. ir. J.T. Udding	System Technology prof. dr. ir. L. Spaanenburg (later withdrawn from assessment)
	Artificial Intelligence and Cognitive Engineering (ALICE) prof. dr. L.R.B. Schomaker

*Institute of Mathematics and Computing Science*

The Institute of Mathematics and Computing Science (Instituut voor Wiskunde en Informatica, IWI) comprises two sections: Mathematics and Computing Science. These sections are not separate administrative units, but are rather clusters of basic units (basiseenheden) formed around chairs and research programs. This report concerns the basic units and the corresponding research programs of the cluster Computing Science.

Following the result of the previous assessment, the university and the board of the Faculty appointed a committee of external experts. In 1999, this committee recommended raising of the group's scientific level (and streamlining the teaching activities). In 2000, the Institute of Mathematics and Computing Science followed these recommendations and reorganized the department. Of the sixteen permanent members of the scientific staff, eight were admitted to the new research institute, one of them conditionally. As a result, the department's emphasis has shifted more from teaching to doing research. The performance of each tenured member of the institute is evaluated annually, assessing their productivity and quality of the research over the preceding five years. The program System Technology was closed. Two new programs were started, in Software Engineering and Bioinformatics. In 2004, another new program, Information Systems, will start. It is worth of appraisal that the institute has put attention to quality management as an essential tool to improve its own visibility and its international position.

The institute has a background in formal aspects of computing and is focusing on application in the life sciences and in modeling intelligence. There is a strongly expressed strategy to achieve this. There are significant facilities in high performance computing and massive data storage available to support this.

The department succeeds in attracting external funding. However, the level of high quality basic research can be improved. The department should also be aware of the risk of fragmentation of the research activity into too many themes with respect to the research capacity. This fact, although not visible in all the research programs, indicates some lack of focus, which in the mid term could depress even more the quality of research outcomes despite of the efforts in quality evaluation and assessment.

#### *Recent developments*

A new unit in Bioinformatics was established to which prof. R. C. Jansen was recruited in early 2002. This unit is the kernel of the Groningen Bioinformatics Centre (GBIC), which is operated jointly by the Faculty of Mathematics and Natural Sciences and the Faculty of Medical Sciences. The research program of the GBIC concentrates on the development of analytical concepts, methods and models for the purpose of unraveling complex biological and biomedical traits with the aid of genetic and genomic technologies. From the perspective of computer science, they are involved in the development of information systems, high performance computing, data mining and computational sciences (statistical methods). The Committee feels that although the emphasis on life science applications is a positive development, it should not be at the expense of other parts of computer science.

#### *Department of Artificial Intelligence and Cognitive Engineering*

The assessment at the RUG includes the department of Artificial Intelligence and Cognitive Engineering (ALICE), founded in 2001. The Faculty of Mathematics and Natural Sciences and the Faculty of Behavioural and Social Sciences (which acts as commissioner) are the main participants in this department. With the founding of this department, research that used to be distributed over several departments became concentrated in one group, with a full professor, prof. L.R.B. Schomaker. The emphasis is on logic in multi-agent communication, working models of cognition, pattern recognition in reading systems and cognitive robotics.

Although research plans and directions of investigation appear to be timely and substantially in line with the actual trends in artificial intelligence, there are serious lacks at both the infrastructure and human resource investment levels that can make, if not solved quickly, this effort wasted.

Resources allocated to the institute for infrastructure are insufficient, as recognized also in the self-assessment report. Particularly critical is the lack of adequate infrastructure and accommodation facilities. This department critically needs a single laboratory supporting for both its education and research mission. The current computing environment is clearly inadequate.

Human resources are also insufficient and need additional investments in order to guarantee a sufficient level of quality. On the other hand, more national alliances with well-established groups and institutes must be established in order to favour cultural and experience exchange. The Committee suggests that concrete agreements of collaboration are established with other groups at the international level to favour exchange of young researchers and cooperation activities.

A positive point is that interdisciplinarity is recognized as an important factor in the development of the research activity.

## **RUG1: Software Engineering**

program leader: prof. dr. J. Bosch  
research input 2001: 2.40 fte

quality: very good  
productivity: excellent  
relevance: very good  
vitality and feasibility: excellent

The Software Engineering research group was established in the fall of 2000. The group is young, expanding rapidly, moving from exploration to development. The group focuses on empirical software assessment and design, specifically software product families, software architecture, particularly in methodologies and techniques. They see three areas of strategic importance: software variability management, dynamic software architectures and the explicit modeling of design decisions. Part of this group's mission is cooperation with industry. They have established significant contacts with industry, a growing number of Ph.D. students, and growing sources of external funding. All of these are positive. The quality and quantity of publications are very high. These are often in high quality international proceedings, which the Committee views as equivalent to high quality journals in this field. This group will need more senior staff members and professional staff for adequate tool building, which will be an important component of their future research. Given the size of the group a narrow focus is normal, but the Committee would expect that this widens with any future expansion of the group.

## **RUG2: Fundamental Computer Science**

program leader: prof. dr. G. Renardel de Lavalette  
research input 2001: 4.80 fte

quality: good  
productivity: satisfactory  
relevance: good  
vitality and feasibility: satisfactory

The program Fundamental Computing Science does research in mathematical logic and formal methods. The group strives for synergy by working in joint projects, such as recently in the area of intelligent agents. They have worked in diverse topics in program correctness and logic, including theorem proving and distributed graph algorithms. The research program appears somewhat scattered for such a small group. Therefore, the Committee recommends that the program leader tries to focus efforts and to expand the group through external funding. The effort towards publication could be more intense in the domain of logic and proof theory. There are publications on program correctness in good journals (such as *TCS* and *Distributed Computing*).

### **RUG3: Computing and Imaging**

program leader: prof. dr. N. Petkov  
research input 2001: 7.90 fte

quality: good  
productivity: good  
relevance: good  
vitality and feasibility: good

In February 2001, the High Performance Computing & Imaging group dropped the indication *High Performance* because in recent years high performance computers played primarily a facilitating role. The research program covers a number of interrelated areas in image processing, computer vision, scientific computing, computational geometry and visualization. In the period under review this research program has reached a critical mass and is split into two separate programs that will be performed in two independent administrative units; (i) Intelligent Systems, concentrating on biologically motivated computer vision and machine learning and (ii) Scientific Visualization and Computer Graphics. This program focuses on life science applications. A new chair has been established by the faculty in 2001 and has been filled by the end of 2002. A new administrative unit will be created around this chair and part of the personnel of the current research program Computing and Imaging will be transferred to this new unit. The demand for this type of research comes from many disciplines within the faculty: astronomy, physics, chemistry, pharmacy, biology, and medicine. The group is well focused and has made a successful effort to increase the number of publications.

### **RUG4: System Technology**

program leader: prof. dr. L. Spaanenburg  
research input 2001: 2.20 fte

Personnel changes in the System Technology research program led to the discontinuation of the group, hence the RUG has withdrawn the program from this assessment.

### **RUG5: Artificial Intelligence and Cognitive Engineering**

program leader: prof. dr. L.R.B. Schomaker  
research input 2001: 1.60 fte

quality: good  
productivity: good  
relevance: good  
vitality and feasibility: good

The department of Artificial Intelligence and Cognitive Engineering was created in January 2001. This was originally an interdisciplinary program of the Psychology Department, but in 2001, it became a separate institute, under the name of ALICE, with its own chair. The research consists of three subprograms:

- Cognitive Modeling
- Multi-Agent Systems
- Autonomous and Perceptive Systems

The research in ALICE is interdisciplinary in nature. With Computing Science, it shares an interest in formal modelling. These models can be symbolic, statistical or hybrid in nature. With psychology, it has in common an interest in natural cognition. The goal is to describe fundamental qualities of cognition in such an explicit way that computational models of perceptual, cognitive and movement-control functions can be constructed.

The institute is working on dynamic logic and epistemic logic to model teamwork and other issues in multi-agent systems, as well issues in pattern recognition to attach meaning to multi-sensory data, and cognitive modelling, specifically on bounded rationality. They have been very successful in education, which could be the basis of further expansion. Research personnel is now financed completely from education and external funding. The research program is still in its very early phases and is heavily based on junior researchers. The group has not yet reached an adequate level of excellence and international reputation. The group's ambition cannot be achieved with its current capability. The Committee recommends a stronger integration with computer science. However, the group attracts non-traditional (e.g., psychology) students to computer science and it is important not to lose this source of students and this intellectual diversity.



## 4.8 University of Twente

### *Faculty of Computer Science*

<b>Assessment 1996</b>	<b>Assessment 2001</b>
	Application Protocol Systems prof. dr. ir. D.M. Konstantas
Architecture & Implementation of Digital systems prof. dr. ir. Th. Krol	Computer Architecture Design and Test of Embedded Systems prof. dr. ir. Th. Krol
Databases prof. dr. P.M.G. Apers, dr. H. Balsters, dr. H.M. Blanken	Databases prof. dr. W. Jonker
Laboratory of Systems Research prof. dr. S.J. Mullender ir. P.G. Jansen, ir. A.L. Schoute	Distributed and Embedded Systems prof. dr. P.H. Hartel
Formal Methods for Distributed Systems Design prof. dr. H. Brinksma,	Formal Methods and Tools prof. dr. H. Brinksma dr. H. Alblas
	Information Systems prof. dr. R.J. Wieringa
	Intelligent Media and Language Technology prof. dr. ir. A. Nijholt
Software and Language Engineering & Theoretical Computer Science prof. dr. ir. A. Nijholt, prof. dr. F.M.G. de Jong, dr. ir. M. Aksit, dr. G.F. van der Hoeven, drs. J.A. van Hulzen, dr. J. Zwiers	Software Engineering dr. ir. M. Aksit
Telecommunication Systems & Performance prof. dr. ir. I.G.M.M. Niemegeers, dr. ir. V.F. Nicola	Telematics Systems and Services prof. dr. ir. I.G.M.M. Niemegeers
Telematics Systems & Architecture prof. dr. ir. C.A. Vissers, dr. L. Ferreira Peres	

In 1993, the UT decided to reorganize its main research activities by creating a small number of multi-disciplinary research institutes. The Center for Telematics and Information Technology (CTIT) was one of them. The leading idea was that the new scientific challenges would be on the interface between existing disciplines, and that because of that multi-disciplinary research must be fostered.

For the Faculty of Computer Science this meant that almost all of its research was done in the context of the CTIT, in which a number of other disciplines participated, such as electrical engineering, mathematics, education technology, business management, public administration, and mechanical and civil engineering.

Through the CTIT, the UT tried to integrate the two worlds of ICT, traditionally computer science, and Telematics, traditionally telecommunications. It also tried to strengthen the link between application domains and ICT. This resulted in research projects in which the perspective of applications played a more important role. It also promoted the reorientation of some of the chairs within the Faculty of Computer Science. Since the last computer science research evaluation, a number of chairs modified their specializations. New professors were appointed who shared the CTIT philosophy with respect to integration and applications.

The CTIT has defined a number of strategic areas for multidisciplinary research:

- The interaction between communication and computer science in telematics
- Embedded systems
- Multi-media
- Security

The ambition is to combine research and application in these areas. The research is organized in terms of chairs that cooperate for each of these themes. There is a good coverage of many technical areas of computer science and a good foundation in engineering. The institute is ambitiously trying to play a leadership role in the Netherlands and has clear dynamic management based on strategical research orientations. The department is very strong in certain areas with a clear international reputation. They have many contacts with industry and a good influx of external funding.

Since 1996, three programs were discontinued: Method Engineering, Intelligent Engineering Systems and Knowledge-Based Systems. However, the faculty has started three new programs. The Application Protocol Systems program was established in 2001 and it is expanding. It covers telematics applications and protocols. The focus is on wireless communications and e-health applications. It is about to merge with the Architecture group. The mission of the Information Systems group, which was started in February 1998, is to perform research on the design of distributed information systems for organizations. In 1998 the cluster Media and Language Technology was formed, dealing with human-computer interaction.

In 2001/2002, the UT reduced the number of faculties and introduced a system of schools and institutes. As a result, computer science was placed in a joint faculty with Electrical Engineering and Mathematics.

The decision of organizing research activities around a small number of multi-disciplinary research institutes is to be regarded as a positive strive to provide adequate responses to the request of innovation and future developments in the field of computer science and engineering. The faculty provides a balanced research program between technological developments, fundamental research and application-oriented research. This strategy, if maintained, will presumably make it possible to improve his capability of technological transfer in the mid term. The capability of attracting funds from the industry has been definitely very good. The amount of contract research per staff member in 2001 is also good.

The faculty has also demonstrated high attention to new research trends and societal needs, launching new research programs.

On the other hand, the Faculty of Computer Science seems to be in a constant process of reorganization. Possibly, the local system at Twente has too much administrative overload and administrative support can be improved. Another weakness might be the staff's limited awareness of the research policies and their low involvement in the decision making process. Therefore, the Committee gently suggests avoiding too much organizational overhead and top-down steering.

The research output in terms of publications of some groups is lower than in other universities, which seems to indicate that there is less of a culture in this respect. Research productivity is good in average, although there are a few groups with very low scientific productivity and quality. In general, the Committee observes that research outputs are quite different from one group to the other.

It appears that the faculty does not have a clearly defined quality assessment process that is used as a basis for the allocation of resources and the redirection of research focuses.

Overall score for the institute: very good to excellent

## **UT1: Application Protocol Systems**

program leader: prof. dr. ir. D.M. Konstantas  
research input 2001: 3.18 fte

research program: good  
quality: good  
productivity: satisfactory  
relevance: very good  
vitality and feasibility: unsatisfactory

The Application Protocol Systems program was established in 2001, being detached from Telematics Systems and Services, and it is under expansion. Its research covers the top layers (as defined in the OSI model) and its mission is the design, development and integration of applications based on technology and research done in the lower OSI layers.

The focus is wireless communications and e-health applications. The subprogram *Application Protocols Security* concentrates on the study of security issues for networked applications, while the subprogram Internet Applications concentrates on video streaming applications. The target of the program is to develop innovative applications based on wireless communication technologies (such as WLAN, UMTS, Bluetooth), studying at the same time all the requirements and issues related to performance, quality of service, security and software design. The target is to develop a health care system that will allow the continuous monitoring of vital signs and their transmission to a health center. A second part of the work is in the area of agent technology, where the group explores the use of agent technologies to solve or alleviate some of the problems within the context of Computer Supported Cooperative Work (CSCW). The results of this work have a direct application in the e-health domain, for the collaboration of doctors, paramedics and patients.

This research is exciting; it has great importance and societal relevance. It is very positive that a spin-off company is emerging. It was set up recently but has not obtained a stable first stream money to institutionalize its activity. The group is now about to merge with the architecture group.

## **UT2: Computer Architecture Design & Test of Embedded Systems**

program leader: prof. dr. ir. Th. Krol  
research input 2001: 5.52 fte

research program: very good  
quality: good  
productivity: satisfactory  
relevance: very good  
vitality and feasibility: very good

The chair Computer Architecture & Test of Embedded Systems (CADTES) is an interfaculty department of the Faculty of Computer Science and the Faculty of Electrical Engineering, and it is composed of the following groups:

- Computer Architecture and Embedded Systems
- Testable Design and Test

The latter is in the Faculty of Electrical Engineering and is outside the scope of this report.

The mission of the group is to contribute to design methods and architectures for efficient embedded systems. The group leader is a professor in computer science and Electrical Engineering, which brings an important engineering sensibility to the project and a multidisciplinary flavour to the department. Embedded systems have both computer science and electrical engineering challenges and thus it is important that the group maintain strong connections to both departments. This group is also working on the important new area of reconfigurable architectures and embedded sensor networks which require power aware computation and communication as well as new protocol stacks. Based on the strength of this project, Intel has selected Twente as their focus university in The Netherlands. This project cooperates with many other projects in the institute and has very strong connections to industry.

### **UT3: Databases**

program leader: prof. dr. W. Jonker  
research input 2001: 8.76 fte

research program: very good  
quality: very good  
productivity: very good  
relevance: very good  
vitality and feasibility: good

This group has been working on two themes: data models and tools (especially object-oriented) and database technology (especially parallel ones). The group cooperates with other groups in Twente, such as Information Systems, Formal Methods and Tools, and Intelligent Media and Language Technology. There are two subprograms:

- Data Models and Tools
- Database Technology

*Data Models and Tools* addresses fundamental topics and aims to offer tools to verify at compile time whether the manipulation of objects at run time is according to the integrity rules, which have been specified in advance. This is motivated by the observation that, in general, computer science lacks checking tools compared to that of other engineering disciplines. Before tools can be constructed, a sufficiently expressive data model has to be defined, with a solid mathematical foundation. The fundamental work in this subprogram is a continuation of work during the previous period.

*Database Technology* deals with application-oriented topics. The emphasis is on efficient query formulation and processing, and on describing objects in an existing object oriented data model. The research is now being integrated into work on retrieval for mixed structured, semi-structured, and multimedia databases. This is a good direction but may be a little over-ambitious for a relatively small group. There are also leadership issues that need to be resolved, as the group leader has only one day a week available for his research and for leading the group.

### **UT4: Distributed and Embedded Systems**

program leader: prof. dr. P.H. Hartel  
research input 2001: 5.87 fte

research program: very good  
quality: very good  
productivity: good  
relevance: excellent  
vitality and feasibility: very good

This group Distributed and Embedded Systems (DIES) has two subprograms:

- Embedded Systems Support for Multimedia and real-Time Applications
- Secure Systems Engineering

The first subprogram focuses in general on real-time performance, looking at real-time operating systems and (energy) efficient, flexible and possibly wireless computer systems architectures. The second subprogram focuses on dependability, addressing high-integrity O.S. kernels, verification of time-dependent behaviour and security measures. The group uses formal methods as an approach.

The mission of the DIES research group is to perform research that leads to improvements in distributed and embedded systems engineering, enhancing the quality of embedded and distributed systems. This mission is shared with the Computer Architecture Design & Test Embedded Systems group (CADTES), and fulfilled in cooperation with other groups that develop methods and tools for this, inside the faculty and outside. The combination of real-time and security is a unique strength of the group and it is of great industrial relevance, because the research is focused on applications from electronic business, traffic and transport, multimedia content and tools, public systems and services. While system functionality remains important, today more and more emphasis is put on convenience, efficiency, mobility, reliability and security. The group is growing fast and is well managed. More connection with network research might be valuable.

### **UT5: Formal Methods and Tools**

program leader: prof. dr. H. Brinksma  
research input 2001: 7.01 fte

research program: excellent  
quality: very good  
productivity: very good  
relevance: very good  
vitality and feasibility: good

The research program Formal Methods and Tools is concerned with the study, development, and application of mathematical theories and methods to the design, modeling and analysis of reactive systems, including the development and application of supporting software tools. It builds on extensive experience of the group in concurrency theory in general, and process algebraic approaches in particular, to the modeling of distributed, reactive systems with applications in communication protocol systems, embedded systems, and complex software systems.

This strong group works on three fronts: fundamental research in formal methods, e.g., performance modeling process calculus; making these effective in tools, e.g., the TorX environment; and using the tools in serious application studies with external bodies, e.g., the *Nieuwe Waterweg* storm surge barrier at Rotterdam. The group's philosophy is one of mutually profitable feedback between the three fronts. The group works with several other groups at Twente, such as Embedded Systems, Software Engineering and Distributed Systems. There is a problem in attracting and retaining master students.

### **UT6: Information Systems**

program leader: prof. dr. R.J. Wieringa  
research input 2001: 6.61 fte

research program: very good  
quality: very good  
productivity: good  
relevance: very good  
vitality and feasibility: good

The goal of this group, which started in February 1998, is to develop solid technology for information systems. They do research on generic design technologies for distributed information systems in organizations, including workflow systems, groupware and ERP systems. There are three subprograms:

- Information Systems Specification
- Architecture Design
- Requirements Engineering

*Information Systems Specification* research is concerned with notations for information systems design, in particular with the integration of formal and semiformal notation, e.g. with further development of UML. The associated development of appropriate work methods is addressed in the work on architecture design and requirements engineering.

*Architecture Design* consists of the design of a structure of software components in relation with the architecture of the organization and that will satisfy the software requirements. The focus is on infrastructures for electronic commerce.

*Requirements Engineering* consists of investigating the problem context, identifying stakeholders, goals and problems, and deriving from this a set of desired properties of a system that would help achieve the goals and solve the problems. The focus is on evolutionary implementation of information and communication technology. Although they take a pragmatic point of view, there is at this moment a low influx of external funding.

The group leader is very well known internationally, and is usually involved in the arrangement of international scientific conferences in this area. The research program is well structured and very relevant to the wider needs of forging cooperation among computer professionals and non-professionals in the design and evolution of information systems in organizations. Their dissemination has been very effective.

## **UT7: Intelligent Media and Language Technology**

program leader: prof. dr. ir. A. Nijholt  
research input 2001: 13.94 fte

research program: good  
quality: good  
productivity: excellent  
relevance: good  
vitality and feasibility: good

The current cluster was founded in 1998, when the department decided to split the group Software Engineering and Theoretical Computer Science in a group Software Engineering with a full chair and a group around the themes Language, Knowledge and Interaction. The chair in Theoretical Computer Science changed his focus, while maintaining his interest in natural language processing, to the broader area of human-computer interaction. The Knowledge-Based Systems group, formerly an independent group with a full-time professor, became part of the cluster in 1999. The chair's size was reduced to 0.2 fte in this period, because a position for 0.8 fte was taken elsewhere and all staff members except one left this group. The emphasis has been put on applying advanced computer science issues (software engineering, agent technology, artificial intelligence, machine learning, graphics) on interface design. The aim has been to orient the research in each of these areas towards possible integration of results in new theories and advanced prototype systems that can be evaluated. For that reason, after 1998, they have introduced an internal global research program (AVEIRO: *Agents in Virtual Environments*) in which the connections between the different areas are exploited in order to successfully stimulate mutual interactions and use of results.

The group has moved into the area of human computer interaction from a computer science point of view. They design, model and build user interfaces specifically in the area of ambient intelligence. There is strong cooperation with Dutch industry in this area and good attraction of future funding. The reputation of the group is good. Too much external funding might however lead to a lack of balance between permanent senior staff and work on specific projects. The topics being studied however present good opportunities and may help to rejuvenate the group.

### **UT8: Software Engineering**

program leader: prof. dr. ir. M. Aksit  
research input 2001: 4.80 fte

research program: good  
quality: very good  
productivity: good  
relevance: very good  
vitality and feasibility: good

This group is divided into the following subprograms:

- Aspect-Oriented Software Composition
- Synthesis Based Software Architecture Design
- Soft Computing Applied to Software Development
- Design for Correctness

The Software Engineering group aims to contribute to the solution of the problems of stakeholders by developing and/or selecting optimal models along the software engineering process. A model is called optimal if it satisfies the constraints imposed by its context, i.e., the market, stakeholders, enabling technology, financial conditions, etc. These constraints are formulated in terms of quality factors, which therefore define the dimensions of the relevant characteristics of models. The software engineering process should be an optimization process, which balances the quality factors of a model within a given context. To address these problems, the group carries out research activities in four complementary subprograms. The first three research activities aim to enhance the quality factors of models at three particular phases of the software engineering process. The fourth research activity aims to compute, measure and/or optimize quality.

This group works on a broad array of topics in software engineering: software architecture, process and quality. A notable past contribution, on which they continue to carry out research, is the aspect-orientated programming paradigm. They also try, laudably, to apply more formal approaches in their work, for example fuzzy logic. It seems that the scientific input is largely concentrated on the project leader himself. Therefore, the Committee recommends that the group be strengthened and broadened, especially regarding its abilities in more traditional computer science areas related to software engineering. The group works with other groups in Twente, such as Formal Methods and Tools, and Information Systems. The difficulty in doing serious tool development is a real issue for this group.

### **UT9: Telematics Systems and Services**

program leader: prof. dr. ir. I.G.M.M. Niemegeers  
research input 2001: 15.53 fte

research program: good  
quality: good  
productivity: good  
relevance: good  
vitality and feasibility: good

The Telematics Systems and Services (TSS) group is an interfaculty department of the Faculty of Computer Science and the Faculty of Electrical Engineering. The TSS group consists of the following discipline groups:

- Communication Networks (CN)
- Quantitative Analysis and Methods (QAM)
- Architecture of Distributed Systems (ARCH)
- Management of Telematics Systems and Services (TMG)
- Application Protocol Systems (APS, until January 2001)
- Photonic Networks (PN)

The mission of the TSS group is the development of an integrated approach for designing complex telematics systems, such that different functional layers (ranging from transmission to application protocols) and different system requirements (such as correctness, performance and maintainability) can be taken into consideration to form a single system that can be embedded in its user environment. The CN, PN and APS groups mainly address functions within telematics systems, while the ARCH, QAM and TMG groups mainly address methodological aspects for the design, analysis and management of telematics systems.

The two key professors have left this group. Prof. C.A. Vissers went to the Telematica Instituut on the campus of the University of Twente, while prof. I.G.M.M. Niemegeers took on management responsibility. In 2002 he left to assume a position at the University of Delft. The presence of this institute offers many opportunities for synergy. The group intends to split into two groups, one focusing on communication and another on services. The team needs to identify more focused missions for the two groups and to find a strong leader for the new services group. This is a very wide area and the Committee recommends that the team focus their efforts on a more circumscribed range of research goals.

## Appendix A:

### Official Note of the Appointment of the Review Committee for Academic Research in Computer Science, September 19, 2003

The Executive Board of the Association of Universities in the Netherlands (VSNU), duly observing the *Protocol 1998 for the Quality Assessment of Research*, the *Discipline Protocol for the Assessment of Research in Computer Science*, the letters to the Executive Boards of the University of Amsterdam, the Free University, Utrecht University, the University of Groningen, the University of Nijmegen, the University of Twente, the University of Eindhoven and the University of Maastricht, in which the research assessments have been formally announced, and the approval of the Committee Members by the Royal Netherlands Academy of Arts and Sciences (KNAW),

#### DECREES

1. A Review Committee for Computer Science has been appointed in conformity with the *Protocol 1998 for the Quality Assessment of Research*.
2. Prof. dr. Luc Steels (Free University of Brussels) has been appointed as Chairman and Member of the Review Committee.

The following persons have been appointed as Members of the Committee:

Prof. dr. Ralph-Johan Back  
Prof. dr. Alberto Del Bimbo  
Prof. dr. David Harel  
Prof. dr. Gilles Kahn  
Dr. Carl Kesselman  
Dr. Johan de Kleer  
Prof. dr. Gordon Plotkin  
Prof. dr. Arne Sølvberg

The VSNU has appointed drs. B. Bauland as secretary of the Review Committee.

3. The Review Committee's tasks – in accordance with the Protocols concerned – are:
  - 3.1. to assess the quality of research on the basis of the information provided by faculties and the institutes and through interviews;
  - 3.2. to advise how quality might be enhanced.
4. The findings of the Review Committee will be published in a public report. In accordance with the *Protocol 1998* the report will include at least the following sections:
  - 4.1. a description of the assessment process and the experiences encountered;
  - 4.2. a national appraisal – from an international viewpoint and in accordance with international quality norms – of the standing and the quality of research in the Netherlands for the discipline as a whole; in which, if relevant, a distinction is drawn between the different subdisciplines. The Committee pays attention to the topics indicated by the discipline committees in their discipline protocol;
  - 4.3. a general appraisal of the research of each faculty (or department or institute), including an assessment of its research profile;
  - 4.4. quality assessments per program with an accompanying commentary.
5. The universities concerned will submit programs for assessment.
6. The Review Committee will decide on its own assessment procedures, taking into account the guidelines of the *Protocol 1998*.

7. The Review Committee submits its report to the VSNU.
8. The VSNU pays the Chair and Members of the Review Committee a fixed compensation.  
This sum is agreed before the start of the work. The Chair and Members of the Review Committee submit their travel expenses to the VSNU via the Secretary of the Review Committee.
9. Copies will be sent to: the Executive Boards of the universities concerned; the Board of the Royal Netherlands Academy of Arts and Sciences (KNAW) the Board of the Netherlands Organization for Scientific Research (NWO), the Minister of Education, Culture and Sciences.

The president of VSNU,

Mr. E.M. d'Hondt

## Appendix B:

### Curricula vitae of the Members of the Review Committee for Computer Science

#### **Prof. Ralph-Johan Back**

Ralph-Johan Back is Professor of Computer Science at Abo Akademi University, Turku, Finland. He has presently a five-year research position (Academy professor) at the Academy of Finland. He is the director for one of the Centers of Excellence nominated and funded by the Academy of Finland (Center for Formal Methods in Programming). He is the founder of TUCS (Turku Centre for Computer Science) and its first director, 1993-2000. He received his Ph.D. from University of Helsinki in 1978. He has spent a postdoctoral year at the Mathematical Center (now CWI) in Amsterdam (1979-1980), held a professors position at the University of Tampere (1982-1983), and been a visiting professor at Caltech (1991-1992) and University of Utrecht (1994). He is the inventor of the Refinement Calculus (1978) and the co-inventor of the Action system formalism (1982, together with Reino Kurki-Suonio). He has written two books on the Refinement Calculus, one published in 1980 and the second (jointly with Joakim von Wright) in 1998. His main interests are formal methods (in particular programming logics, programming methods, semantics and mechanized reasoning), distributed and parallel systems, multiprocessor technology, software engineering and teaching of mathematics. He is a member of the Academia Europæa.

#### **Prof. Alberto Del Bimbo**

Alberto Del Bimbo is full Professor of Computer Engineering at the University of Florence, Italy. Since 1998 he is the Director of the Master in Multimedia of the University of Florence. At the present time, he is Deputy Rector of the University of Florence, in charge of Research and Innovation Transfer.

His scientific interests are pattern recognition, image databases, multimedia and human-computer interaction. He has delved into object recognition and image sequence analysis, multimedia databases and content-based retrieval. Prof. Del Bimbo is the author of over 170 publications in the most distinguished international journals and conference proceedings. He is the author of *Visual Information Retrieval*, a monograph on content-based retrieval from image and video databases edited by Morgan Kaufman.

He is Member of IEEE (Institute of Electrical and Electronic Engineers) and IAPR (International Association for Pattern Recognition). Prof. Del Bimbo was the President of the IAPR Italian Chapter, from 1996 to 2000 and Member at large of the IEEE Publication Board from 1998 to 2000. He is presently Associate Editor of Pattern Recognition, Journal of Visual Languages and Computing, Multimedia Tools and Applications Journal, Pattern Analysis and Applications, IEEE Transactions on Multimedia, and IEEE Transactions on Pattern Analysis and Machine Intelligence.

He was the Guest Editor of several special issues on image databases in highly respected journals. He was the General Chairman of the ninth IAPR International Conference on Image Analysis and Processing, ICIAP '97 – Florence (1997) and the General Chairman of the sixth IEEE International Conference on Multimedia Computing and Systems, ICMCS'99 – Florence (1999).

#### **Prof. David Harel**

David Harel has been at the Weizmann Institute of Science in Israel since 1980, and has been Dean of the Faculty of Mathematics and Computer Science since 1998. He is also co-founder of I-Logix, Inc. He received his Ph.D. from MIT in 1978. He has held visiting appointments at IBM, Carnegie-Mellon and Cornell Universities, Lucent Technologies, NASA and more. In the past he worked in several areas of theoretical computer science, including computability, logics of programs, database theory, and automata theory. In recent years he has become involved in software engineering, visual languages, layout of diagrams, modeling and analysis of biological systems, and the synthesis and

communication of smell. He is the inventor of statecharts, and co-inventor of live sequence charts, and was part of the design team of the Statemate and Rhapsody tools. His work is central to the UML. He devotes part of his time to expository work, including series on Israeli radio and television, and writings intended for a more general audience. He has received a number of awards, including ACM's Karlstrom Outstanding Educator Award, and the Israeli Prime Minister's Award for Software. His book, *Algorithmics: The Spirit of Computing* was the Spring 1988 Main Selection of the Macmillan Library of Science. He is a Fellow of the ACM and of the IEEE.

#### **Dr. Gilles Kahn**

Gilles Kahn is a former student of École Polytechnique (class of 1964). He began his career as a researcher at Stanford University in California where CEA, the French atomic energy agency, had sent him. His work was concerned with parallel programming. He rejoined INRIA in 1971. As project head, he conducted research on programming environments and later on computer proof environments. From January 1980 to July 1983 he was part of INRIA's management. In 1983, he participated in the creation of the INRIA Sophia Antipolis research unit where he started a research project on a programming environment: the Centaur system, based on a mathematical description of programming languages. Among the scientific responsibilities exercised by Gilles Kahn, in addition to his research work, is his participation in the commission of enquiry on the 501 Ariane flight in July 1996. He was also responsible, with Didier Lombard, for the publication of the report on *Research and Development, the Key to a New Expansion of Telecommunications In France*, in November 1996.

Gilles Kahn is also a member of the Academia Europæa and of the Scientific Board of the École Normale Supérieure of Lyon. He also chairs the Scientific Board of Cermics (the research center of the École des Ponts) and takes part in the Steering Committee of the International Institute of Software Technology of the United Nations University. In 1992, he received the Michel Monpetit Prize from the Academy of Science. In 1998, he was the first researcher in computer science to enter the French Academy of Science in the division of 'mathematical and physical sciences and their applications'.

#### **Dr. Carl Kesselman**

Carl Kesselman is the Director of the Center for Grid Technologies at the Information Sciences and a Research Associate Professor of Computer Science, at the University of Southern California. He received a Ph.D. in computer science from the University of California at Los Angeles, a Masters of Science in Electrical Engineering from the University of Southern California, and Bachelors in Electrical Engineering and Computer Science from the University of Buffalo. Dr. Kesselman's current research interests are in all aspects of Grid computing including basic infrastructure, security, resource management, high-level services and Grid applications. Together with dr. Ian Foster, he co-leads the Globus Project™, one of the leading Grid research projects in the world. An important result of the Globus has been the development of the Globus Toolkit™, which has become the de-facto standard for Grid computing. Dr. Kesselman has received the 1997 Global Information Infrastructure Next Generation Internet award, the 2002 R&D 100 award, the 2002 R&D Editors choice award, and the Ada Lovelace Medal from the British Computing Society.

#### **Dr. Johan de Kleer**

Johan de Kleer received his Ph.D. in Artificial Intelligence from the Massachusetts Institute of Technology in 1979. Widely published in the areas of qualitative physics, model-based reasoning, truth maintenance systems, and knowledge representation, Dr. de Kleer has co-authored three books: *Readings in Qualitative Physics*, *Readings in Model-Based Diagnosis*, and *Building Problem Solvers*. In 1987, he received the prestigious Computers and Thought Award at the International Joint Conference on Artificial Intelligence. Johan de Kleer is Manager of the Systems and Practices Laboratory, Palo Alto Research Center (PARC). The laboratory is interdisciplinary, conducting research ranging from social science to robotics.

Its research is based on the perspective that people, technology and the world with which they interact form a system that must be honored in order to make fundamental breakthroughs. Dr. de Kleer champions work to develop methodologies and technologies to support knowledge creation, use and sharing in organizations.

### **Prof. Gordon Plotkin**

Gordon Plotkin is a graduate of the University of Glasgow. He completed his doctorate at the University of Edinburgh in 1972, on the artificial intelligence topic, *Automatic Methods of Inductive Inference*. Since then his interests have moved more to theoretical computer science, where he has made contributions to the development of the denotational and operational semantics of programming languages and domain theory, and has made fundamental studies in full abstraction, the lambda calculus, structural operational semantics, sequentiality, concurrency and logical frameworks. His current interests include the algebraic theory of computational effects and computational systems biology. Most of his career has been spent at the University of Edinburgh where he is now Professor of Theoretical Computer Science, but he has also had a number of visiting positions, at Aarhus, Dec SRC, MIT, Paris and Stanford. He is a co-founder of the Laboratory for the Foundations of Computer Science (LFCS) and a Fellow of the Royal Society.

### **Prof. Arne Sølvberg**

Arne Sølvberg is Professor of Computer Science at the Norwegian University of Science and Technology (NTNU), Trondheim, Norway, since 1974. He received a siv.ing. (M.Sc.) degree in Technical Physics in 1963, and a dr.ing. (Ph.D.) degree in Computer Science in 1971, both from NTNU. Since 2002 he is Dean of the Faculty of Information Technology, Mathematics and Electrical Engineering at NTNU.

He has been active in international organizations for research cooperation. He was Norwegian national representative to IFIP General Assembly in 1979-1982. He has been chairman of IFIP WG8.1 for Information Systems Design in 1982-1988. He was a trustee in the VLDB Endowment until 1994. He was a co-founder of the CAiSE conference series. He has been a Visiting Scientist with IBM San Jose Research Labs, with the University of Florida, with the Naval Postgraduate School in Monterey, and with the University of California at Santa Barbara.

His main fields of competence are information systems design methodology, database design, information modeling, CASE tools and information systems engineering environments. He leads the research group for information systems at NTNU's Department of Computer and Information Science. He has been the advisor of more than twenty Ph.D. students over the last ten years. Since 1988 he has participated in several EU-sponsored research projects. He presently focuses his research on issues of information services, in particular semantic modeling of information, and modeling of services, e.g., in e-commerce.

### **Prof. Luc Steels**

Luc Steels was educated in linguistics and computer science at the University of Antwerp (Belgium) and the Massachusetts Institute of Technology (US). After working as researcher at the MIT AI Laboratory, he joined Schlumberger-Doll Research Labs in the US, focusing on the application of knowledge systems to the interpretation of geophysical data. In 1983 he founded the Artificial Intelligence Laboratory at the Vrije Universiteit Brussel (VUB) and became full professor of Computer Science. He was co-founder and first chairman of the computer science department at the VUB until 1994. In 1996 he founded the Sony Computer Science Laboratory and became the first director. He is still part-time professor at the VUB. Steels has worked in the main subdisciplines of artificial intelligence: natural language (particularly with recent work on modeling the origins and evolution of grounded languages through robotic experiments), robotics and vision (as one of the initiators of the 'behaviour-based approach'), knowledge systems (with contributions to knowledge-level analysis and design methodologies), and AI programming languages. Steels published a dozen books, mostly as editor or co-editor, and about two hundred scientific papers. He is an ECAI fellow and member of the New York Academy of Sciences.



# Appendix C:

## Discipline Protocol for the Review of Computer Science (with Annex)

### 1. Introduction

The *Assessment of Research Quality: Protocol 1998* (Utrecht, VSNU, 1998) describes the general principles and minimum requirements for the assessment of research quality as carried out in the *VSNU program for the assessment of the quality of research*. In addition to this, the present document specifies specific wishes and areas of attention, which should be incorporated in the assessment of computer science research that will take place in 2002.

The previous assessment of computer science, which took place in 1996 and which covered the period 1991-1995, was a joined assessment together with Mathematics. One of the recommendations of the Review Committee that carried out this evaluation was that future assessments of research in mathematics and computer science should be conducted separately. This suggestion was taken over by the VSNU. The 2002 research assessment of computer science will cover the period 1996-2001.

The following universities will participate in this research assessment:

Universiteit Leiden	Faculteit Wiskunde en Natuurwetenschappen
Universiteit Utrecht	Faculteit Wiskunde en Informatica
Rijksuniversiteit Groningen	Faculteit Wiskunde en Natuurwetenschappen
Rijksuniversiteit Groningen	Faculteit Psychologische, Pedagogische en Sociale Wetenschappen
Universiteit Maastricht	Faculteit Algemene Wetenschappen
Universiteit van Amsterdam	Faculteit der Natuurwetenschappen, Wiskunde en Informatica
Vrije Universiteit Amsterdam	Faculteit der Exacte Wetenschappen
Katholieke Universiteit Nijmegen	Faculteit der Natuurwetenschappen, Wiskunde en Informatica
Technische Universiteit Delft	Faculteit Informatietechnologie en Systemen
Technische Universiteit Eindhoven	Faculteit Wiskunde en Informatica
Universiteit Twente	Faculteit Informatica

### 2. Delineation and Required Expertise of Committee Members

In view of the research in the programs to be assessed, specific expertise should be represented in the Committee in the following subareas:

- Computer Systems and Networks
- Parallel and Distributed Computing
- Modeling, Simulation and Visualisation
- Multimedia
- Embedded Systems
- Information and Knowledge Systems
- Intelligent Systems, including Cognition
- Software Engineering
- Algorithms and Complexity
- Logic, semantics, Formal Models and Methods

This includes the priority themes that were put forth in the NOAG-i 2001-2005.

Members of the Review Committee should have a sufficiently broad view on the methodology and impact of computer science research as a whole, and should show a positive attitude towards both fundamental and applied aspects of research and the interdisciplinary character of the applications.

In view of the research in the programs to be assessed, specific expertise is required in the fields mentioned above. The Committee will be qualified to assess areas of research with a multi-disciplinary character which fall within more than one field.

The Review Committee will consist of as many members as necessary to cover all fields mentioned above, with a minimum number of five and a maximum of seven, the chair included. The Committee may decide to consult external experts when necessary.

The chairperson shall ensure that the Committee as a whole will feel responsible for the review of each (sub) program.

### **3. Information for the Committee and Procedures**

The research assessment computer science will cover the research published in the years from 1996 up to and including 2001.

The Review Committee is independent and will determine its own method of working, but within the framework of *Protocol 1998* and this *Discipline Protocol*. The assessment will be performed on the basis of a self-evaluation report provided by the research program directors and the faculty. The Committee will have meetings with all program directors, and if desired by the Committee, other participants in the research programs (e.g. Ph.D. students and postdocs). Each university involved may apply for a site-visit of (a part of) the Committee. It is left to the Committee to judge the arguments and to decide whether or not it includes site-visits as part of the assessment.

In preparation of the meetings, the Committee will announce the topics and the goal of the discussions that will be held with the faculty board (or an equivalent council) and the separate groups during the meeting.

The Review Committee shall assess each program within the scope of the mission statement of the program; it will also give an appraisal of the choice of the scientific area covered in the program in view of international developments of computer science.

Publications in scientific journals and conference proceedings as well as (chapters of) books should be taken into consideration.

The Committee is asked to take into account the future perspective of research programs and the recommendations of the previous assessment.

### **4. Research Programs**

A research program is defined as 'a coherent set of research activities having a common mission'; the work is executed by a group of people from the same institute. A program may contain research from more than one of the fields specified above. From the descriptions of the missions of the research programs the choice of the division into programs should become clear.

For the division into programs it is recommended that the situation in the last year of the evaluation be taken as starting point and any predecessors be incorporated in the description, cf. *Protocol 1998*, p. 30.

In principle, all research groups operating in computer science within the participating divisions shall be subject to evaluation in the research assessment.

An exception is allowed for those groups that are being phased out.

The research of a group that has experienced a significant switch in the research program during the period 1996-2001 will in general be considered as one (sub-)program or as part of merged (sub-)programs. Particularly for these groups and new groups that have started only recently, emphasis should be put on the future perspective of the program.

Graduate Research Schools are not subject of this quality assessment; an overview of the participation in different Graduate Research Schools will suffice.

### **5. Program Members**

In the self-evaluation report, the list of program members of each program shall include the following ranks:

- professors ('hoogleraar')
- associate professors ('universitair hoofddocent')
- (senior) lecturers/assistant professors ('universitair docent')
- fellows (e.g. KNAW fellows, EU fellows) and others with a Ph.D. degree involved in research such as postdocs

In accordance to the VSNU Protocol the list shall include all permanent staff members who were actively involved in the design, management and/or execution of the program during (part of) the assessment period. The list shall indicate the period during which the members were involved while being appointed by or paid for research at the institution (either through direct or indirect governmental funding (eerste en tweede geldstroom) or through external, industrial or European Union funding (derde geldstroom)).

## 6. Research Input of Academic Staff

In the assessment the research input of all personnel will be quantified on the basis of a fixed standard for each function. For the different functions the following standards shall be applied:

- |  |         |
|--|---------|
| • professors ('hoogleraar'):                                       | 0.4 fte |
| • associate professors ('universitair hoofddocent'):               | 0.4 fte |
| • (senior) lecturers/assistant professors ('universitair docent'): | 0.4 fte |
| • postdocs, fellows  | 1.0 fte |
| • junior researchers (aio/oio's)                                   | 0.8 fte |

Major deviations from the standard input due to special circumstances could be accounted for. The research input of the personnel will be calculated in proportion to the duration of the appointment. All junior researchers at the postgraduate level who have not (yet) obtained a Ph.D. degree are considered as Ph.D. students, including aio/oio's (see *Protocol 1998*, appendix 3, Section C, 6. Research output, p. 37 + p. 38). Postgraduate students involved in training in industrial design (TWAIO's) and technical staff shall not be included.

## 7. Output Categorization

Referring to the types of publications, which are mentioned in *Protocol 1998*, Appendix 4 (pp. 41-44), the following categories are taken into account in the table concerning research output in numbers:

- Ph.D. theses;
- academic publications, divided into refereed journal articles, refereed contributions to international conferences, and other refereed academic publications.

*Preconditions:*

- Publications from two or more authors participating in different research programs, either within one institution or in different institutions, will be included in all different participating research programs.
- Publications from part-time staff members or guests who are also employed by another organization will be included on the condition that the involvement of the particular research program is clear from the publication.
- 'Other refereed academic publications' include books and chapters.
- For contributions to conferences (published in the proceedings) it is required that the conference was international and that the contributions were refereed.
- other forms of scientific output (not covered by the above mentioned categories), such as e.g. software that is being used to some extent outside the research group where it has been developed.
  - Abstracts in journals, conference proceedings in the form of abstracts and all other non-refereed publications will not be included.
  - Editorships will not be included.

In accordance with these categories the table concerning research output in numbers (see *Protocol 1998*, appendix 3, Section C, 6. Research output, p.38) should read:

research output in numbers		1996	1997	1998	1999	2000	2001	total
Ph.D. theses								0
academic publications	refereed journal articles							0
	refereed contributions to international conferences							0
	other refereed academic publications (including books and chapters)							0
other forms of scientific output								0
<b>totals</b>								

In the self-evaluation report, a list of research output containing all Ph.D. theses, and all academic publications (with the restrictions stated above) for the period of the assessment will be provided.

In addition to the above-mentioned categories, the list of research output may contain other proofs of scientific productivity such as organization of congresses, editorships, etc. These last categories shall be included at the wish of the members-members for programs for which they are an important element of the research output.

Besides the above-mentioned research output, for each program five key publications from the period 1996-2001 will be presented and listed (see *Protocol 1998*, appendix 3, Section C, p.38, item 13).

### 8. Other Indicators for Quality, Reputation and Innovative Potential

For each program, in addition to the above-mentioned research output, other indicators for quality, reputation and innovative potential of the program shall be given. Possible indicators are e.g.:

- a) externally financed projects (EU, NWO (including STW), industry etc.);
- b) honorary doctorates, (inter)national awards, guest-professorships, editorships of learned journals, memberships of international editorial committees, memberships of international conference organizations and program committees, board/executive memberships, and elected memberships of international scientific organizations (professional societies, academies);
- c) specific results in citation indices.

### 9. Further Relevant Information for this Assessment

In the progress report attention will be paid to the following subjects:  
the role of the research program in the educational program. This can be done either for the organization as a whole (in part B of the report) or in part C (for each research program);  
local, national and international cooperation between the programs;  
interdisciplinary aspects of the program;  
the innovative approach of the program;  
the attention to HRM, in particular the professional training and guidance of Ph.D. students and permanent staff for personal academic development.

## 10. Procedures and (Tentative) Time Schedule

The following time schedule will be discussed and fine-tuned with the chairman of the Committee.

<b>Month</b>	<b>action</b>	<b>responsibility</b>
0 (before March 2002)	preparation of discipline protocol	DOO, VSNU, universities
1 (March 2002)	proposals for discipline protocol, the Committee chairperson and members	DOO, universities
2-3 (April- May 2002)	procedure for chairperson appointment, approval of <i>Discipline Protocol</i>	VSNU, KNAW
3-4 (May-June 2002)	procedure for Committee members appointment and chairman	DOO, VSNU, KNAW
6 (August 2002)	submission of information to VSNU before September 1, 2002	universities
9 (November 2002)	Committee meetings	Committee, VSNU, universities
12 (February 2003)	submission of draft report for institutes	Committee, VSNU
15 (May 2003)	publication of final report	VSNU

## **Annex to the Protocol for the Research Assessment Computer Science**

1. This annex is intended to determine to what extent the Draft Evaluation Protocol KNAW-NWO-VSNU can or must be incorporated in the research assessment for computer sciences.

### *Research Schools*

2. The research in computer science in the Netherlands is organized in three research schools specific for computer science (ASCI, SIKS and IPA), and the Dutch Research School in Logic (OzsL). The orientation of the schools and the participation of the various research groups within these schools is an important aspect in the evaluation and in the report. The Review Committee takes into account the orientation of research groups towards specific research schools.

### *Documentation*

3. The documentation provided by the institutions must comply fully with the *Protocol 1998*, and can be supplemented with an optional annex in which aspects of the *Draft Protocol 2002* are highlighted.

These aspects are (both for the level of the institute and for the level of the program):

- a) the organizational structure in which the research takes place, both in terms of the university/faculty/institute and in terms of the links with research schools, etc. (see *Draft Protocol 2002*, first paragraph of part A in appendix 3);
- b) an overview of the steering mechanisms, with a description of the procedures, management, quality control (see *Draft Protocol 2002*, parts A2 and B1 in appendix 3);
- c) an outline of the future perspectives (see *Draft Protocol 2002*, parts A11 and B10 in appendix 3). This may be done in the form of an 'Analysis of strengths and weaknesses, opportunities and threats' (see *Draft Protocol 2002*, chapter 4, page 11).

### *Committee*

4. The Committee will be asked to produce a report that takes into account all the information provided by the documentation as submitted.
5. The Review Committee must be composed such that there is a considerable amount of expertise on the major fields of research in the research schools. For each of the research schools (SIKS, IPA and ASCI) the Committee will have at least two members with acknowledged expertise in the areas of research in these schools.
6. The Review Committee conducts site visits of the groups participating in the review. The members of the Committee with expertise in the fields covered by the institute must participate in the site visit to that institute.

October 2, 2002

## Appendix D: Scientific Input per Program

	Technische Universiteit Eindhoven	program leader	graduate school	research input 2001	research input of academic staff '96-'01 (fte)
TUE1	Formal Methods	prof. dr. J.C.M. Baeten	IPA	14.70	81.30
TUE2	Software Construction	prof. dr. B.W. Watson	IPA	2.80	23.20
TUE3	Parallel Systems	prof. dr. P.A.J. Hilbers, dr. J.J. Lukkien	IPA	11.10	56.00
TUE4	Visualisation	prof. dr. ir. J.J. van Wijk	ASCI	2.80	18.10
TUE5	System Design and Analysis	prof. dr. ir. J.F. Groote	IPA	7.30	34.50
TUE6	Information Systems	prof. dr. P. de Bra, prof. dr. K.M. van Hee	SIKS	9.10	33.30
				<b>47.80</b>	<b>246.40</b>

	University of Twente				
UT1	Application Protocol Systems	prof. dr. ir. D.M. Konstantas		3.18	3.18
UT2	Computer Architecture Design and Test of Embedded Systems	prof. dr. ir. Th. Krol		5.52	22.90
UT3	Databases	prof. dr. W. Jonker	SIKS	8.76	51.66
UT4	Distributed and Embedded Systems	prof. dr. P.H. Hartel	IPA	5.87	32.56
UT5	Formal Methods and Tools	prof. dr. H. Brinksma	IPA	7.01	37.91
UT6	Information Systems	prof. dr. R.J. Wieringa	SIKS	6.61	19.94
UT7	Intelligent Media and Language Technology	prof. dr. ir. A. Nijholt	SIKS IPA	13.94 4.80	80.35 21.50
UT8	Software Engineering	prof. dr. ir. M. Aksit			
UT9	Telematics Systems and Services	prof. dr. ir. I.G.M.M. Niemegeers	TGS	15.53	97.10
				<b>71.22</b>	<b>367.10</b>

	<b>Vrije Universiteit Amsterdam</b>	<b>program leader</b>	<b>graduate school</b>	<b>research input 2001</b>	<b>research input of academic staff '96-'01 (fte)</b>
VU1	Artificial Intelligence	prof. dr. J. Treur	SIKS/ OzsL	12.30	47.70
VU2	Information Management and Software Engineering	prof. dr. J.C. van Vliet	SIKS/ ASCI	11.10	58.20
VU3	Computer Systems	prof. dr. A.S. Tanenbaum	ASCI	11.60	50.00
VU4	Theoretical Computer Science	prof. dr. J.W. Klop	IP/OzsL/ SIKS	2.30	23.80
				<b>37.30</b>	<b>179.70</b>

	<b>University of Maastricht</b>				
UM1	Knowledge and Agent Technology	prof. dr. H.J. van den Herik	SIKS	8.37	38.68
				<b>8.37</b>	<b>38.68</b>

	<b>University of Groningen</b>				
RUG1	Software Engineering	prof. dr. J. Bosch		2.40	2.80
RUG2	Fundamental Computer Science	prof. dr. G. Renardel	OzsL/ IPA	4.80	29.20
RUG3	Computing and Imaging	prof. dr. N. Petkov	ASCI	7.90	34.20
RUG4	System Technology	prof. dr. L. Spaanenburg	IPA	2.20	32.50
RUG5	Artificial Intelligence and Cognitive Engineering	prof. dr. L.R.B. Schomaker	SIKS	1.60	1.60
				<b>18.90</b>	<b>100.30</b>

	<b>University of Nijmegen</b>				
KUN1	Foundations	prof. dr. H.P. Barendregt	IPA	7.08	23.98
KUN2	Software Technology	prof. dr. R. Plasmeijer	IPA	3.57	27.57
KUN3	Information Retrieval and Information Systems	prof. dr. T. van der Weide	SIKS	2.77	21.45
KUN4	Informatics for Technical Applications	prof. dr. F. Vaandrager	IPA	11.52	52.13
				<b>24.94</b>	<b>125.13</b>

	<b>University of Amsterdam</b>	<b>program leader</b>	<b>graduate school</b>	<b>research input 2001</b>	<b>research input of academic staff '96-'01 (fte)</b>
UvA1	Algorithms and Complexity	dr. P. van Emde Boas	OzsL	1.54	25.56
UvA2	Constructive and Intensional Logic	prof. dr. J.F.A.K. van Benthem, prof. dr. D.H.J. de Jongh	OzsL	2.90	46.41
UvA3	Intelligent Autonomous Systems	prof. dr. ir. F.C.A. Groen	ASCI	6.18	37.66
UvA4	Language and Inference Technology	dr. M. Masuc, dr. M. de Rijke	OzsL/ SIKS	9.67	16.21
UvA5	Computational Informatics	prof. dr. P.M.A. Sloot	ASCI	7.10	47.95
UvA6	Programming Methods and Environments	prof. dr. J.A. Bergstra, prof. dr. P. Klint	IPA	3.48	36.50
UvA7	Intelligent Sensory Information Systems	prof. dr. ir. A. Smeulders	ASCI	11.48	69.83
UvA8	Advanced Computing Systems Engineering	prof. dr. L.O. Hertzberger	ASCI	8.50	49.00
				<b>50.77</b>	<b>329.12</b>

	<b>Utrecht University</b>				
UU1	Algorithmic Systems	prof. dr. J. van Leeuwen	IPA	5.00	26.8
UU2	Decision-Support Systems	prof. dr. ir. L.C. van der Gaag, dr. ir. D. Thierens	SIKS	4.70	5.3
UU3	Geometry, Imaging and Virtual Environments	prof. dr. M.H. Overmars	ASCI	13.29	64.3
UU4	Intelligent Systems	prof. dr. J.-J. Ch. Meyer	SIKS	5.50	41.6
UU5	Large Distributed Databases	prof. dr. A. Siebes	SIKS	1.90	2.3
UU6	Software Technology	prof. dr. L.G.T.L. Meertens, prof. dr. S.D. Swierstra	IPA	11.00	34.6
				<b>41.39</b>	<b>174.9</b>



## **Appendix E:**

### **Checklists for Internal Use by the Committee**

The Evaluation Committee may use the following checklists for the assessment of an institute and its research programs. Filled in checklists will not be published but are meant as a tool only.

*5 = excellent, 4 = very good, 3 = good, 2 = satisfactory, 1 = unsatisfactory*

#### **Institute**

How do you evaluate the institute with respect to:

- 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 of the institute
  - 1.8 Societal relevance of the institute
  - 1.9 Balance of the strengths and weaknesses of the institute
- Overall assessment of the institute

Remarks and questions:

#### **Research Program**

How do you evaluate the program with respect to:

- 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 relevance
  - 1.9 Balance of the strengths and weaknesses
- Overall

#### **Quality**

How do you evaluate quality with respect to:

1. Originality of the approach and ideas
  2. Significance of the contribution to the field
  3. Coherence of the program
  4. Publication strategy
  5. Prominence of the program director
  6. Prominence of the other members of the research group
  7. Quality of scientific publications (scientific impact)
  8. Quality of other results
- Overall assessment of quality

#### **Productivity**

Considering the number of staff, how do you evaluate the productivity with respect to:

1. Number of Ph.D. theses
2. Number of scientific publications
3. Number of professional publications

4. Other results (if applicable)
  5. Distribution of published output within the group
- Overall assessment of productivity

**Relevance**

Considering the stated mission of this program, how do you evaluate the relevance of the research with respect to:

1. The advancement of knowledge
2. The dissemination of knowledge
3. The implementation of knowledge

Overall assessment of relevance

**Vitality and Feasibility**

Considering the present status and future developments (if known) of staff and facilities, how do you evaluate the long-term viability of the program:

1. In view of the past scientific performance
2. In view of future plans and ideas
3. In view of staff age and mobility

Overall assessment of vitality

## Appendix F:

### Graduate Schools for Computer Science

#### 1. SIKS: Dutch Research School for Information and Knowledge Systems

SIKS' mission statement is:

- to perform high-level fundamental and applied research in the field of information and computing science; more particularly in the field of information and knowledge systems;
- to organize a high-quality four-year educational program for its Ph.D. students, employed at ten universities in the Netherlands or at leading companies in the field of ICT;
- to facilitate and stimulate cooperation and communication between members (Ph. D. students, research fellows, senior research fellows and associated members), and between the School and its stakeholders, including leading (industrial) companies in the field of ICT.

The research program concerns the study of information systems and knowledge systems (*Informatie- en Kennissystemen* or IKS) from the perspectives of the following scientific areas:

- Database systems, as studied in computer science
- Information systems, as viewed from their areas of application
- Knowledge engineering, as studied in artificial intelligence
- Software engineering, as it is applied to IKS

For more information, see: [www.siks.nl](http://www.siks.nl)

#### 2. IPA: Institute for Programming Research and Algorithmics

The principal goal of IPA is to educate researchers in the field of programming research and algorithmics. This research field comprises: the study and development of formalisms, methods, and techniques to design, analyze, and construct software systems and components. Research in IPA is concentrated in three research areas:

- Algorithms and complexity theory
- Formal methods
- Software technology

IPA has chosen the following topics as foci for the application of research:

- Testing
- Software architecture
- Embedded systems
- Algorithms for planning and design
- Natural computing
- Software renovation

For more information, see: [www.win.tue.nl/ipa](http://www.win.tue.nl/ipa)

#### 3. ASCI: Advanced School for Computing and Imaging

The research in ASCI focuses on two main themes: Computer Systems and Imaging Systems.

*Computer Systems* deals with methods and techniques for the design and implementation of advanced computer systems, especially parallel, distributed, embedded and real-time systems. These kinds of computer systems are essential for large applications such as weather forecasting, the modeling of molecular structures for the development of new medicines, and so on. These and many similar applications need high performance

computer systems. In addition, highly distributed systems, such as the Internet, are becoming increasingly important.

*Imaging Systems* focuses on methods and techniques for the analysis and synthesis of images. Many of the applications, such as the ones mentioned above, generate enormous amounts of data, which humans can only interpret after some form of computer processing. Image synthesis aims at the visualization of data for the human eye, while image analysis is more oriented to the automatic interpretation of data. In addition, sensor systems are being studied, such as magnetic resonance devices.

These two areas frequently overlap, creating areas of fruitful research. For example, advanced imaging systems often need massive parallel computing systems due to the amount of data to be processed. Multimedia is another increasingly important area.

For more information, see: [www.asci.tudelft.nl](http://www.asci.tudelft.nl)

#### **4. OZSL: Dutch Graduate School in Logic**

The aim of the *Onderzoekschool Logica* is to guide the development of logic research in the Netherlands in the direction of the vision of logic as a core part of an emerging new science of information processing, and to make sure that the Netherlands will continue to play a prominent role in this development. The ambitions of the school translate into the following mission statement:

1. to continue the traditionally prominent position of Dutch logic research in the foundations of mathematics;
2. to further develop Dutch research activities in the fields of logic in computer science, logic and artificial intelligence, and logic, philosophy and linguistics (areas where Dutch logic has achieved considerable success in the past two decades);
3. to encourage the development of new areas where logic, viewed as the science of the formal aspects of information processing, could play an important role;
4. to disseminate the insights that logic can yield about various aspects of information processing outside academia (in particular, to pre-academic training in secondary schools, to higher vocational training in computer science, and to information processing in the software industry).

For more information, see: [www.ozsl.uva.nl](http://www.ozsl.uva.nl)

#### **5. TGS: Telematics Graduate School**

The Telematics Graduate School (TGS) is a research school that performs multidisciplinary research on telematics systems and the use of telematics. The secretariat of the TGS is provided by the University of Twente. TGS has chosen to focus on research programming and is therefore completely integrated with the Centre for Telematics and Information Technology (CTIT), a multidisciplinary research institute of the University of Twente, whose mission is to conduct research on the design of complex telematics and information technology systems, including their embedding in the user environment. The research of the Telematics Graduate School is situated at the heart of the CTIT, i.e., it is aimed at telematics research in a multidisciplinary context. The following research themes are central:

- Telematics services
- Embedded systems for ubiquitous computing and communication
- Security and privacy in a networked world
- Multimedia and virtual reality

For more information, see: [www.tgs.ctit.utwente.nl](http://www.tgs.ctit.utwente.nl)

## Appendix G: Grades for the Programs According to the SEP Scale

5 = excellent, 4 = very good, 3 = good, 2 = satisfactory, 1 = unsatisfactory

In this table figures have been used. With + and – the Committee has indicated some subtleties that could not be expressed in the general description of the grades of the Standard Evaluation Protocol.

RP = research program  
Q = quality  
P = productivity  
R = relevance  
V&F = vitality and feasibility

<b>Technische Universiteit Eindhoven</b>		<b>RP</b>	<b>Q</b>	<b>P</b>	<b>R</b>	<b>V &amp; F</b>
TUE1	Formal Methods	4	4	3	4-	4
TUE2	Software Construction	3	3	4	3	3-
TUE3	Parallel Systems	3	3	4	4	3
TUE4	Visualisation	2	3	3	3-	2
TUE5	System Design and Analysis	3½	3	3	4-	3
TUE6	Information Systems	4	3	4	4	4
<b>Universiteit Twente</b>						
UT1	ApplicationProtocol Systems	3	3	2	4+	1
UT2	Computer Architecture Design and Test of Embedded Systems	4	3+	2	4+	4-
UT3	Databases	4-	4-	4	4+	3+
UT4	Distributed and Embedded Systems	4	4	3	5	4
UT5	Formal Methods and Tools	5-	4+	4	4+	3+
UT6	Information Systems	4-	4	3	4	3
UT7	Intelligent Media and Language Technology	3-	3	5	3	3+
UT8	Software Engineering	3+	4-	3	4	3
UT9	Telematics Systems and Services	3-	3+	3	3+	3-
<b>Vrije Universiteit Amsterdam</b>						
VU1	Artificial Intelligence	4+	5-	4	5-	4
VU2	Information Management and Software Engineering	3+	3+	4	4-	3
VU3	Computer Systems	4+	5-	3	4	4
VU4	Theoretical Computer Science	3	4	3	3	3+
<b>Universiteit Maastricht</b>						
UM1	Knowledge and Agent Technology	3	4-	5	4	3

<b>Rijksuniversiteit Groningen</b>		<b>RP</b>	<b>Q</b>	<b>P</b>	<b>R</b>	<b>V &amp; F</b>
RUG1	Software Engineering	n.a.	n.a.	n.a.	n.a.	n.a.
RUG2	Fundamental Computer Science	n.a.	n.a.	n.a.	n.a.	n.a.
RUG3	Computing and Imaging	n.a.	n.a.	n.a.	n.a.	n.a.
RUG4	System Technology	n.a.	n.a.	n.a.	n.a.	n.a.
RUG5	Artificial Intelligence and Cognitive Engineering	n.a.	n.a.	n.a.	n.a.	n.a.
<b>Katholieke Universiteit Nijmegen</b>						
KUN1	Foundations	4	5	2	4+	3
KUN2	Software Technology	2	3	2	3-	2
KUN3	Information Retrieval and Information Systems	3	3	4	3	4
KUN4	Informatics for Technical Applications	5	4	2	5	4
<b>Universiteit van Amsterdam</b>						
UvA1	Algorithms and Complexity	3	4	5	3+	2
UvA2	Constructive and Intensional Logic	4	4+	3	3+	3
UvA3	Intelligent Autonomous Systems	3	4-	3	4	3
UvA4	Language and Inference Technology	3	3	5	4	3
UvA5	Computational Informatics	4	4	4	4-	4
UvA6	Programming Methods and Environments	3+	3+	3	3	3-
UvA7	Intelligent Sensory Information Systems	4+	4+	5	5	5-
UvA8	Advanced Computing Systems Engineering	3	3	2	3	3
<b>Universiteit Utrecht</b>						
UU1	Algorithmic Systems	4+	5-	3	3+	3-
UU2	Decision-Support Systems	4+	4	4	4	4
UU3	Geometry, Imaging and Virtual Environments	4+	4	3	3+	4
UU4	Intelligent Systems	4-	4	4	3	4-
UU5	Large Distributed Databases	2	3-	3	3	3
UU6	Software Technology	4	3+	3	3	3

## Appendix H:

### Grades for the Programs According to the VSNU Protocol 1998

5 = excellent, 4 = good, 3 = satisfactory, 2 = unsatisfactory, 1 = poor

<b>Technische Universiteit Eindhoven</b>		<b>Q</b>	<b>P</b>	<b>R</b>	<b>V &amp; F</b>
TUE1	Formal Methods	4,5	4	4.375	4.5
TUE2	Software Construction	4	4.5		3.75
TUE3	Parallel Systems	4	4.5	4.5	4
TUE4	Visualisation	4	4	3.75	3
TUE5	System Design and Analysis	4	4	4.375	4
TUE6	Information Systems	4	4.5	4.5	4.5
<b>Universiteit Twente</b>					
UT1	ApplicationProtocol Systems	4	3	4.625	2
UT2	Computer Architecture Design and Test of Embedded Systems	4.125	3	4.625	4.375
UT3	Databases	4.375	4.5	4.625	4.125
UT4	Distributed and Embedded Systems	4.5	4	5	4.5
UT5	Formal Methods and Tools	4.625	4.5	4.625	4.125
UT6	Information Systems	4.5	4	4.5	4
UT7	Intelligent Media and Language Technology	4	5	4	4.125
UT8	Software Engineering	4.375	4	4.5	4
UT9	Telematics Systems and Services	4.125	4	4.125	3.75
<b>Vrije Universiteit Amsterdam</b>					
VU1	Artificial Intelligence	4.875	4.5	4.875	4.5
VU2	Information Management and Software Engineering	4.125	4.5	4.375	4
VU3	Computer Systems	4.875	4	4.5	4.5
VU4	Theoretical Computer Science	4.5	4	4	4.125
<b>Universiteit Maastricht</b>					
UM1	Knowledge and Agent Technology	4.375	5	4.5	4

<b>Rijksuniversiteit Groningen</b>		<b>Q</b>	<b>P</b>	<b>R</b>	<b>V &amp; F</b>
RUG1	Software Engineering	4.375	5	4.5	5
RUG2	Fundamental Computer Science	4	3	3.75	3.25
RUG3	Computing and Imaging	4	4	4	4
RUG4	System Technology	n.a.	n.a.	n.a.	n.a.
RUG5	Artificial Intelligence and Cognitive Engineering	3.75	4	4	4
<b>Katholieke Universiteit Nijmegen</b>					
KUN1	Foundations	5	3	4.625	4
KUN2	Software Technology	5	3	3.75	3
KUN3	Information Retrieval and Information Systems	4	4.5	4	4.5
KUN4	Informatics for Technical Applications	4.5	3	4	4.5
<b>Universiteit van Amsterdam</b>					
UvA1	Algorithms and Complexity	4.5	5	4.125	3
UvA2	Constructive and Intensional Logic	4.625	4	4.125	4
UvA3	Intelligent Autonomous Systems	4.375	4	4.5	4
UvA4	Language and Inference Technology	4	5	4.5	4
UvA5	Computational Informatics	4.5	4.5	4.375	4.5
UvA6	Programming Methods and Environments	4.125	4	4	3.75
UvA7	Intelligent Sensory Information Systems	4.625	5	5	4.875
UvA8	Advanced Computing Systems Engineering	4	3	4	4
<b>Universiteit Utrecht</b>					
UU1	Algorithmic Systems	4.875	4	4.125	3.75
UU2	Decision-Support Systems	4.5	4.5	4.5	4.5
UU3	Geometry, Imaging and Virtual Environments	4.5	4	4.125	4.5
UU4	Intelligent Systems	4.5	4.5	4	4.375
UU5	Large Distributed Databases	3.75	4	4	4
UU6	Software Technology	4.125	4	4	4

## Appendix I: Abbreviations and Nomenclature

Aio	Ph.D. student appointed by the university (assistant in opleiding)
ASCI	Advanced School for Computing and Imaging (research school)
Bsik	Subsidy for investments in the research capacity in the Netherlands (Besluit Subsidie Investerings Kennisinfrastructuur)
CWI	Centre for Mathematics and Computer Science (Centrum voor Wiskunde en Informatica)
DOO	Discipline Committee (disciplineoverlegorgaan): inter-university consultative body of faculty representatives. May be subdivided into
two	or more subcommittees (kamers)
Fte	Full time equivalent
IPA	Research School for Programming Research and Algorithmics
JACQUARD	Joint Academic and Commercial Quality Research & Development
KNAW	Royal Netherlands Academy of Arts and Sciences (Koninklijke Nederlandse Academie van Wetenschappen)
KUN	University of Nijmegen (Katholieke Universiteit Nijmegen)
NOAG-i	National Research Agenda for Computer Science (Nationale Onderzoeksagenda Informatica)
NWO	Netherlands Organization for Scientific Research (Nederlandse Organisatie voor Wetenschappelijk Onderzoek)
Oio	Ph.D. student appointed by NWO (onderzoeker in opleiding)
Ozsl	Graduate School in Logic (Onderzoekschool Logica)
PROGRESS	Program for Research on Embedded Systems & Software
RUG	Groningen University (Rijksuniversiteit Groningen)
SEP	Standard Evaluation Protocol 2003-2009 for Public Research Organizations
SIKS	Research School for Information and Knowledge Systems
STW	Technology Foundation STW is the Dutch funding agency for application oriented university research and is a part of NWO (Technologiestichting STW)
TGS	Telematics Graduate School
TNO	Netherlands Organization for Applied Scientific Research (Nederlandse Organisatie voor toegepast natuurwetenschappelijk onderzoek)
TUE	University of Eindhoven (Technische Universiteit Eindhoven)
uhd	Associate professor (universitair hoofddocent)
ud	Assistant professor (universitair docent)
UM	University of Maastricht (Universiteit van Maastricht)
UT	University of Twente (Universiteit Twente)
UU	Utrecht University (Universiteit van Utrecht)
UvA	University of Amsterdam (Universiteit van Amsterdam)
VSNU	Association of Universities in the Netherlands (Vereniging van Universiteiten)
VU	Free University Amsterdam (Vrije Universiteit)
WP	Academic staff (wetenschappelijk personeel)
WP1	Academic staff directly funded by government (eerste geldstroom wp)
WP2	Academic staff funded by NWO and KNAW (tweede geldstroom wp)
WP3	Academic staff funded by third parties, not NWO or KNAW (derde geldstroom wp)



## Appendix J:

### ADDENDUM/ERRATUM

After publication of its report, the Review Committee has received a letter from the Executive Board of Groningen University in which the Board notifies the Committee that they wish to object to the assessment of programme RUG 3 “Computing and Imaging”. The objections of Groningen University (RUG) focused on two points:

1. The quality and the relevance (in terms of advancement, dissemination and application of knowledge) of programme RUG 3 were underrated by the Committee.
2. The original assessment had insufficiently taken into account the specific mission of the Institute of Mathematics and Computing Science and the Faculty of Mathematics and Natural Sciences of the RUG, which concentrates on publications in high quality international scientific journals and dissertations. This had a negative influence on the ratings of programme RUG 3, e.g. because the equal weight factor that the committee used for journal articles and conference proceedings in the calculation of research output and the heavy weighting of post-docs used in the calculation of the personnel input (2.5 times that of a faculty member) put this programme at a disadvantage.

The committee has seriously studied the arguments and objections, on the basis of extensive documentation provided by Groningen University, and has found that there are grounds for an addition to and a revision of the assessment:

- It appears that some miscommunication has occurred during the site visit which determined a negative impression about the contribution of the programme to the implementation of knowledge. In our original assessment, we had the impression that the programme should broaden its scope by looking at more fundamental issues and tackle more generic problems. However, looking more closely at the concrete applications and deliverables, the Committee observes a clear orientation towards applications of imaging technologies to biology and medicine, and that within those domains the problems have generic significance (breast cancer identification, identification of bacteria, diatom identification, functional neuroimaging, bioinformatics, biological vision modelling, development of algorithms, microflora simulation, etc).
- After studying not only the five key publications, but the entire body of publications, we notice a progressive improvement in the quality of publications from 1996 to 2001 and a progressive focusing on two principal areas of investigation: pattern recognition and image processing, and computational geometry and scientific visualisation. As a sign of reached maturity, the program has been split by RUG in two distinct programs: on Intelligent systems (biologically motivated computer vision and machine learning), and Scientific Visualization and Computer Graphics (for life science applications).

Considering the contributions to the implementation of knowledge, the scientific impact of the entire publication body, and the progressive improvement and maturity achieved in the programme, our original score for Relevance was too severe. On these grounds the Committee has changed the score for Relevance from “Satisfactory” to “Good”.

The Committee also sees reasonable arguments by RUG on the point of the quality score of RUG3. The Committee definitely wishes to acknowledge that the mission of the programme gives special attention to publications in high quality international scientific journals, following the advice of the previous review committee in 1996. The output of the programme shows that this policy has been successful.

The fact that in the productivity calculations equal weight was given to journal papers and conference contributions, was based on considerations that the Committee finds valid regarding the field of computer sciences as a whole, but we acknowledge that in the more science orientated fields of computer imaging this reasoning has its limitations. The Committee has not changed the score for Quality (“Good”), mainly because we felt we were unable to re-tune all assessments in this stage.

