Research Review of Mathematics during 2003–2008 at the six Dutch Universities of Amsterdam (UvA), Amsterdam (VU), Groningen (RUG), Leiden (UL), Nijmegen (RU), and Utrecht (UU)

June 22, 2010

Contents

Preface

This report summarizes the results of the peer review assessment of the research programmes in mathematics of six universities, UvA, VU, RUG, UL, RU, and UU, in The Netherlands during the period 2003-2008. According to the *Plan van aanpak onderzoeksbeoordeling Wiskunde 2003-2008*, the evaluation was carried out by a Committee consisting of a chair and seven members, plus a secretary. The areas of expertise of the Evaluation Committee covered Algebra, Analysis, Applied Analysis, Dynamical Systems, Geometry, Numerical Analysis, Probability Theory, Systems and Control, and Decision Theory. The information in print provided to the Evaluation Committee consisted of a *Self Assessment Report 2003-2008* by each university, the evaluation *Research Assessment Mathematics, QANU, August 2004 (1996-2001)*, and the *Standard Evaluation Protocol 2003-2009*. Data over the year 2002 was presented in order to ensure continuity with the previous review. The chair of the Committee also served as chair for the assessment of the research programmes in Applied Mathematics for the three Dutch technical universities. The assessment procedures were largely the same for both assessments. In discussions of the Committee, the chair explained how the assessments for the technical universities were carried out.

The Committee wishes to express its gratitude for the efforts made by all involved parties to prepare the documentation required for this evaluation. This documentation contained valuable information and formed a very useful basis for the evaluation procedure. The Committee received also a CWTS bibliometric analysis report for all groups involved[1]. The Committee has not made an evaluation of this CWTS study. It was used as additional information in order to support the findings of the Committee, and to help prevent possibly wrong conclusions. The CWTS report was used only in a late stage of the evaluation procedure and did not influence our initial findings, nor did it contribute significantly to any of our final conclusions.

Preliminary reviews of each institute and programme were prepared independently by two members of the Committee in the fall of 2009. These preliminary reviews were not distributed over the Committee: they served merely to ensure that each part of the documents had been studied more carefully by at least two members. These reviews were summarized and defined the basis for the the main part of the evaluation process. During November 15–20, 2009, the Committee met in person in Utrecht in meeting rooms hired from the Department of Law of Utrecht University. All groups involved were invited to come to Utrecht. This helped to make the assessment more efficient, because no time was lost in travelling for the Committee members so that the whole procedure could be completed within five days. A disadvantage was that the Committee could not smell the atmosphere, nor inspect the working circumstances at the universities. During the meeting days, the Committee met with directors of the institutes, representatives of each group, and a selection of PhD students. The Committee also met with representatives of each faculty, usually the Dean and the "Onderzoeksdirecteur". The discussions, which took in the order of 45 minutes for each group, took place in a pleasant informal atmosphere and they proved essential for the convergence of the opinions within the Committee to their final state. The Committee is very thankful to all involved representatives for their willingness to share their opinions and concerns with us in a very frank manner. At the end of the meetings for each university, the chair reported the first impressions at an informal meeting.

[1] Alesia A. Zuccala, Martijn S. Visser and Henk F. Moed, "Bibliometric Study for the Mathematics Departments at Dutch General Universities", Centre for Science and Technology Studies (CWTS), Leiden University, Draft Version 11 November 2009.

The Committee acknowledges the secretarial support, in the person of Dr. Herman te Riele, for all administrative matters and technical guidance for the evaluation procedure. He made also certain that our meeting in The Netherlands was well organized. Herman, in daily life a mathematician at CWI, made excellent notes of the meetings. These were very helpful to support our memories while drafting this report.

Let me take this opportunity, as chair of the Committee, to thank my fellow Committee members for their commitment and dedication to this evaluation process. We have worked together as a true team, open-minded and thoughtful. This made the assessment an as pleasant task as could be. We all realized the formidable challenge of this task, the importance and consequences for the assessed groups, and I am pleased to conclude that this report reflects the consensus opinions of the Committee.

Henk A. van der Vorst
Chair

Chapter 1

Introduction

1.1 The Dutch System for Quality Assessment of Research

The quality assessment of research in mathematics is part of an assessment system worked out in the *Standard Evaluation Protocol For Public Research Organizations* of January 2003 by the Association of Universities in The Netherlands (VSNU), the Netherlands Organization for Scientific Research (NWO), and the Royal Netherlands Academy of Arts and Sciences (KNAW).

1.2 The Review Committee for Mathematics

The Review Committee for Mathematics consisted of the following persons. Their specialities are given in italics.

- Prof.dr. Henk A. van der Vorst, Mathematical Institute, Utrecht University (retired), chair
  computational science, numerical mathematics
- Prof.dr. Werner Ballmann, Mathematisches Institut, Rheinische Friedrich-Wilhelms-Universität Bonn, Germany
  geometry
- Prof.dr. Eva Bayer, Ecole Polytechnique Fédérale de Lausanne, Switzerland
  algebra, number theory
- Prof.dr. Alain Bensoussan, University of Texas at Dallas, Texas, U.S.A.
  systems theory, operations research
- Prof.dr. Peter Jagers, Department of Mathematical Statistics, Chalmers University of Technology and University of Gothenburg, Sweden
  stochastics
- Prof.dr. Tom Koornwinder, Korteweg-de Vries Institute for Mathematics, University of Amsterdam (retired)
  pure analysis
- Prof.dr. Elmar Schrohe, Institut für Analysis, Leibniz Universität Hannover, Germany
  analysis
- Prof.dr. Sebastian van Strien, Department of Mathematics, University of Warwick, England
  dynamical systems

A short curriculum vitae of each of the Committee Members is given in Appendix A.

Dr.ir. Herman J.J. te Riele, Centrum Wiskunde & Informatica Amsterdam, was appointed Secretary of the Review Committee.

1.3 Independence

All Committee members have signed the following declaration of unbiasedness:

... declares that his/her contribution to the assessment of research of Mathematics at the six Dutch universities of Amsterdam (UvA), Amsterdam (VU), Groningen, Leiden, Nijmegen, and Utrecht will be objective and without prejudice. His/her knowledge of and connections with these six Dutch universities will not influence this.

1.4 Scope of the Assessment

The review Committee was asked to perform an assessment of the research at six institutes concerning Mathematics at the University of Amsterdam (UvA), the VU University Amsterdam (VU), Groningen University (RUG), Leiden University (UL), Radboud University Nijmegen (RU), and Utrecht University (UU). The review covers the research of seventeen research programmes over the period 2003 – 2008.

In accordance with the Standard Evaluation Protocol 2003-2009 for Public Research Organisations (SEP), the Committee's tasks were to assess the quality of the institutes and the research programmes on the basis of the information provided by the institutes and through interviews with the management, research leaders, and PhD students, and to advise how this quality might be improved.

1.5 Data provided to the Committee

The Committee has received the following detailed information:

1. Self-evaluation reports of the six institutes under review, including all the information required by the Standard Evaluation Protocol (SEP), with appendices;
2. Copies of five key publications per research programme;
3. CWTS studies.

1.6 Procedures followed by the Committee

The Committee proceeded according to the SEP. Prior to the first Committee meeting, each institute and research programme was assigned to two Committee members for review. A preliminary assessment was independently formulated on the basis of the key publications[1]. The Committee discussed the preliminary assessments. For each research programme a number of comments and questions were decided upon. The Committee also agreed upon procedural matters and aspects of the assessment. The final assessments are based on the documentation provided by the institutes, the key publications and the interviews with the management and with the leaders of the programmes[2]. For logistic reasons, no site visits took place, but representatives from the institutes were invited for interviews to a central location in Utrecht (Pietershof) on November 16–20, 2009 (see the schedule in Appendix B). After the interviews, the Committee discussed the scores and comments. The text for the report was finalised through e-mail exchange. The final version was presented to the institutes for factual corrections and comments. The comments were discussed by the Committee and led to changes in the report on a number of points. The final report was

[1] Two different forms were used; one for the Institutes and one for the Programmes: see Appendix D.

[2] In this report, the assessments made by the review committee are always given under the boldface heading: **Assessments**, ending at the next numbered (sub)paragraph. Many texts are copied literally or almost literally (i.e., made anonymous) from the self evaluations and the SWOTs of the institutes. By copying these texts the committee confirms them but these should *not* be considered as assessments by the review committee.

presented to the Boards of the participating universities and was printed after their formal acceptance. The Committee used the rating system of the SEP. The meaning of the scores is described in Appendix C.

Chapter 2

General Remarks

Research in mathematics at the six universities in this assessment as a whole should cover a wide field. This is necessary for education and research. Sub-areas in mathematics are not isolated identities: Insights and results flow naturally between these sub-areas. New results in geometry or analysis may lead to new results in stochastics or numerical analysis, and vice versa. Many applications in other sciences, industry, and daily life can be traced back to various sub-areas in mathematics, from very applied to very pure. However, given the small sizes of the programmes, it is clear that not all sub-areas can or should be covered by each university. Indeed, we observed that there is quite some specialization and focus per university, while together and in concert they still cover a broad part of mathematics. This combination of local specialization and global collaboration, in order to maintain the full spectrum of research at the national level, was further stimulated by the so-called research cluster programme. All mathematical groups in this assessment haven been involved in these clusters, have contributed to it and have benefited from it. It should also be mentioned that the Dutch mathematicians work together remarkably well in their educational programmes, most notably in the Dutch Mastermath programme.

We mentioned the small sizes of the various programmes. Compared with the situation in other European countries these programmes are very small indeed, even if we consider them as clusters at the national level. Without going into much detail, it was mentioned as an example by the foreign experts in the Committee that France has about 4000 mathematical researchers in the system[1]. It would be embarrassing and painful to mention the number of mathematical researchers in The Netherlands in this public report. This kind of information is not new, similar numbers for other countries have been published in various reports on the problematic research situation for mathematics in The Netherlands[2]. The common opinion of the foreign members was that if we had to give a score for viability of the Dutch research environment for mathematics, then that score would be very low. Within the rather hostile research climate for the fundamental sciences, the Dutch mathematical research programmes are almost as viable as can be. Whether they are large enough to take part in the international research arena in such a way that new and important developments are picked up rapidly enough and digested for the Dutch innovation based economy is a different question.

The sizes of the groups have to do with the Dutch funding system. In this system, the amounts of basic funding depend on parameters that are used to subdivide the lump sum of research money over the universities (and hence over Departments and Institutes). These parameters include the numbers of undergraduate students, the numbers of PhD theses and the amount of research funds acquired from the "Tweede Geldstroom", mainly NWO and STW. The total number of students in mathematics in The Netherlands is stunningly low, to be compared, for instance, with some

[1] `ftp://trf.education.gouv.fr/pub/edutel/personnel/enssup/demogsup2007.pdf`

[2] "Concentratie & Dynamiek. Een strategie voor de wiskunde", NWO, May 2008, en "Masterplan Toekomst Wiskunde", NWO, December 2008.

universities in France or Germany. The amount of money in the "Tweede Geldstroom", available from NWO for the Exact Sciences (Mathematics, Informatics, and Astronomy) is also low, too low in comparison with most other sciences. The total number of PhD positions in the NWO-Vrije Competitie, is in the order of 10 for all Dutch mathematical programmes together. A small part in the NWO-cake automatically leads to a small part in direct funding. In this sense, mathematics is underfunded. If, for budget reasons, the "Tweede Geldstroom" cluster-funding is reduced, then that would be disastrous, also because of its effects on the basic funding.

One could argue that the relatively small numbers of students do not need more staff. This is only partly true. Mathematics differs from most other sciences in that it studies virtual entities, which live mainly in the brains of the researchers. It is all about insight and only in small part on facts. This means that students have to be trained in acquiring, building, and judging insight, rather than spending their time with the learning of facts or by doing experiments in a lab. The numbers of teaching classes is, for mathematics, not more than for any other science and, because of the low numbers of students, the time spent in this form of teaching is relatively low. However, the amounts of time necessary for individual coaching for helping to build understanding and insight is enormous. We became aware of this once more in our discussions with the PhD students. They invariably mentioned that the doors of their advisers are always open and that they used these opportunities almost on a daily basis rather than a weekly one. This is also an explanation of the empirical fact that a thesis adviser in mathematics can hardly handle more than about four students all together. For the discussions on the research topics it is necessary to have understanding of the deep theoretical results which asks for deep concentration. It is almost impossible to spread this deep concentration over more than three or four different topics. The numbers of students have risen over the past years, while staff has decreased in numbers. The general complaints on the heavy teaching duties in the interviews and self-assessment reports are very understandable.

This should all be taken into account when a Committee investigates scope and level of mathematics programmes. In past evaluations the quality of these programmes have been assessed in general as above average, and as competitive at the international level. As a result of budget cuts, the relatively weaker groups have often been stopped, and reorganizations have taken place to maintain coherence in the smaller sized groups that had to keep a broad spectrum of expertise. Necessarily this has locally led to posing priorities, which often means that one has to give up important areas of expertise. One has to do more with less manpower. It is evident that this cannot go on endlessly, without negative effects. One has to realize that critical mass is mandatory in order to be able to compete at the highest international level. One has to be member of an international network in order to stay aware of the newest trends and discoveries and these new developments may be essential for breakthroughs in the applications at hand. Our evaluation has been made with the above in mind. It would not be fair to punish hard working and highly competent researchers for insufficient funding.

We found, much to our positive surprise, that the mathematics groups in general are well-composed with sufficient coherence in order to absorb and deal with important and highly relevant research challenges. This is often the result of quite recent reorganizations or reshuffling of groups and in that respect for some groups the evaluation comes a bit early to see the positive effects in more glory. However, in most cases the indications point in positive directions and give confidence for the viability of all groups. Practically all of the researchers involved in this assessment act in the forefront of international research and are visible there, by publications, by presentations on conferences and the like and by participating in international, often informal, networks. Research in mathematics has long been viewed as a highly individual activity, but, even if this would have been true in the past, this is in any case not the situation in modern research. We have seen that there is not only much research contact within programmes, but also across programmes and at the national scale. We have also observed that over the past evaluation period, the researchers have become much more involved in all sorts of applications. There are frequent contacts with industry, society, other sciences (for instance, the life sciences). As an example we mention the

active participation in forensic sciences. Expert knowledge in statistics is now used in some important court cases. New insights in number theory, a field almost as pure as can be, are of utmost importance for security in financial (or online) transactions.

A word on the *scores*. For the ratings we have used, of course, the guidelines in the SEP protocol. Although they seem to be clear, they often posed problems to the Committee. For example, there seems to be a tendency that only the two highest SEP-scores (4 and 5) are acceptable for the responsible leaders. This might lead to undesirable inflation. The SEP-score 3 indicates that (we cite from the SEP protocol): "the work is competitive at the national level and will probably make a valuable contribution in the international field. Institute is considered internationally visible and a national player." Given the fact that research in mathematics is carried out at a very high level both in our country and in neighbouring countries (where the Committee members come from), a score 3 really means "good" at that high level, and it certainly does not mean anything less than "good". We have followed the SEP Guidelines as closely as possible and if a group was considered to be good, without any negative aspects, we used the score 3.
There are some groups in The Netherlands working on rather narrow fields of mathematics. This sometimes poses problems with respect to determining adequate scores. For instance, quality could be above average in the respective field, but the work could be of restricted interest to the broader community. Similar arguments hold for productivity and relevance. This means that such groups are more dependent on specializations and preferences represented in the Committee than groups working on broader fields of mathematics.
The information for *productivity* received by the Committee was not uniform. In the Self Evaluations, some Institutes mentioned the refereed papers separately, others mixed them with other sorts of publications. Some Institutes included publications of emeritus professors or papers from persons who had a very marginal fte-part in the programmes. There is also the problem of multi-authored versus single-authored papers. Then, the fte-effort by the researchers is counted differently among Institutes: Some list their researchers on average for .5 fte, others take .4 fte as a standard. Some produce very long papers, others sometimes papers of a few pages of length. These observations make it difficult to compute and rate productivity in a direct and transparent way, but we have taken these considerations into account as good as we could. We encountered also problems with respect to the ratings for *relevance*. It might be easier for an applied mathematician than for a pure mathematician to be relevant for society or industry. We agreed on the opinion that relevance has to do with circles in the following sense. A researcher can be very relevant within his own field of expertise (the first circle), but also for a much wider area of mathematics (the second circle), or even for other areas of science or for society (a third circle). As a rule of thumb we rated good relevance in only the first circle with 3, good relevance in the second circle too with a 4, and good relevance in the third circle with a 5.
Finally, the Committee points out that the scores are a *tool*, not a *goal in themselves*. The Committee has used the scores in line with current practice in The Netherlands, but emphasizes that the scoring system should offer enough flexibility to use it as a tool for improvement. It would be undesirable to misuse the system in such a way that only very high scores become standard. Research in mathematics in The Netherlands is as excellent as can be under the given circumstances.

Chapter 3

Korteweg-de Vries (KdV) Institute for Mathematics of the University of Amsterdam (UvA)

3.1 Assessment at Institutional Level UvA

3.1.1 Introduction

The Korteweg-de Vries Institute for Mathematics (KdV Institute, or KdVI for short) is the mathematical research institute of the Faculty of Science (Faculteit der Natuurwetenschappen, Wiskunde en Informatica) of the Universiteit van Amsterdam (UvA). The KdV Institute is responsible for mathematical research within the UvA. It also provides the lecturers and instructors for the mathematics teaching within the Faculty of Science (and in addition some teaching outside this Faculty), for which the Onderwijsinstituten (teaching institutes) carry the formal responsibilities. The research carried out at the KdV Institute is embedded in several national and international organizations. KdVI is one of the founders of the Thomas Stieltjes Institute for Mathematics, and virtually all of its staff belongs to one of its programmes. More recently, KdVI participated in the successful application for the NWO research cluster Geometry and Quantum Theory (GQT), in which members of the Research Programme Algebra, Geometry and Mathematical Physics participate. Members of KdVI also participate in two other NWO research clusters: NDNS+ and Diamant. There is formal (and informal) collaboration with the Center for Mathematics and Computer Science (CWI), the Vrije Universiteit (VU), both in Amsterdam, and with EURANDOM in Eindhoven. Within the UvA KdVI participates in the String Theory Group, a joint venture with the Institute of Theoretical Physics (ITFA).

3.1.2 Leadership

Director:	Prof. dr. J.J.O.O. Wiegerinck (as of August 2005)
	Prof. dr. C.A.J. Klaassen (January 2003 - August 2005)
	Prof. dr. T.H. Koornwinder (November 1997 - January 2003)
Deputy Director:	Prof. dr. E.M. Opdam (as of August 2005)
Business Manager:	Drs. E. de Jong (until August 2007), Drs. I.M. van Loon (as of August 2007)
Management Team:	Dr. H.G.J. Pijls, Dr. W. Hoffmann (January 1998- August 2005)
Scientific Advisory Board:	Prof. dr. P. Embrechts (ETH Zürich)
	Prof. dr. M. Kreck (Universität Bonn)
	Prof. dr. W.Th.F. den Hollander (Leiden University)
	Prof. dr. P. van Moerbeke (UCL, Louvain-la-Neuve)

Leadership within the KdVI may be characterized as facilitating towards the senior researchers, while towards the PhD students and postdocs the style is coaching. Leaderships styles within the programmes are similar to this. It is regarded as counterproductive to try and steer expert senior mathematicians in their research. However, the management strongly encourages the scientific staff to compete for grants and projects. Full professors discuss institute policy issues every month at a lunch meeting. Twice a year there are more formal meetings of all tenured staff members.

3.1.3 Mission and Goals

The Korteweg-de Vries Institute for Mathematics furthers the science of mathematics, both in its theoretical and applied aspects, and aims to stimulate the application and appreciation of mathematics in other academic disciplines and in society as a whole.

The Korteweg-de Vries Institute has high standards in research as well as in teaching, and strives to collaborate with other institutes within and outside of the Faculty of Science for well-balanced contributions to the mathematical aspects of their research, teaching, and consultancy. The Korteweg-de Vries Institute considers it a compelling task to protect the cultural heritage of mathematics by raising the interest in the study of mathematics and to educate its students to be open-minded, dependable mathematicians.

3.1.4 Strategy and Policy

KdVI aims to excel both in pure mathematical research and in research that is driven by questions from other sciences, industry and society. This is reflected in the three research programmes:

Algebra, Geometry, and Mathematical Physics,
Analysis (pure and applied), and
Stochastics (statistics and probability).

It is regarded as a strategic goal that the KdVI is well embedded in the Faculty of Science, through teaching mathematics for other disciplines as well as through joint research projects with other departments. The natural partner is Theoretical Physics (ITFA).

KdVI's strategy is to capitalize on its research capacities and to optimize funding from the Netherlands Organization for Scientific Research NWO (so-called 2e geldstroom funding). The funding by NWO of three national mathematics clusters has thus determined its policy to a large extent. These clusters are research groups consisting of roughly 20-25 excellent senior mathematicians from Dutch universities working in a common sub-discipline of mathematics. So far, three clusters received NWO funding: Diamant (Discrete Interactive and Algorithmic Mathematics, Algebra and Number Theory) in 2005, NDNS+ (Nonlinear Dynamics of Natural Systems) in 2005, and GQT

(Geometry and Quantum Theory) in 2006. Cluster funding was mainly intended for pre-finance of positions in the sub-discipline, but could be used for many purposes. The Faculty of Science decided to focus on supporting matching participation for the GQT cluster, leading to three tenured positions in the Programme Algebra, Geometry, and Mathematical Physics. As a response to the recommendations of the QANU-VSNU 1996–2001, it was decided to substantially strengthen the Programme Stochastics, mainly through establishing a new chair in Applied Probability. KdVI is also one of the institutes involved in the formation of a fourth cluster: the Stochastics cluster STAR, which could lead to additional support for Stochastics. Despite the limited financial means, KdVI has succeeded in achieving just a minor decrease in the size of the Programme Analysis. Within this programme, a new appointment at the full professor level has led to an important impulse for the area of Numerical Analysis within KdVI.

While the bulk of the KdVI PhD students are appointed on projects that are funded by NWO, some PhD projects are funded by industrial partners (non-NWO). Although not easy to realize within KdVI because of the strong fundamental component of most of its research, these projects form a significant part of its overall profile, and they demonstrate the (economic) value of its expertise for industry and society.

The introduction of ERC European funding created a possible source for funding projects. KdVI intends to exploit this intensively in the future.

Assessment of the Committee on Leadership, Mission and Goals, and Strategy and Policy

The institute of mathematics has undergone significant change during the review period. In each of the research programmes, senior staff moved elsewhere; new professors were appointed, often resulting in the creation of new research directions. These appointments were often based on opportunities ("who is available"), rather than on fixed ideas about who was needed. Because of this practical approach, the institute seems to be in good shape and clear about its aims. The institute also moved to a new building (after the review period), and it seems one can be cautiously optimistic about the effects of this move. In particular, the increased proximity to Physics and to CWI will create new opportunities for collaboration.
The Committee is pleased that in spite of the many changes which occurred in the recent past, motivation has been maintained.
Although the KdVI concentrates mainly on fundamental research and aims at a level of excellence, it recognizes the importance of applications. The strong links with Theoretical Physics and the development of numerical mathematics are examples of this attention. The decision of the Faculty to match the participation to the cluster GQT has led to three tenure positions in the first programme. The orientation towards numerical mathematics as well as the reinforcement of the programme *Stochastics* are appreciated by the Committee.
An effort should be made towards the promotion of the PhD programme internationally. The joint Master of Mathematics with VU University will certainly help improving the attractiveness of Amsterdam.
In the coming years, important issues will be at stake. For example, a new teaching model will be implemented at the Faculty level. It is important in this context that the situation for mathematics will improve. Since the Institute has the responsibility of teaching mathematics in the Faculty of Science and also beyond, it is a funding opportunity, but one must be careful in maintaining sufficient time for research.

3.1.5 Resources

KdVI's hiring strategy has been to select the best mathematician who fits well into the programme in question; the particular specialization of the candidate has been of secondary concern. This policy may lead to some change of accent within the programme, but a considerable gain in po-

tential and visibility is usually achieved. If there are vacancies for both a full professorship and a further position within a single programme, then KdVI's policy has been to attempt to hire the full professor first, after which the new professor is involved in decisions on subsequent hiring. In the mean time, if additional teaching capacity is required, then temporary staff is attracted by opening temporary postdoc positions.

Tables 3.1, 3.2, 3.3, and 3.4 display the distribution of research fte's over the various types of research staff for the institute as a whole, and for the Programmes Algebra, Geometry and Mathematical Physics, Analysis, and Stochastics, respectively.
In these staff tables, a full-time tenured researcher is counted as 0.5 fte. For the non-tenured staff a postdoc is counted as 0.9 fte and a PhD student as 0.75 fte.

Table 3.1: Research staff at institutional level

In fte	2002	2003	2004	2005	2006	2007	2008
Tenured staff	8.30	8.55	8.10	7.85	7.95	9.60	10.00
Non-tenured staff	10.40	9.30	6.40	4.45	5.40	7.55	7.90
PhD students	15.00	15.30	14.30	10.00	12.60	14.60	12.45
Total research staff	33.70	33.15	28.80	22.30	25.95	31.75	30.35

Table 3.2: Research staff in the Programme Algebra, Geometry and Mathematical Physic

In fte	2002	2003	2004	2005	2006	2007	2008
Tenured staff	2.90	3.00	3.30	3.20	3.00	3.20	3.65
Non-tenured staff	4.90	4.70	2.70	1.20	1.85	4.40	4.90
PhD students	8.65	8.50	7.95	5.05	5.70	6.70	4.00
Total research staff	16.45	16.20	13.95	9.45	10.55	14.30	12.55

Table 3.3: Research staff in the Programme Analysis

In fte	2002	2003	2004	2005	2006	2007	2008
Tenured staff	3.20	3.55	3.10	2.85	2.90	3.35	3.20
Non-tenured staff	3.85	3.10	2.40	2.05	1.40	2.25	2.60
PhD students	3.70	4.05	2.80	2.35	3.05	3.30	3.20
Total research staff	10.75	10.70	8.30	7.25	7.35	8.90	9.00

3.1.6 Funding Policies

Tables 3.5 and 3.6 give details on the funding and expenditure, both in k€ and in %, during the period 2002–2008. Table 3.7 gives the breakdown of the funding over the three research programmes.

Assessment of the Committee on Quality of Resources, Funding Policies and Facilities

The KdVI has taken advantage of one of the clusters, namely GQT, in its hiring policy and has been able to hire very promising mathematicians. This has been the case for all three programmes, but particularly for the first programme. Since the quality and not so much the specialization

Table 3.4: Research staff in the Programme Stochastics

In fte	2002	2003	2004	2005	2006	2007	2008
Tenured staff	2.20	2.00	1.70	1.80	2.20	3.05	3.15
Non-tenured staff	1.55	1.40	1.20	1.10	1.90	0.80	0.40
PhD students	2.65	2.75	3.55	2.60	3.85	4.60	5.25
Total research staff	6.40	6.15	6.45	5.50	7.95	8.45	8.80

Table 3.5: Funding and expenditure at institutional level, in k€

	2002	2003	2004	2005	2006	2007	2008
Funding:							
Direct funding	2,143	2,273	2,151	1,954	2,622	2,945	3,198
Research funds	346	386	289	313	436	480	478
Contracts	100	184	326	354	228	461	715
Other	64	21	81	89	51	203	239
Total	2,653	2,864	2,847	2,710	3,337	4,089	4,666
Expenditure:							
Personnel costs	2,596	2,704	2,524	2,382	3,264	4,230	4,203
Other costs	113	153	101	138	244	96	139
Total	2,709	2,857	2,625	2,520	3,508	4,326	4,342

has been the driving force in recruiting, some shift in research orientations has occurred. The Committee appreciates the focus on mathematical physics, on numerical analysis, stochastic operations research and forensic statistics.
Concerning funding, the decline of the direct funding, which affects the Dutch landscape as a whole, has obvious drawbacks. In particular, it might influence the capability of offering attractive positions to the best scientists.
Funding should be sufficient to give opportunities to young promising faculty members and to encourage the search of external funding.
The number of PhD students should increase. The recent increase of the number of mathematics students at the university (in line with the national increase) is a positive element. The possibility of funding is of course a key for improving the situation. The Committee suggests that the UvA pre-finances PhD positions for which grant applications have been submitted.
Concerning facilities, the new building is certainly a great opportunity, provided attention is given to the need for local IT support, in particular within the Science Faculty.

3.1.7 Academic Reputation

The KdVI has provided an overview with awards, memberships, (guest) editorships, invited lectureships, appointed professorships, fellowships, (co)organisation of conferences, visiting professorships and other academic achievements of the staff members.

3.1.8 Societal Relevance

Most of the KdVI research is of a predominantly theoretical nature. In general KdVI aims at dissemination of its work to society indirectly through the work of more practically oriented scientists. An outstanding exception was IBIS. This institute operates within UvA Holding BV and has been extremely successful in transferring knowledge (statistics, six sigma) to industry and society; witnessed by its high financial profits, also to the benefit of KdVI. IBIS was hosted by the KdVI,

Table 3.6: Funding and expenditure at institutional level, in %

	2002	2003	2004	2005	2006	2007	2008
Funding:							
Direct funding	81	79	76	72	79	72	69
Research funds	13	13	10	12	13	12	10
Contracts	4	6	11	13	7	11	16
Other	2	1	3	3	2	5	5
Total	100	100	100	100	100	100	100
Expenditure:							
Personnel costs	96	95	96	95	93	98	97
Other costs	4	5	4	5	7	2	3
Total	100	100	100	100	100	100	100

Table 3.7: Distribution of funding over research programmes

In %	2002	2003	2004	2005	2006	2007	2008
Programme Algebra	49	49	48	42	41	45	38
Programme Analysis	32	32	29	33	28	28	31
Programme Stochastics	19	19	22	25	31	27	31
Total	100	100	100	100	100	100	100

but moved in 2009 to the Faculty of Business and Economics, because its activities have gradually changed towards Quantitative Economics and Management. The societal impact of KdVI's research is also witnessed by projects with the Dutch Forensic Institute (NFI), collaborations with system biologists, several projects with financial institutions and banks, and supervision of a PhD student working for TNO, etc.

On a popularizing level, members of the KdV Institute participate in the Mathematics and Industry conferences, which have generated quite some publicity. Geertje Hek has been on national television with two of these projects: the Euro-diffusion project, which dealt with modelling and measuring (with the help of thousands of interested school kids) the spread of foreign Euro coins throughout The Netherlands; a second project was concerned with answering a question of the ARTIS aquarium on keeping the water in the basins at a constant temperature. Activities of Jan van de Craats to improve the quality of mathematics teaching at high schools and elementary schools in The Netherlands have been successful and are recognized throughout the country. KdVI expects that this will have a positive effect on quality and enrolment of mathematics students and, eventually, on research. Robbert Dijkgraaf is very active in stimulating the interest for mathematics and sciences. He took the initiative for www.proefjes.nl, a site aiming at increasing the interest of children in science. He contributes to several national television shows popularizing science and mathematics. Several other staff members have been interviewed about or in relation with their research by newspapers and by national television

Assessment of the Committee on Academic and Societal Relevance

The Academic relevance and quality of KdVI is very high. Its reputation inside and outside The Netherlands is outstanding. Funding from Spinoza, VENI, VIDI, VICI programs, the Academy and from the clusters GQT and NDSN+ confirms this reputation. Also an invitation to speak at the ICM and publications in high quality journals such as Inventiones, Acta Mathematica, Foundations of Computational Mathematics, American J. of Statistics, Annals of Applied Probability and

others, are indicative of this prestige.
The societal relevance of the programme *Stochastics* is very high; the other programs also are highly relevant, in particular in view of collaborations with other fields, like the first program with theoretical physics. This should help improving the situation concerning PhD students.

3.1.9 Balance of Strengths and Weaknesses

SWOT-analysis of KdVI at large:

Strengths

- *Quality of Staff.* The excellence of the KdVI research staff is widely recognized.
- *Width.* KdVI's research portfolio covers a broad range of mathematical disciplines, predominantly in pure maths, but there is a substantial involvement in applied maths too.
- *Network.* KdVI has an extensive network, both nationally and internationally. Particularly the collaborations with VU, CWI, EURANDOM, and within the String-group are visible and fruitful.
- *Funding.* Participation in the NWO clusters, with a high profile in the GQT cluster; a consistent stream of grants and projects with industry and non-profit research organizations.
- *Location.* Since 2009 in one location with the other teams of the Faculty of Science, and in the immediate vicinity of CWI.

Weaknesses

- *Student numbers.* The small number of maths students in recent years makes KdVI vulnerable for any policy change that puts more emphasis on teaching performance. Increased efforts to attract students have resulted in considerable improvement in 2009-2010.
- *Transfer to industry and society.* Limited involvement in applied projects, especially after IBIS left. Limited visibility of KdVI research in the media.
- *Recruitment of PhD students.* International visibility of the PhD programme needs improvement.
- *Gender issue.* Women are underrepresented in all staff ranks including PhD students.

Opportunities

- *New application areas.* Growing interest for applications of maths in other sciences and industry. One for instance observes a growing need for sophisticated maths in the social sciences, which may potentially lead to innovative new maths and new collaborations. The application of maths in the life sciences will continue.
- *More service teaching.* Growing need for maths education in the Science faculty as well as in other faculties. This may generate additional income.
- *Recognition of maths as crucial element in education.* In the public debate, the importance of maths is increasingly emphasized.
- *UvA funding structure.* Direct funding for PhD diplomas supervised by KdVI members (fixed amount per thesis, directly at the disposal of KdVI).
- *European funding.* EU funding becoming available for science through the recently created ERC-grants.

Threats

- *Grants and subsidies.* The larger funding programmes (both national and European) tend to fund more applied research.
- *Financial policy of university.* National and UvA financial policy becoming more teaching and less research oriented. UvA financial policy is to divert funds from the Science Faculty.

Assessment of the Committee on Strengths and Weaknesses

The KdVI has excellent connections both nationally and internationally, and is embedded in a faculty with high quality. The Institute has shown its capability in obtaining grants. The KdVI has made a clear analysis of its strengths and weaknesses, in particular recognizing efforts towards increasing the number of PhD students and towards applications and promotion of the activities. The Committee approves the analysis and encourages the institute to pursue its progress towards expanding and use of opportunities. One aspect which is not mentioned in the self-evaluation and which the Committee would recommend to consider is related to the internal cooperation. Indeed, the Institute covers a very broad spectrum and has not so much manpower. It certainly makes a lot of sense, not only to look for external cooperation, which is done successfully, but also to look for internal synergies, among the three programs and with programs in nearby academic institutions. This recommendation applies particularly to the new activity in numerical analysis, but also to the programme *Stochastics*. The good relations between UvA, VU and CWI in close vicinity are definitely a major asset. The Dean and more globally the University Authorities should consider all the possibilities of promoting and taking advantage of the real strength that the KdVI represents for the country.

3.2 Assessment per Programme UvA

The Committee assessed the three programmes of UvA as follows:

Programmes	**Quality**	**Productivity**	**Relevance**	**Viability**
UvA1 Algebra, Geometry, and Mathematical Physics	5	4	5	5
UvA2 Analysis (pure and applied)	4	4	3	4
UvA3 Stochastics (statistics and probability)	4	4	5	4

The detailed assessments per programme follow in the next three sections of this report.

3.2.1 UvA1 Algebra, Geometry and Mathematical Physics

Programme number:	UvA1
Programme director:	Prof.dr. G.B.M. van der Geer
Research staff 2008:	12.55 fte
Assessments:	Quality: 5
	Productivity: 4
	Relevance: 5
	Viability: 5

Short description
The research programme in Algebra, Geometry and Mathematical Physics covers central topics in this widely ramified and connected field and aims to connect actively with new developments in the field. The research is focused at topics which are classified under the titles Algebraic Geometry, Lie Theory and Mathematical Physics. The programme has a long tradition at the UvA, but

the emphasis changes through the years. The group maintains a strong international collaboration.

SWOT-analysis of UvA1:

Strengths:

- High scientific level of members of the group.
- Balanced age distribution.
- Good collaboration and good national and international contacts.

Weaknesses:

- Restricted means to keep talented people in the group and offer them a career perspective.
- Limited number of PhD positions and postdocs; small size of the group.

Opportunities:

- The research interests of the group are similar to the areas where research is very active and promising.
- Good opportunities for international collaboration.

Threats:

- The small size of the group and the weak financial position of the KdVI and the Faculty of Science.
- The relatively small number of students.

Assessments

Quality
The quality of this program is excellent. The emphasis is on publishing quality papers, in leading journals, invited talks at important conferences, NWO grants and editorships. The group is very visible internationally.

Productivity
The productivity is considered very good, with some members of the group having an outstanding research output. The number of PhD's is good.

Relevance
The relevance of the group is excellent. Because of its strong links to both mathematical physics and algebraic geometry, the group is able to play a role far beyond mathematics. Its presence in the field of discrete mathematics enhances this relevance.

Viability
The viability of this programme is excellent. The group has been rejuvenated, and has been extremely successful in attracting research funding. Its interactions with mathematical physics give it a clear focus.

Conclusions
The program focuses on a wide field of research ranging from algebraic geometry to mathematical physics and combinatorics. The research group has clear focus, and has been successful in appointing young promising talent. Provided the department is able to nurture the existing talent, and offer clearer career prospects, it should continue to do extremely well. The department should consider pre-financing PhD positions for which NWO grants are in the review stage. Also young staff has been very successful in getting research funding, but some may no longer be eligible for some of the grant opportunities. Perhaps EU funding could be pursued more vigorously.

3.2.2 UvA2 Analysis (Pure, Applied and Numerical)

Programme number:	UvA2
Programme director:	Prof.dr. T.H. Koornwinder (until September 2008)
	Prof.dr. J.J.O.O. Wiegerinck (as of September 2008)
Research staff 2008:	9.00 fte
Assessments:	Quality: 4
	Productivity: 4
	Relevance: 3
	Viability: 4

Short description
The research program Analysis covers some of the central topics in this broad field. The topics studied in the Pure Analysis sub-programme are Special Functions, Dynamical systems, Complex Analysis and Potential Theory. In the Applied Analysis sub-programme the main topics are Partial Differential Equations, Dynamical systems, and Numerical Analysis. In the review period, the emphasis in the Applied Analysis programme changed from Dynamical Systems to Numerical Analysis. Furthermore, the study of Dynamical systems became less applied and moved towards the Pure Analysis Programme. The emphasis on Special functions in this Programme will not be continued because of retirements. The Analysis Programme is embedded in the research school Thomas Stieltjes Institute for Mathematics, and it partially belongs to the NDNS+ cluster.

SWOT-analysis of UvA2:

Strengths:

- Strong Numerical Analysis group within The Netherlands
- Strong new assistant professors
- Connection with CWI

Weaknesses:

- Programme is small, no succession of Koornwinders position foreseen
- Position in NDNS+cluster weakened (Doelman went to CWI, next to Leiden)

Opportunities:

- Continuation of NDNS+ cluster will contain Numerical Analysis
- Possibilities for acquisition of outside funded projects in applied (numerical) analysis, may be enhanced by successor of Hemker
- Combining complex analysis & dynamical systems

Threats:

- Loss of positions
- Loss of research time because of increasing teaching loads

Assessments

Quality
The quality of this programme is very good. This is shown by publications in leading journals, editorships, and contributions to internationally respected conferences. Several members of the

programme are recipients of prestigious NWO-grants.

Productivity
The number of publications is very good, also in regard of their quality. The number of PhD theses is good.

Relevance
The relevance of the programme is good to very good. Some members have been active in the Study group Mathematics in Industry, which in one case has led to quite some publicity. Other than this, the programme seems to be very relevant within its own field, with, so far, modest direct application outside their field.

Viability
The current staff is quite young, is very talented, and has solid plans for the future. Coherence of the programme needs attention.

Conclusions
As so many other programmes, this one has gone through difficult times because of the loss of key persons (due to retirement and leaving) and budget restrictions. Despite this, the programme has managed to rejuvenate. The ambition is to become the leading group in numerical analysis, with emphasis on analysis, in The Netherlands. This may not be unrealistic, but at this moment the group is scattered in focus and the leaders should strive for more coherence. The programme should also make sure to be visible and active in national initiatives for Computational Science programmes. That would help to make the programme more relevant. Another point of attention is the relatively low number of PhD students. As we understand, direct funding from the university does not permit any increase so that members of the programme have to keep a keen eye on all sorts of possible funding at the national and European level. The national Computational Science initiatives might offer chances for the future.

3.2.3 UvA3 Stochastics

Programme number:	UvA3
Programme director:	Prof.dr. C.A.J. Klaassen
Research staff 2008:	8.80 fte
Assessments:	Quality: 4
	Productivity: 4
	Relevance: 5
	Viability: 4

Short description
The research programme Stochastics covers the two main areas within Stochastics, namely, Probability Theory and Statistics, both fundamental and applied, with Stochastic Operations Research viewed as Applied Probability Theory. The roots of this programme are in the Nineteen Forties in the initiative of David van Dantzig to foster this field and its applications at the University of Amsterdam and the Mathematical Centre. The sub-programmes of the Stochastics programme have been called Mathematical Statistics, Industrial Statistics, and Probability Theory. Furthermore, there is the special theme group for Financial Mathematics. The research is embedded into the research school Thomas Stieltjes Institute for Mathematics, and there is close collaboration with EURANDOM. A special feature of this programme has been the intimate connection with the Institute for Business and Industrial Statistics of the University of Amsterdam (IBIS UvA BV), which supports quality and efficiency improvement projects based on statistical methodology. As of April 2009 IBIS UvA BV has been positioned within the Faculty of Economics and Business

(FEB).

SWOT-analysis of UvA3:

Strengths:

- The scientific excellence of the UvA3 group members is widely recognized; two members of the group are senior adviser at Eurandom; there are many research ties to high ranking researchers and institutes.
- The group has a substantial societal impact, in particular through the in-house industrial-statistics company IBIS UvA BV, but also through various joint projects with industry and non-profit knowledge institutes.
- The group is unique in that it not just covers the wide spectrum of Stochastics (i.e., probability theory, statistics, and stochastic operations research), but it also is active in application domains as industrial statistics and optimization, financial mathematics, communication networks, and statistics for biology.

Weaknesses:

- Given the broad field it covers, the size of the group is rather small, in particular in probability theory.
- The relocation of IBIS UvA BV to the FEB weakens the position in industrial statistics.

Opportunities:

- Strengthening the participation in STAR and EURANDOM, and extending the collaboration with the Netherlands Forensic Institute on Forensic Science, with the Life Sciences group at CWI and the Section Computational Science of the UvA on Systems Biology, and with financial institutions and the Faculty of Economics and Business on Financial Mathematics.

Threats:

- The Stochastics group naturally has close contacts with other sciences and society, and contributes much to the valorization of the KdVI. However, this interdisciplinarity threatens the group's *own*, fundamentally–oriented, research, and also leads to the relatively heavy load in service teaching.

Assessments

Quality
This is a very good group in statistical inference and applied probability, notably queueing theory and industrial/economic applications. Members of the group serve on the editorial board of several leading scientific journals and some of them received awards and prizes.

Productivity
Productivity is very good. The number of PhD theses defended is high. Group members also serve industry.

Relevance
This programme has its particular strength in close contacts with problems formulated outside mathematics, in other sciences and in industry, and in society at large, like forensic matters, where they are embarking on new activities.

Viability
The viability of the group is very good. Its traditionally strong activities in applied probability

with an OR profile have been renewed, and other activities are starting.

Conclusions
This programme now seems to renew itself with a focus on probability theory applied towards management and economics, and forensic science. This is in line with UvA traditions, and naturally complements other Amsterdam activities. The Committee warmly supports this tuning of research efforts.

Chapter 4

Department of Mathematics of the VU University Amsterdam (VU)

4.1 Assessment at Institutional Level VU

4.1.1 Introduction

The "Wiskundig Seminarium" of the Vrije Universiteit was founded in 1930, and grew out to the Faculty of Mathematics and Computer Science in the 1970s. In 1998 the Faculty of Mathematics and Computer Science was incorporated in the Faculty of Sciences (FEW), together with Physics and Astronomy, and Chemistry, incorporating the former three faculties as divisions. In 2001 it was decided to reorganize the Faculty of Sciences into four organizational units, one of which is the Department of Mathematics.

The reorganizations were focused on creating stronger and more professional administrative services as well as better opportunities for multidisciplinary research and education.

4.1.2 Leadership

The organizational structure is fairly simple. The head of the department (during 2003-2006 this was Aad van der Vaart, during 2006-2009 Ger Koole, currently Ronald Meester) runs the department on a daily basis, and does so in close contact with the other three members of the so called "management team". These are the director of education "onderwijsdirecteur" (during 2003-2007 this was Freek van Schagen, since then Jan Bouwe van den Berg), the chair of the scientific committee (ARW), (during the period of review, this was first Joost Hulshof, after that Ronald Meester; currently Joost Hulshof is again chair of the ARW), and the department manager Shirley Chedi. Each of the three research sections is headed by one of the full professors in the section. Communication between the various levels takes place informally, as well as in formal meetings. Important issues are also discussed with the other full professors of the department during "full professor lunches", roughly once every month.

4.1.3 Mission and Goals

The research mission of the Department of Mathematics is two-tiered: to perform research on the frontier of mathematical knowledge, motivated by scientific and societal questions and needs, yet emphatically including a fundamental component. Where possible, the aim is to carry out research on the crossroads of practical questions and fundamental mathematical results, exploiting the interplay between theory and applications. The research policy is hence directed at finding a balance between applications and the formal-logical nature of mathematics. In comparison with the preceding decades the balance has shifted towards research motivated by applications in other

sciences such as epidemiology, medicine, economics, biology and the natural sciences, and also in business, the financial and other sectors of society. Next to acknowledging the influence from outside mathematics, the internal development of mathematics as an autonomous science is stressed.

To fulfil this mission the research activities are concentrated within three sections: *Analysis*, *Geometry*, and *Stochastics*. Furthermore, the policy is directed towards greater consistency within the sections. The three sections are considered of equal importance, even though the sizes may differ, reflecting the needs of the educational programmes, and the potential for multidisciplinary research.

4.1.4 Strategy and Policy

The department has opted for specialization into the fields of analysis, stochastics and topology/geometry.

Faculty members are selected based on excellence and the compatibility of their interest and research activities (past performance and plans for the future) with the mission of the department. It is considered desirable that all faculty members, younger and older, are capable of planning and carrying out autonomous research, as success in mathematics is more dependent on individual creativity and achievement than on hierarchic organization. Scientific steering therefore takes place, where necessary, through interaction at the level of research groups.

Next to acknowledging the influence from outside mathematics, the internal development of mathematics as an autonomous science is stressed. This is one of the motivations for building a strong geometry section. Moreover, we maintain a significant fundamental research component in the Analysis and Stochastic sections, and recruit the staff accordingly.

During the review period Mathisca de Gunst was granted the title of Professor of mathematics for the life sciences. Jan Bouwe van den Berg and Rob van der Vorst were promoted to Professor of differential equations and their applications, and Professor of dynamical systems respectively. Rob van den Berg was appointed professor of spatial probability for 0.2 fte. Piet Groeneboom, who had a 0.2 appointment, retired, while Bert Zwart, who joined CWI for his main position was appointed as a special professor. On the whole the appointments have led to a further strengthening of the leadership in the Sections of Analysis and Stochastics, and are in agreement with the research mission of the department.

The main changes at the full professorship level took place in the Section Geometry. After a long search period the vacant chair in geometry was finally filled with the appointment of Dietrich Notbohm as Professor of geometry. An additional (partial) chair in algebra was created for Rob de Jeu, and Jan Dijkstra was appointed Professor of topology for 0.6 fte. Although the Section Geometry is still the smallest of the three sections in the department, the new appointments have created a strong group that ensures the connection to pure mathematics.

The attention for multidisciplinary research fits very well in the research strategy of the VU University Amsterdam and the Faculty of Sciences. The university is in the process of organizing research in interdisciplinary research institutes. While researchers will remain based within the structure of Faculties and Departments, the institutes will unite researchers from different sciences in joint programs. At the moment the Department of Mathematics is represented in the Neuroscience Campus and the Network Institute. It may join several other institutes in the areas of medicine and life sciences, finance, or social science. While the department is positive about these connections, it is also noted that certainly not all of mathematics can be represented through these institutes; the board of the university has acknowledged this.

To promote the multidisciplinary aims of the research mission, the Department of Mathematics has also developed many individual research relationships on the VU University campus, including the VU Medical Center, and the Faculties of Earth and Life Sciences, Psychology, Economics and Movement Sciences. The contacts with individual researchers on concrete projects are extremely fruitful. A few researchers have a joint appointment or a working agreement with the VU Medical Centre.

At the national level the Department of Mathematics participates within the Thomas Stieltjes Research School for Mathematics. While the research schools still perform a number of useful tasks (meetings, prizes, study weeks for students), their role in the national coordination of research is expected to be taken over by the mathematics clusters. The Department of Mathematics is a double node (with both the Analysis and Stochastics groups) in the NDNS+ cluster (Nonlinear Dynamics of Natural Systems), which was founded and funded in 2004. The Stochastics group is one of the important participants in the STAR cluster, which was founded in May 2009. The working areas of both clusters are close to the mission of the department.

The Department of Mathematics also participates in the Centre for Medical Systems Biology (CMSB), a national centre of excellence in genomics, and in the Netherlands Institute for Systems Biology (NISB).

Assessment of the Committee on Leadership, Mission and Goals, and Strategy and Policy

Mathematical research at the VU is organized in an institute with three programmes. The structure is transparent, leadership is informal but nevertheless effective. This may also be attributed to the current dean, who happens to be a mathematician. Despite problems encountered at the national level, the VU has managed to create a positive research climate for its mathematicians. The mission statement of the institute is ambitious in the sense that it strives for emphasis on fundamental aspects but with a keen eye for applications. The dean evaluates the professors on a yearly basis and discusses their achievements and problems with them. Emphasis is on quality rather than on numbers of papers. A healthy strategy in the eyes of the Committee. The Committee was quite pleased to see an optimistic staff in an, at the moment, very good research environment. The institute strives for coherence within the three programmes, but this has not led to separate entities with barriers in between. Matters like hiring of new staff are discussed at the institute level.
The Committee concludes that mathematics at the VU is organized well, funded adequately (within the usual constraints of national funding), and that its mission has resulted in a visible competitive institute.

4.1.5 Resources

The department bases its recruitment policy both on the quality of potential candidates, and on the need for teaching in various areas, like the natural sciences, the life sciences, BMI (Business Mathematics and Information science), financial mathematics and the teaching of its own (under)graduate courses. It strives for a balanced department, with ample attention to both applied and pure mathematics, reasonably spread out over the various sections.

There are several possibilities for personal development of the research staff. The university offers various courses ranging from improving communication and writing skills to improving teaching skills; a course on teaching skills will become mandatory for new assistant professors in the near future, according to new VU regulations.

Assistant professors ("UD") are often hired initially on a four or five year contract, but they may also be appointed immediately for unlimited duration ("onbepaalde duur"), depending on qual-

ifications and market conditions. Fixed term appointments are made by the department head, whereas unlimited contracts need the approval of the board of the Faculty of Sciences.

Promotion of a "UD" to the higher position of Associate Professor ("UHD") is not automatic, and depends on both excellence of the candidate and the current composition of the department. The rules and procedure have been made explicit in regulations by the Faculty of Sciences ("UHD"-regeling). Proposals for promotion are prepared by a special committee, and submitted by the department head to the board of the Faculty of Sciences.

Appointments of full professors need the approval of the board of the university and the College of Deans. Proposals are prepared by special committees, appointed by the dean of the Faculty of Sciences. Typically such appointments concern chairs on fields in mathematics that are considered necessary for the research and educational programs of the department. Appointments based solely on personal merit are rare, but more common in mathematics than in other sciences, in agreement with the important role played by individual excellence in mathematical research. In the past years the department has also made several part-time appointments, with the purpose of granting both the title of Professor and the ius promovendi to qualified researchers.

PhD Students The budget of the department includes direct funding for 8 PhD students, which are awarded to chairs based on quality of a research proposal and a candidate. The department has been increasingly active and successful in acquiring additional funding from NWO or European agencies. Notwithstanding the small numbers of mathematics students in The Netherlands the department has managed to attract good students to all open positions. The master's programmes for foreign students play an increasingly important role in attracting these students. Besides the standard salary during 4 years, every PhD student is awarded €5000 for travel and books during the course of the studies. A research plan and agreement is written at the beginning of the PhD term. PhD students receive training directly from the supervising professor, and also take part in the educational programmes of the research schools, or other networks.

Postdocs The budget of the department includes one permanent "departmental" postdoc position. This is awarded to one of the chairs in the department based on the quality of a research proposal and the strength of the proposed candidate. Other direct funding, for instance, arising from temporary vacancies, is also sometimes used for the funding of postdocs.

Tables 4.1, 4.2, 4.3, and 4.4 display the distribution of research fte's over the various types of research staff for the department as a whole, and for the Programmes Analysis, Stochastics, and Geometry, respectively.
In these staff tables, a full-time tenured researcher is counted as 0.4 fte. For the non-tenured staff a postdoc is counted as 0.8 fte (and sometimes 0.9, depending on the circumstances) and a PhD student as 0.8 fte.

Table 4.1: Research staff at institutional level

	2003	2004	2005	2006	2007	2008
Tenured staff	7.02	7.30	7.30	7.86	7.99	8.49
Non-tenured staff	3.96	4.51	8.16	7.12	7.80	10.61
PhD students	9.88	16.48	20.57	23.86	24.71	18.36
Total staff	20.86	28.29	36.03	38.84	40.50	37.46

Table 4.2: Research staff Analysis

	2003	2004	2005	2006	2007	2008
Tenured staff	2.50	2.40	2.40	2.15	2.70	2.80
Non-tenured staff	0.70	1.20	3.50	2.85	2.57	4.10
PhD students	2.77	5.00	5.60	6.27	5.19	3.71
(Sub)total staff	5.97	8.60	11.50	11.27	10.46	10.61

Table 4.3: Research staff Stochastics

	2003	2004	2005	2006	2007	2008
Tenured staff	2.77	3.14	3.54	4.36	3.89	3.93
Non-tenured staff	0.76	3.31	4.66	4.27	4.87	4.25
PhD students	6.24	9.85	11.87	13.32	14.92	10.65
(Sub)total staff	9.77	16.30	20.07	21.95	23.68	18.83

4.1.6 Funding Policies

Tables 4.5 and 4.6 give details on the funding and expenditure, both in k€ and in %, during the period 2003–2008. Table 4.7 gives the breakdown of the funding over the three research programmes.

As shown in the tables, during the review period direct funding has increased a little, research funding has increased considerably, and contract funding has fluctuated.

The research funding consists of the Open Competition Mathematics (mostly small PhD student and postdoc projects), the "Vernieuwingsimpuls" (VENI, VIDI, VICI), the NDNS+ cluster, and multidisciplinary projects (genomics initiative, CMSB, computational life sciences). In the last few years the department has been quite successful in attracting research funding. The research policy directed at applications explains part of this success, but also the age composition of the department (which is essential for the VENI/VIDI/VICI program) and incidental funding, such as the cluster.

Contract research concerns for an important part European funding, as commercial contract research is viewed as insufficiently scientific in nature by the majority in the department. Applications of mathematics are mostly directed at other sciences, with scientific and not financial objectives. European funding is likely to become more important in the coming years.

Direct funding has diminished because of a change in the university allocation models and a shift of money from the universities to NWO. Nevertheless the management hopes to be able to sustain the department at the current size. Several national initiatives to strengthen the position of the sciences (mathematics clusters, "deltaplan natuurwetenschappen") will hopefully make up for part of the deterioration of the allocation models. The main strategy for obtaining research funding is to keep and attract excellent researchers.

Assessment of the Committee on Quality of Resources, Funding Policies and Facilities

The funding policy (direct funding) is transparent and the department allows for 8 PhD positions from direct funding, which is becoming more and more rare in The Netherlands. Apart from this, the institute has been successful in attracting NWO grants for PhD students. The budget of the department allows also for a postdoc position. Contrary to developments elsewhere, where IT

Table 4.4: Research staff Geometry

	2003	2004	2005	2006	2007	2008
Tenured staff	1.76	1.76	1.36	1.35	1.40	1.76
Non-tenured staff	2.50	0	0	0	0.36	2.26
PhD students	0.87	1.63	3.10	4.27	4.60	4.00
(Sub)total staff	5.13	3.39	4.46	5.62	6.36	8.02

Table 4.5: Funding and expenditure at departmental level, in k€

	2003	2004	2005	2006	2007	2008
Funding:						
Direct funding	3,085	3,091	3,413	3,192	3,076	3,170
Research funds	515	698	786	916	990	872
Contracts	164	173	319	130	199	131
Total	3,764	3,961	4,518	4,238	4,266	4,174
Expenditure:						
Personnel costs	2,253	2,600	2,779	2,984	3,427	3,692
Other costs	82	168	161	187	182	147
Total	2,336	2,768	2,940	3,171	3,609	3,840

support is being centralized, the bigger department, in which the institute is embodied, has the policy to keep IT support nearby. In any case: the help desk is nearby and the Committee is very happy to see this. IT support is essential and quick help is essential as well.

4.1.7 Academic Reputation

The department has provided an overview with awards, memberships, (guest) editorships, invited lectureships, appointed professorships, fellowships, (co)organisation of conferences, visiting professorships and other academic achievements of the staff members.

4.1.8 Societal Relevance

Concerning collaboration and dissemination outside the scientific community the following activities are mentioned:

- Research in the obp (optimization of business processes) group of the stochastic section is applied in telecommunication and health care management, leading for example to PhD students that are funded by companies and partial appointments of VU staff in innovative industrial projects;
- Some aspects of the department's probability program find its way to actual use in legal court cases;
- The department actively participates in the annual "mathematics with industry" study group, in which actual problems from industry are solved by students and staff members. The department has organized this national event in 2002 and will do so again in 2011;
- Some members of the department are interested in the role of mathematics in philosophy. Their specific mathematical skills sometimes turn out to be useful;
- In financial statistics there has been collaboration with ABN/AMRO and SNS REAAL banks.

Table 4.6: Funding and expenditure at departmental level, in %

	2003	2004	2005	2006	2007	2008
Funding:						
Direct funding	82	78	76	75	72	76
Research funds	14	18	17	22	23	21
Contracts	4	4	7	3	5	3
Total	100	100	100	100	100	100
Expenditure:						
Personnel costs	96	94	95	94	95	96
Other costs	4	6	5	6	5	4
Total	100	100	100	100	100	100

Table 4.7: Distribution of funding over research programmes

In %	2003	2004	2005	2006	2007	2008
Programme Analysis	43	28	25	24	9	23
Programme Stochastics	40	65	70	68	83	66
Programme Geometry	17	7	5	8	8	11
Total	100	100	100	100	100	100

Assessment of the Committee on Societal Relevance

The VU mathematicians are active in national research clusters, most notably NDNS+ and in the forthcoming fourth cluster STAR. For obvious reasons the programme on Stochastics is very relevant even outside the university (e.g., in telecommunications), but all groups are stimulated by their leaders to act in multidisciplinary projects, according to the mission statement. This has led to interesting and fruitful relationships with other faculties, including the VU Medical Center, Psychology, Earth and Life Sciences. The institute participates in the Centre for Medical Systems Biology, a national centre of excellence in genomics. In the view of the Committee, the institute has a very good policy in trying to make its mathematics visible and relevant for other sciences.

4.1.9 Balance of Strengths and Weaknesses

SWOT-analysis of the department at large:

Strengths and opportunities
The research staff of the department publishes widely and frequently in excellent journals. It hosts a significant number of internationally acknowledged leaders in various fields. It has been very successful in obtaining research grants, and has a reputation both in theoretical work as in applied mathematics. The department has grown significantly over the last decade. Its PhD programme has been successful, leading to a relatively high number of PhD defences, and, based on exchange programs with eastern Europe (and possibly Asia), expecting even more in the near future. The research staff provides excellent opportunities for mathematics in life sciences and mathematics in business applications. It has enjoyed the benefits of participating in the NDNS+ cluster, and the new STAR cluster is likely to provide additional opportunities for appointing young researchers.

Weaknesses and threats
The most obvious weakness is the low number of students, which is also a liability with regards to attracting high quality PhD candidates. A complicating factor is the fact that low student

numbers in mathematics are a nation-wide problem, partly caused by the way mathematics is taught in high school (nowadays, most high school teachers do not have a university degree).
The most obvious threat is the dependency on the financial allocation model used by the board of the university. There has been a significant change in the financial allocation model used by the board of the university, which makes the funding much more dependent on the number of mathematics students, which is relatively small.
Another threat is constituted by the way research money is allocated by NWO. There is a tendency in the Dutch society to put more weight on competition, not only with other mathematics departments, but recently also with computer science and astronomy, and in the very near future also with chemistry. It is not so clear how one should compare research proposals in such diverse areas of science. Generating money has become much more important now than a decade ago; this is not necessarily a bad thing, but certainly the possibilities for pure mathematics are limited compared to other exact sciences.

Assessment of the Committee on Strengths and Weaknesses

The low number of students is perceived a weakness by the institute, but the Committee believes that the number of students enrolled in the Bachelor programme of the institute follows the national, increasing, trend. The institute seems to have more than an average share in this because of its special educational programmes with econometrics. Furthermore, the institute has an adequate strategy for trying to attract more students.
The funding strategy for the past period has resulted in a rather balanced and viable institute. The effects of the future funding strategy model of the university are unclear yet, but the Committee hopes that the possible negative effects do not lead to reductions of any size in the research activities. The grant facilities of NWO are far below what is necessary or adequate, but this is a national threat. The VU University should be well aware of this. External grant facilities, other than from NWO, are not so obvious for fundamental research programmes. Efforts made by the department for attracting grants seem to be well-coordinated and realistic.

4.2 Assessment per Programme VU

The Committee assessed the three programmes of VU as follows:

Programmes	Quality	Productivity	Relevance	Viability
VU1 Analysis	4	3	4	5
VU2 Stochastics	5	5	5	5
VU3 Geometry	4	3	3	4

The detailed assessments per programme follow in the next three sections of this report.

4.2.1 VU1 Analysis

Programme number:	VU1
Programme director:	Prof.dr. J. Hulshof (until 2006)
	Prof.dr. R.C.A.M. van der Vorst (as of 2006)
Research staff 2008:	10.61 fte
Assessments:	Quality: 4
	Productivity: 3
	Relevance: 4
	Viability: 5

Short description
The department's Analysis programme concerns partial differential equations, dynamical systems, variational and topological methods, operator theory, control and system theory, and applied analysis. Its aim is to develop methods for solving integral, differential and matrix equations, via analytical and topological methods and to solve problems arising in applications. There is strong interaction between all components and a strict subdivision is neither desirable nor possible.

SWOT-analysis of VU1:
For this, the Self Evaluation report refers to the SWOT-analysis of the department at large (see Section 4.1.9).

Assessments

Quality
The quality of this programme is very good. This is shown by publications in leading journals and coauthor-ships of books, editorships, and organisation of internationally respected conferences. Several members of the programme are recipients of prestigious NWO-grants.

Productivity
The research output is good, if one restricts attention to publications in refereed journals. Two research monographs were coauthored, one new and one completely revised. The number of PhD theses was modest, but there is a clear upward trend in recent years.

Relevance
The relevance of the programme is very good. There are interactions with and many applications to biology. There are also applications to physics. Members of the group are active in the annual Dutch Study group Mathematics in Industry and they have made a successful grant application at STW/NWO in order to continue this annual event during 2008-2012.

Viability
The current staff is quite young and very talented. The programme is very coherent. Clear research plans exist for the future.

Conclusions
The group is remarkable in that three of the four full professors work in nonlinear pde's, dynamical systems and related areas and that they also publish together regularly. This makes it a very attractive place for this area in applied mathematics. The group in operator theory and system theory is now much smaller than before, but it is still very active and productive. Several younger programme members, supported by personal NWO grants, help the programme to cover a broad spectrum of applied analysis and to reach out to application fields.

4.2.2 VU2 Stochastics

Programme number:	VU2
Programme director:	Prof.dr. R.W.J. Meester
Research staff 2008:	18.83 fte
Assessments:	Quality: 5
	Productivity: 5
	Relevance: 5
	Viability: 5

Short description
The department's Stochastics programme (informally) distinguishes between probability, statistics, and obp (optimization of business processes).

SWOT-analysis of VU2:
For this, the Self Evaluation report refers to the SWOT-analysis of the department at large (see Section 4.1.9).

The new STAR cluster is expected to be helpful for appointing young researchers in the future. Otherwise, this section is confident that it can sustain its research at the current level.

Assessments

Quality
This is an internationally strong group, in probability theory as well as in statistical inference, and in biological applications. Publications appear in the best journals, professors are active and well respected the world over. Group members serve the international academic community at editorial and other positions.

Productivity
The group has published extensively and members are frequently invited to prestigious conferences and other universities. The number of PhD theses defended is high.

Relevance
Much of the work of the group in probability has a background in physics and has relevance for networks and epidemic spread. Their research in statistics is also highly relevant in other sciences. There is a strong tradition of modelling of cell membranes, but also other biological applications.

Viability
This is a relatively young group with solid plans. No immediate retirements threaten the group. It has been renewing itself continuously, as is illustrated by its recent shift towards forensic probability.

Conclusions
This is a strong programme of top quality.
It is tempting to think that this programme might profit from stronger coordination with other Amsterdam groups. However, in the view of the Committee the Amsterdam milieu should be rich enough to sustain a few independent (though interacting) environments in stochastics, each with their own focus.

4.2.3 VU3 Geometry

Programme number:	VU3
Programme director:	Prof.dr. J. van Mill (until 2006)
	Prof.dr. J.J. Dijkstra (as of 2006)
Research staff 2008:	8.02 fte
Assessments:	Quality: 4
	Productivity: 3
	Relevance: 3
	Viability: 4

Short description
The Geometry Section is involved in research in Geometric Topology, General Topology, Algebraic Topology, Algebraic K-Theory, and the History and Philosophy of Mathematics.

SWOT-analysis of VU3:
For this, the Self Evaluation report refers to the SWOT-analysis of the department at large (see Section 4.1.9).

Assessments

Quality The quality of this group is very good in an international context. It concerned, for major part of the time span of this assessment, leading people in a relatively small, but respected, field of mathematics. The recent addition of researchers with more central research areas offers promise for the future.

Productivity The number of articles published by the group is high. The number of PhD theses was low, but several are expected to be completed shortly after the assessment period. On the average, this leads to a good score.

Relevance The relevance of the work in the traditional directions of the group is good, but mainly within the corresponding fields. The new directions represented in the group are mainstream, and the corresponding work is recognized in a much broader community. We expect the relevance of the group to increase.

Viability Following our line of thought, expressed under quality, we believe that it is a wise idea to broaden the scope of the group and we are pleased to see that the group has managed to attract strong young people with new fields of interest. There is good hope that these new fields, mainly algebraic topology and K-theory, will give a new drive to the group.

Conclusions
Major part of the assessment period was marked by good quality work in a restricted area. Obviously, this was well recognized and the group managed to rejuvenate and to find contact with more central directions of mathematics. It seems a good move to start the research direction algebraic topology. This modern and mainstream field is underrepresented in The Netherlands and could turn out to be one of the attractions of the group in the future. The new research focus also opens up the possibility to more interaction with other research groups in modern mathematics in The Netherlands and elsewhere. This may also lead to more PhD students and more external funding of the group. Members of the group are increasingly active in applying for some of the more substantial grants. The Committee is confident that this process will contribute to an attractive and internationally competitive research group.

Chapter 5

Institute of Mathematics and Computing Science (IWI) of Groningen University (RUG)

5.1 Assessment at Institutional Level RUG

5.1.1 Introduction

The Institute of Mathematics and Computing Science (*Instituut voor Wiskunde en Informatica*, abbreviated IWI) is part of the Faculty of Mathematics and Natural Sciences (abbreviated FMNS) of the University of Groningen. It was founded in the early 1990s. It consists of the disciplines of Mathematics and Computing Science. The mathematics part of the IWI has participated in the two rounds of external research assessment which took place in the Fall of 2009: Mathematics, organized by the general universities, and Applied Mathematics, organized by the technical universities.

5.1.2 Leadership

IWI Mathematics contains four research programmes, namely

1. Dynamical Systems, Algebra, Geometry & Mathematical Physics,
2. Systems, Control & Analysis,
3. Computational Science & Numerical Mathematics and
4. Statistics & Probability.

The two programmes Dynamical Systems, Algebra, Geometry & Mathematical Physics and Systems, Control & Analysis, participate in the External Research Assessment Mathematics, while the programme Computational Science & Numerical Mathematics participates in the External Research Assessment Applied Mathematics. The programme Statistics & Probability is not included in any of the assessments, since its chair has been vacant during the entire period of review until Summer 2008 (when Prof.dr. E.C. Wit was welcomed as the new chair).

From 2003 to 2008 the IWI-director has been Prof. dr. N. Petkov (Computing Science, chair of Intelligent Systems), on January 1st, 2009 succeeded by Prof. dr. H.W. Broer. Since the beginning of 2009, the management of the IWI is carried out by a Board in which both Mathematics and Computing Science are represented. An Advisory Council of external experts is currently being

formed, designed for monitoring the quality of the IWI from a distance.

Both the Board and the Advisory Council of the IWI guard the quality of research.

5.1.3 Mission and Goals

The mission of IWI Mathematics is to perform outstanding academic research and teaching in mathematics, and to maintain international leadership in this. An important part of this is the aim to transfer IWI's scientific results to other areas of science and technology, and to initiate and expand multi-disciplinary research collaborations. The symbiosis between mathematics and applied mathematics, between pure and multi-disciplinary research, is considered a distinguishing characteristic of the institute.

5.1.4 Strategy and Policy

IWI Mathematics maintains, in the spirit of an increasing focus on more applied research, an important general position in the modelling of scientific phenomena in earth and life sciences, medical sciences, information science, (mathematical) physics, astronomy, technology and engineering, with direct contributions from computational mechanics, dynamical systems, systems and control, and statistics, while disciplines like numerics, analysis, geometry and algebra are contributing in an essential way. The symbiosis between pure and applied mathematics, and between mono- and multi-disciplinary research and teaching, is said to be a distinguishing characteristic of the institute. This is reflected by a research atmosphere that is fostering internal collaboration and cross-fertilization, and stimulating collaboration within mathematics as well as with other areas of science and technology.

In order to maintain and enhance this research strategy, contacts have been formed with a large number of research institutes within academia, in- and outside the University of Groningen, funding agencies like NWO, STW and FOM, and with the Dutch Large Technological Institutes (Grote Technologische Instituten, abbreviated GTIs) for challenging joint ventures and for the possibilities of funding research. IWI Mathematics aims to intensify these contacts in the future. One main collaboration on the national level takes place within the NWO research cluster Nonlinear Dynamics of Natural Systems (NDNS+).

The aim of the NWO-cluster NDNS+ is to foster the exchange of ideas, views, insights, problem formulation and methods amongst scientists interested in mathematics and in earth and life sciences. Here fundamental aspects play a crucial role. These activities include bio-statistics and systems biology. The cluster establishes a strong team in which the research and education in nonlinear dynamics of natural systems is stimulated and coordinated at a national level. The members of the cluster are among the active participants, but there are many more. An important objective is to attract young talented researchers to the field, to motivate them and to help them getting an overview.
The centre of the NWO-cluster NDNS+ is situated in the IWI, where Prof dr. H.W. Broer is the managing director. The major partners of NDNS+ are research groups within the CWI and the VU (Amsterdam) and within the UL (Leiden), which involves all dynamical systems and a substantial part of stochastics research in The Netherlands. The acquisition of the NDNS+-center in Groningen fits with the strategic plan of the FMNS regarding multidisciplinary cooperation, in particular in the direction of life and medical sciences.

Assessment of the Committee on Leadership, Mission and Goals, and Strategy and Policy

The leaders of IWI have a clear and efficient strategy to carry out the well-chosen mission and goals. Although the focus clearly is on applications of mathematics, the institute also pursues

high quality research in fundamental mathematics.
The department as a whole should present itself more systematically as being strong in "systems" (ranging from systems theory to dynamical systems).
The NWO cluster NDNS+ is an asset of the institute. It initiates and supports interactions with mathematicians and researchers from other fields in The Netherlands and internationally.

5.1.5 Resources

The tenure track system for scientific personnel was introduced by the FMNS in 2001, being one of the first in The Netherlands. It offers young scientists a clear career perspective, with tenure and promotion to associate professor after five years: so tenure immediately provides the *ius promovendi*. Another five years after this, promotion to full professor is envisioned. The tenure track faculty members are supposed to set up their own independent research line, together with their PhD students and postdocs. At the beginning of their appointment they are supplied with one PhD position by the FMNS and another PhD position by the IWI. Also they are provided with their own budget.

Included in the tenure track programme, there is the successful FMNS-wide *Rosalind Franklin programme for hiring female tenure track assistant professors.* The Rosalind Franklin programme has two distinguishing features. Firstly, it offers women favourable research working conditions and the individual career perspectives of the "Career Paths in Science" programme. Secondly, the programme focuses on excellence by soliciting applications from female researchers in all areas of science covered within FMNS. Recently, two such appointments within mathematics have taken place.

Tables 5.1, 5.2, and 5.3 display the distribution of research fte's over the various types of research staff for the department as a whole, and for the Programmes Dynamical Systems, Algebra, Geometry & Mathematical Physics and Systems, Control& Analysis, respectively.
In these staff tables, a full-time tenured researcher is counted as 0.4 fte. For the non-tenured staff a postdoc and a PhD student are counted as 0.8 fte.

Table 5.1: Research staff at institutional level

	2003	2004	2005	2006	2007	2008
Tenured staff	4.75	4.6	5.3	5.15	5.4	5.4
Non-tenured staff	2.9	2.6	2.25	2.7	3.15	1.4
PhD students	14.25	14.3	18.25	18.0	20.85	20.95
Total research staff	21.9	21.5	25.8	25.85	29.3	27.85

Table 5.2: Research staff DSAG&MP

	2003	2004	2005	2006	2007	2008
Tenured staff	1.6	1.6	2	2	2.35	2.5
Non-tenured staff	1.3	0.8	0.25	0.8	2.25	0.9
PhD students	7.3	6.25	8.55	8.1	10.6	11.45
Total research staff	10.2	8.65	10.8	10.9	15.2	14.85

Table 5.3: Research staff SC&A

	2003	2004	2005	2006	2007	2008
Tenured staff	1.95	1.65	1.7	1.55	1.4	1.6
Non-tenured staff	1.6	1.3	0.0	1.15	0.4	0.0
PhD students	3.75	4.45	5.0	5.3	6.45	6
Total research staff	7.3	7.4	6.7	8	8.2	7.6

5.1.6 Funding Policies

Tables 5.4 and 5.5 give details on the funding and expenditure, both in k€ and in %, during the period 2003–2008.

Table 5.4 shows an annual decrease in direct funding, which is caused by a number of retirements, a decrease in supporting staff, and the introduction of the 'bursaal' system for PhD projects (in which salary costs have been replaced by fellowships). The table also shows a substantial increase in research funds. This is for a large part caused by a number of recent appointments of scientific staff through the NWO supported research cluster NDNS+. It is also caused by an increase in successful research proposals.

Table 5.4: Funding and expenditure at departmental level, in k€

	2003	2004	2005	2006	2007	2008
Funding:						
Direct funding	1,800	1,798	1,804	1,625	1,453	1,444
Research funds	126	249	464	656	826	866
Contracts	85	53	10	5	91	108
Total	2,011	2,100	2,277	2,285	2,369	2,418
Expenditure:						
Personnel costs	1,842	1,951	2,131	2,101	2,162	2,225
Other costs	165	144	156	177	215	186
Total	2,007	2,059	2,287	2,278	2,377	2,411

Table 5.5: Funding and expenditure at departmental level, in %

	2003	2004	2005	2006	2007	2008
Funding:						
Direct funding	90	86	79	71	61	60
Research funds	6	12	20	29	35	36
Contracts	4	3	0	0	4	4
Total	100	100	100	100	100	100
Expenditure:						
Personnel costs	92	93	93	92	91	92
Other costs	8	7	7	8	9	8
Total	100	100	100	100	100	100

Assessment of the Committee on Quality of Resources, Funding Policies and Facilities

Although the institute did not manage to acquire one of the prestigious grants for young researchers (VENI, VIDI, VICI), the share of research funds in the total budget of the institute is still very high, for a substantial part because of the NWO cluster NDNS+.
Direct funding of the institute by the university has decreased in absolute and relative numbers, only partly due to a change in the way the cost of the supporting staff is counted.
The tenure track system with a predefined time for promotion is an asset of the institute. The opportunity to obtain the *ius promovendi* after five years is a positive feature. This tenure track system also includes a programme to support young female mathematicians: the Rosalind Franklin programme.
The IWI has moved into a new building, and the members of the institute are satisfied with the facilities and opportunities offered by the new venue.

5.1.7 Academic Reputation

IWI has provided an overview with awards, memberships, (guest) editorships, invited lectureships, appointed professorships, fellowships, (co)organisation of conferences, visiting professorships and other academic achievements of the members of its two mathematics programmes.

5.1.8 Societal Relevance

The external appreciation of the Mathematics research programmes shows in various ways. One is the direct interaction with technical universities and the GTIs, but also with earth and life sciences, e.g., via the NWO-cluster NDNS+.

In general Mathematics has a great outreach to other disciplines, where novel developments often strongly depend on mathematical techniques. This holds in particular for mathematical physics, the earth and life sciences, engineering and for economics.

Other examples of external appreciation show from the contacts that exist with the Ministry of Education, Culture and Science (OCW) regarding the future of the Secondary School Mathematics curriculum or by the fact that quite a few members of the programmes participate in NWO- or KNAW-committees or in the (board of) the Royal Dutch Mathematical Society (KWG).

At a general societal level external appreciation shows by the fact that many programme members are regularly being asked for contacts with Secondary Schools, or more generally for contributions to the popularization of Mathematics.

Assessment of the Committee on Academic and Societal Relevance

The research of the mathematicians of the institute is acknowledged world wide, as shown for example by their numerous memberships in scientific boards and programmes and by their participation in organising workshops and conferences.
As the institute's research has rather direct impact in earth and life science, the societal relevance of the institute is high.

5.1.9 Balance of Strengths and Weaknesses

SWOT-analysis of IWI Mathematics:

Strengths

- Broad research teams covering a large spectrum of pure and applied mathematics, with many internal collaborations.
- Many collaborations with groups in other scientific and technological disciplines.
- High international visibility by excellent publication track records, invited and keynote talks and by interacting in large scale networks.
- Many PhD students.

Weaknesses

- Relatively small size. [Counteracted by emphasizing collaborations.]
- Not many Master students. [Counteracted by the active involvement in the nation-wide master programme *Mastermath*.]
- Difficulty in attracting excellent PhD students.

Opportunities

- Collaborations with colleagues in other disciplines, and possibilities for interdisciplinary research funding.

Threats

- Decreasing funding for fundamental research.
- A rather thin coverage of the discipline as a whole. [Counteracted by an appropriate IWI recruitment policy.]

Assessment of the Committee on Strengths and Weaknesses

The institute is small, at least the part the Committee has seen at the present assessment. Therefore the research covered by the institute comes from a restricted part of mathematics. On the other hand, the research in the areas which are covered is of very high quality.
A strength is the tenure track system with the chance to obtain the ius promovendi at a relatively early stage of the career, and the Rosalind Franklin programme to support young female mathematicians. These features make the institute more attractive for young mathematicians.
Although it was pointed out by the institute that it is not easy to attract excellent graduate students, the faculty managed to attract an impressive number of PhD students over the assessment period.
The geographic location is a handicap for the organization of common seminars with other research groups in The Netherlands. However, the institute does rather well in this respect and cluster money helps to improve national collaboration.

5.2 Assessment per Programme RUG

The Committee assessed the two programmes of RUG as follows:

Programmes	Quality	Productivity	Relevance	Viability
RUG1 Dynamical Systems, Algebra, Geometry, Mathematical Physics	4	5	4	4
RUG2 Systems, Control and Analysis (pure and applied)	4	5	4	4

The detailed assessments per programme follow in the next two sections of this report.

5.2.1 RUG1 Dynamical Systems, Algebra, Geometry, Math. Physics

Programme number:	RUG1
Programme director:	Prof.dr. H.W. Broer
Research staff 2008:	14.85 fte
Assessments:	Quality: 4
	Productivity: 5
	Relevance: 4
	Viability: 4

Short description
This programme aims to perform outstanding academic research and teaching in Dynamical Systems, Algebra, Geometry & Mathematical Physics and to maintain international leadership in this. Part of this consists of transferring the scientific results to other areas of science and technology, and to initiate and expand multi-disciplinary research collaborations. Symbiosis between mathematics and applied mathematics, between mono- and multi-disciplinary research is provided by a fruitful co-existence and mixture of fundamental and applied aspects.

External validation of RUG1
The outside validation generally shows by the attention obtained from external organisations, e.g., by the membership of NWO evaluation committees (Top, Vegter), or from ministerial (OCW) committees like cTWO (Broer). This tendency is positively influenced by the general mix of pure and applied mathematics. Also the PhD research of the NWO-funded LiOs Gulikers and Sitters, both in a joint project with Van Maanen (Freudenthal Institute for Mathematics and Science Education, Utrecht) can be regarded in this respect. The same holds for the theological PhD project of Smedes.

In this way expertise of the programme is disseminated outside the academic world. In this respect, the editorships should be mentioned of Broer and Vegter in *Epsilon Uitgaven*, a publishing house aiming at the publication of mathematical work of interest to a general audience interested in the sciences. This also holds for external activities like the organization of the Seniorencollege Groningen Drenthe (HOVO) by Broer in 2007 and again in 2009, in which Broer, Top and Vegter are taking part as lecturers. In 2003, 2008 and again in 2009, Top was invited to write a number of mathematical contributions for the next popular science calendar[1] in Belgium and The Netherlands. Another activity to popularise mathematics, is the book *Speeltuin van de wiskunde* which Top and B. de Smit (UL) published in 2003. Since then, it has been reprinted already four times. Moreover Broer several times gave lectures for secondary school teachers and pupils regarding the new curricula on Wiskunde D and Natuur, Leven en Technologie. Moreover Broer several times gave lectures for secondary school teachers regarding the new curricula on Wiskunde

[1] Wetenschappelijke Scheurkalender, a yearly publication of Natuurwetenschap & Techniek.

D and Natuur, Leven en Technologie.

Assessments

Quality
The quality of the output of this programme is considered very good. It published a large number of very good papers in good journals. It is very visible internationally.

Productivity
The productivity is considered excellent, with some members of this programme having an outstanding research output. The number of PhD's is excellent.

Relevance
The relevance of the programme is considered very good, in particular because it is increasingly working at the interface of pure and applied problems. The Committee applauds the efforts of the members of this programme in outreach activities, e.g., they have organized quite a lot of conferences.

Viability
The viability of this programme is very good. It has been rejuvenated by one new staff member, giving new opportunities to share leadership more widely. The increasing emphasis on mathematical physics has given this programme added focus.

Conclusions
The scope of this programme covers a rather wide field of mathematics, from dynamical systems, algebra and geometry to mathematical physics. More recently, the leaders decided to restrict the focus, and this is appropriate given the size of the group.
This research programme is very productive, with clear leadership. The department encourages its members to do more applied work. It should ensure that this pressure will not start to dilute the research activities of members of this programme.
The success rate in obtaining research funding was very good. EU funding could be pursued more vigorously.

5.2.2 RUG2 Systems, Control and Analysis

Programme number:	RUG2
Programme director:	Prof.dr. A.J. van der Schaft
Research staff 2008:	7.6 fte
Assessments:	Quality: 4
	Productivity: 5
	Relevance: 4
	Viability: 4

Short description
This program is a merger of two programs Systems & Control and Analysis. The first one was initiated by J.C. Willems, continued by R.F. Curtain. It is at the origin of the reputed school of Systems and Control in The Netherlands, structured first with the Dutch Network of Systems and Control, followed by the Dutch Institute of Systems and Control (DISC). It has strong connections with the cluster NDNS+ (Nonlinear Dynamics of Natural Systems), whose centre is situated in the IWI. The cluster has pre-financed the positions of Van der Schaft and Camlibel.
The research topics are the following:

Behavioural approach to systems and control
Geometric nonlinear systems modelling and control
Piecewise affine systems theory
Hybrid systems
Convolutional coding theory
Infinite-dimensional systems
Extension theory of symmetric operators and operator theory in Krein spaces

Mathematical optimization will be added to the spectrum of research domains with the recent appointment of the Rosalind Franklin Fellow Mirjam Dür.

External validation of RUG2
External validation of mathematical research often runs via other scientific disciplines. In general, the theoretical work on systems and control performed in the programme has had a considerable impact on the more applied research in this area. Port-Hamiltonian systems theory has been received by more application-oriented researchers (in diverse disciplines) as a very useful framework for modelling, simulation and control of large scale multi-physics systems. This is reflected by the success of the EU-IST programme Geoplex. The forthcoming book "Modelling and Control of Complex Physical Systems: the Port-Hamiltonian Approach" (Springer, 2009) by members of the Geoplex project (including A.J. van der Schaft) will help in further disseminating this theory and its potential for applications. An older reference in this area is "L_2-Gain and Passivity Techniques in Nonlinear Controls" (Springer 2000) by A.J. van der Schaft. Simulation software based on this theory has been implemented in the modelling and simulation package 20-Sim (Controllab Products, Enschede, The Netherlands).

The semi-group approach to infinite-dimensional systems theory as partly developed within the programme is widely recognized as an important contribution, with outreach to many application areas. The textbook "An introduction to infinite-dimensional linear systems theory" (Springer 1995) by R.F. Curtain and H.J. Zwart is widely referenced.

The behavioural theory as largely developed in the research programme is widely recognized as a fresh and illuminating way to look at systems and control theory, and to develop new theory. The textbook "Introduction to Mathematical Systems Theory" (Springer, 1997) by J.W. Polderman and J.C. Willems has been important in the dissemination of these ideas.

The historical contribution of the group to the area of geometric control theory is reflected in the textbook "Control Theory for Linear Systems" (Springer, 2001) by H.L. Trentelman, A.A. Stoorvogel, and M.L.J. Hautus.

Finally, the results obtained within hybrid systems have received quite some attention among the scientific community in embedded systems and formal verification theory; see also the textbook "An Introduction to Hybrid Dynamical Systems" (Springer, 2000), by A.J. van der Schaft and J.M. Schumacher.

Assessments

Quality
The quality is very good. This is shown by publications in leading journals, by invited lectures at respectable or even top class international conferences, the involvement in organizing such conferences, and by the participation in European networks.

Productivity
The output in academic publications is as high as one could desire, also in regard of their quality and length. This applies to the output both from Systems & Control and from Analysis. The

total number of PhD theses is very good.

Relevance
The focus is on fundamental applied mathematics. However, there is a close cooperation with experts on more applied domains. There is also a good cooperation with engineering departments.

Viability
The group is rather small. Systems & Control has been rejuvenated very drastically, including a very strong researcher and a few younger promising people. In pure analysis, soon all permanent staff will have retired. One new tenure track hiring in analysis is envisaged.

Conclusions
The Committee is confident about the future of this group, but it has some concern about the future of analysis within the programme. The number of PhD theses in analysis should increase. To some extent, for the part Systems & Control, the potential applications are so numerous that the problem is rather to focus. In the future, there will be an orientation towards systems biology and to network dynamics, such as networks of autonomous robots. This is of course good, but some flexibility has to be maintained.
Future has to show how the new tenure track in analysis will be embedded in the programme. In general, the group appears open to take advantage of opportunities. The present leadership has a good vision, although the new strategy is not yet fully finalized. The recommendation is to accelerate this process, in order to maximize the growth potential.

Chapter 6

Mathematisch Instituut of Leiden University (UL)

6.1 Assessment at Institutional Level UL

6.1.1 Introduction

In the early 1990s, the then "Subfaculteit Wiskunde" of Leiden University gave birth to the present Mathematisch Instituut (MI) of Leiden University and the Leiden Institute of Advanced Computer Science (LIACS).

In The Netherlands, the Leiden MI plays a key role in three of the four national research clusters in mathematics, and it has strategic alliances with the Technische Universiteit Delft (TU Delft) in teaching and with the Centrum Wiskunde & Informatica Amsterdam in research. It is coordinator of the European RTN in Galois theory and explicit methods GTEM. It has held the scientific directorship of the Landelijk Netwerk Mathematische Besliskunde (LNMB) since 1993, and it is administrator of the Thomas Stieltjes Institute for Mathematics.

6.1.2 Leadership

Scientific Director:	prof.dr. G. van Dijk (until 2004)
	prof.dr. S.M. Verduyn Lunel (2004–2007)
	prof.dr. P. Stevenhagen (since 2007)
Director of Education:	prof.dr. P. Stevenhagen (until 2007)
	prof.dr. S.J. Edixhoven (since 2007)
Managing Director:	drs. F. Bakker

The full professors of the institute form the Wetenschappelijke Raad (scientific board) of the institute. They have monthly informal lunch meetings to discuss institute matters.

Two, three times a year a stafvergadering (staff meeting) for all institute members is organized.

The Instituutsraad (institute council) is an independent body within the institute, which can offer solicited or unsolicited advice to the management.

By the end of 2009, the institute will have six full professors in two research clusters:

- Number Theory, Algebra and Geometry (S.J. Edixhoven, H.W. Lenstra, P. Stevenhagen);
- Analysis and Stochastics (A. Doelman, W.Th.F. den Hollander, R.D. Gill).

6.1.3 Mission and Goals

The Mathematisch Instituut strives to do high quality research at the frontiers of mathematical knowledge, and to educate future generations of mathematicians in a challenging research environment.

6.1.4 Strategy and Policy

The institute puts quality above the exact nature of the specialization of its researchers. All but a few of the institute members have been appointed in the last ten years, and this has brought about various changes in the research directions of the institute. Among the "newer" directions are probability and arithmetic geometry, whereas numerical analysis and operations research have lost prominence. Despite all changes, the general character of the research in Leiden has retained its somewhat fundamental nature: pure but with an open attitude towards applications.

The institute tries to remain as broad as possible in both teaching and research by exploiting the benefits of various strategic co-operations.

A strategic cooperation with the CWI in Amsterdam ties several researchers to the Mathematisch Instituut. P. Grünwald and V. Sidoravicius hold "exchange-appointments" in Leiden, whereas B. Koren and R. Cramer have 0.2 appointments in Leiden.

J. Hogendijk from Utrecht held a 0.2 appointment in history of mathematics in the period 2004–2009.

Within the national NDNS-cluster, P. Clément had a full-time appointment (2005–2007) in Leiden, A. van der Vaart (VU Amsterdam) is adviser for one day a week in Leiden, and J.J. Meulman (Faculty of Social and Behavioural Sciences, Leiden) has a 0.2 appointment at the institute.

With the full-time appointment of A. Doelman in January 2010 the institute will have filled all of its full professor positions. The stochastics group will hire an extra staff member to compensate for the departure of F. Redig, who is taking up a professor position in Nijmegen on January 1st, 2010, and for the departure of E. van Zwet to the medical statistics group of the Leiden University Medical Center (LUMC) in February 2009.

In The Netherlands, there are now four clusters in mathematics, and Leiden is a key player in three of them: the analysis group in NDNS, the stochastics group in STAR, and the algebra, geometry and number theory group in DIAMANT. The future of the clusters is not entirely clear in view of the current absence of financial commitments of the parties that have funded the clusters in the period 2005–2010, but it is clear that Leiden will be an integral part of further developments. The national cohesion of Dutch mathematics remains pronounced, and even the pre-cluster research schools (Stieltjes, MRI, EIDMA) continue to play their role and presently strive for a fusion.

Assessment of the Committee on Leadership, Mission and Goals, and Strategy and Policy

Although it is one of the smaller mathematics institutes in The Netherlands, Leiden successfully strives to be among the best. Research activities are focused; the corresponding division of the institute into two groups makes sense. Both are highly visible. Hierarchies seem to be flat and management informal but efficient. The policy to look for talent independent of the actual field of research and to scout for good additions to the faculty at an early stage appears to be effective. Also the tenure track system (see Section 6.1.5) made is effective, as it gives young researchers a fair chance to reach the professor level within a reasonable period of time.

6.1.5 Resources

The institute tries to hire the top people that are available, without specifying a detailed profile before hiring. In many cases, the institute "scouts" suitable additions to the staff, often already long before an actual hiring opportunity arises. This has led to the inclusion of top mathematicians in the staff, and it is illustrated by the fact that four of the six present full professors are members of the Royal Dutch Academy of Sciences (KNAW). The junior researchers in the department are appointed in the "tenure-track system" of the university, and are expected to grow from assistant to associate professor in a period of five years. Their development is closely monitored in their yearly R&O interviews mentioned above. All researchers have opportunity for travel, both on the institute budget and on external funding.

Tables 6.1, 6.2 and 6.3 display the distribution of research fte's over the various types of research staff for the institute as a whole, for the cluster Algebra, Number Theory and Geometry, and for the cluster Analysis and Stochastics, respectively. The contribution of support staff (management, secretarial and ICT) to research is left out. Their contribution to research proper is difficult to measure formally, though in practice this contribution is bound to be rather small. At present, the support staff of the institute comprises a total of 3.8 fte: 0.8 fte institute management, 1.4 fte secretarial staff, and 1.6 fte ICT support.

Table 6.1: Research staff at institutional level

In fte	2003	2004	2005	2006	2007	2008
Tenured staff	6.97	6.91	6.07	7.47	7.93	7.55
Non-tenured staff	2.04	3.11	4.96	3.71	4.23	4.65
PhD students	10.50	13.40	14.11	12.76	15.96	17.29
Total research staff	19.51	23.42	25.14	23.94	28.12	29.49

Table 6.2: Research staff of the cluster *Algebra, Geometry and Number Theory*

In fte	2003	2004	2005	2006	2007	2008
Tenured staff	2.80	2.88	2.96	2.96	3.36	3.52
Non-tenured staff	0.47	1.14	1.60	2.00	2.67	3.20
PhD students	5.37	7.47	8.78	8.96	9.23	8.82
Total research staff	8.64	11.49	13.34	13.92	15.26	15.54

Table 6.3: Research staff of the cluster *Analysis and Stochastics*

In fte	2003	2004	2005	2006	2007	2008
Tenured staff	4.17	4.03	3.11	4.51	4.57	4.03
Non-tenured staff	1.57	1.97	3.36	1.71	1.56	1.45
PhD students	5.13	5.93	5.33	3.80	6.73	8.47
Total research staff	10.87	11.93	11.80	10.02	12.86	13.95

In these staff tables, a full-time tenured researcher is counted as 0.4 fte. Non-tenured staff (i.e., postdocs) and PhD students are counted as 0.8 fte.
Table 6.1 shows that, despite the retirement of full professors Tijdeman, van Dijk, Hordijk and Spijker in the period 2003–2008, the tenured staff has remained of roughly constant size. There

is however a clear growth in non-tenured staff and PhD student numbers during the period. This has been made possible by a growth in research funds (see Table 6.4), and by the institute's efforts to increase its PhD student population.

Tables 6.2 and 6.3 show that the two research clusters of the institute are of comparable size, and that the growth in postdoc numbers has been mostly realized in the Number Theory, Algebra and Geometry cluster.

6.1.6 Funding Policies

The budget of the institute is for a very large part used for the payment of the researchers' salaries. The support staff is very small. With the retirement of F. Bakker, it will further decrease in size. This is in line with the institute's mission of teaching and research, as the material budget for mathematics is traditionally low, and mostly restricted to computer and library facilities.

This situation makes the flexibility with respect to variations in the yearly budget rather minimal, and the institute depends on the unabated generation of external funds to continue its existence. In the past, the risks taken in hiring top people have worked out well, but the current pressure on all Dutch academic mathematicians to acquire additional funding is at odds with the very limited funds available. Tenure track researchers depend on funding from the "NWO Vernieuwingsimpuls" that currently awards only about 5 % of all applications.

The basic funding the institute receives from the university has been lowered by 5 % in 2009 (with respect to 2008), and further budget reductions in subsequent years are being planned. As a consequence, the institute is currently shrinking in size.

The university as a whole is currently embarking on a rather drastic centralization of various facilities, in an effort to reduce costs and increase "efficiency". In the case of the ICT services, which are central in the institute and often of a custom made kind, this tendency is a source of concern, not only in view of the results of similar operations at other Dutch universities.

Tables 6.4 and 6.5 give details on the funding and expenditure, both in k€ and in %, during the assessment period. They show that while the direct funding of research shows only moderate growth beyond inflation correction, the external research funds have grown to account for about 25 % of the yearly budget. This is due to money coming out of the clusters NDNS and DIAMANT, but also to successes in the NWO Vernieuwingsimpuls program (VICI for S.J. Edixhoven, VIDI for O. van Gaans and V. Rottschäfer), and the Spinoza Prize and Akademiehoogleraarschap of H.W. Lenstra. The influx of contract funding has seen a modest start in 2007.

It is good to realize that the moderate growth in direct funding in the period is in fact a corollary of the growth in external research funds, as the allocation models in the university determine the funding amounts on the basis of education parameters (student numbers, diploma counts), but also on the amount of externally acquired research funds. Without the increase in student numbers during the assessment period and the numerous successes in the acquisition of external funding, the direct funding would have decreased substantially in this period.

The funding mechanism described above also gives rise to concern for the future. Sources like the NWO Vernieuwingsimpuls target researchers in the earlier stages of their career, and a small institute like the MI cannot easily adapt its age distribution to the preferences of external funding agencies. Diminishing influx of external research funds immediately translates into diminished direct funding, and leads to a lack of stability in basic research funding.
Table 6.6 below confirms once more that the two research clusters of the MI are of equal size. This makes for a healthy balance of interests in the institute.

Table 6.4: Funding and expenditure at institutional level, in k€

	2003	2004	2005	2006	2007	2008
Funding:						
Direct funding	2,142	2,246	2,300	2,448	2,663	2,843
Research funds	375	594	639	774	834	703
Contracts					129	101
Other						
Total	2,517	2,840	2,939	3,222	3,626	3,647
Expenditure:						
Personnel costs	2,218	2,492	2,407	2,488	2,909	3,161
Other costs	272	418	417	349	463	439
Total	2,490	2,910	2,824	2,837	3,372	3,600

Table 6.5: Funding and expenditure at institutional level, in %

	2003	2004	2005	2006	2007	2008
Funding:						
Direct funding	85	79	78	76	73	78
Research funds	15	21	22	24	23	19
Contracts					4	3
Other						
Total	100	100	100	100	100	100
Expenditure:						
Personnel costs	89	86	85	88	86	88
Other costs	11	14	15	12	14	12
Total	100	100	100	100	100	100

Assessment of the Committee on Quality of Resources, Funding Policies and Facilities

Basic funding depends on predefined parameters, one of which is the amount of "tweede geldstroom". The institute has been successful in this respect, but it is uncertain whether this can be maintained, given the current age distribution.
It is positively acknowledged that Leiden allows for pre-funding for PhD projects that are under NWO-review. This makes it possible to hire promising students and avoids the instant-hiring problems typically encountered with NWO grants. Of course, this strategy is only possible if a certain success rate in acquiring external funds can be maintained.
The institute benefits from cluster funding and if that would end, there is a serious problem, also because of its explicit effects on direct funding.
By and large, researchers are satisfied with their working conditions. There is some concern about the future of ICT facilities. The envisaged centralization of ICT, in view of reported experiences elsewhere, is expected to have negative effects. The commission hopes that this problem can be solved in a workable way in Leiden. Fortunately, the help desks will stay decentralized.

6.1.7 Academic Reputation

The Mathematisch Instituut has provided an overview with awards, memberships, (guest) editorships, invited lectureships, appointed professorships, fellowships, (co)organisation of conferences, visiting professorships and other academic achievements of the staff members.

Table 6.6: Distribution of funding over research clusters

In %	2003	2004	2005	2006	2007	2008
Cluster NTAG	43	44	43	43	51	48
Cluster AS	57	56	57	57	49	52
Total	100	100	100	100	100	100

6.1.8 Societal Relevance

The institute spends a considerable amount of energy on public awareness of mathematics, and on the dissemination of mathematical culture outside the research community. Some of these activities are of national nature, such as the Nationale Wetenschapsdag (for the Mathematisch Instituut R.D. Gill is the coordinator), but others are typical for the Leiden institute. Some examples:

The institute facilitates the appointment of employees of the Koninklijk Wiskundig Genootschap (Royal Dutch Mathematical Society) for the publication of the Nieuw Archief voor Wiskunde, the journal of the society, and similarly the appointment of students working for the youth mathematics journal Pythagoras or for Vierkant voor Wiskunde, aimed at both elementary and high school students.

Via R.D. Gill, the institute has been involved in making the public aware of the legal case against Lucia de B., a Dutch nurse given a life sentence for serial murder of ten patients in her care over the period 1996–2001. Lucia de B. was in police custody/jail from late 2001 until her release in 2008 pending a re-opening of the case in 2009. To no small extent, the reopening was catalyzed by massive protest from academic circles, involving newspaper, television, radio, Internet, petitions, demonstrations, scientific conferences, symposia and publications, including one in Nature.

H. Finkelnberg organizes master classes for talented high school students, as well as for mathematics teachers, and the institute has various even more extended mathematics programs aimed at high school students inside the university program LAPP-Top. The *Wiskundemeisjes* J. Daems and I. Smeets, who are in the process of writing their PhD theses at the institute, enjoy a blog-based popularity in much wider circles than mathematicians ever achieve. The abc-triples website maintained by B. de Smit has attracted the attention (and computer time) of number theorists all over the world.

Lenstra's completion of Escher's Print Gallery made the headlines of the New York Times in 2002. The animations that were subsequently created form the basis of the institute's most popular talk ever, which has been given over 140 times by various institute members in five languages over four continents, and a popular website.

Assessment of the Committee on Academic and Societal Relevance

Leiden certainly is one of the top places for mathematics in The Netherlands with world class researchers in its ranks. There are five members of KNAW alone. Several of the institute's researchers have spoken at the ECM or the ICM or taken part in the organization. Others have been leading in European research networks or the national research clusters. Many have received prestigious prizes or grants.
The work on cryptography, in which Leiden is one of the leading places, is highly important for security of transactions in a computer-based society. The research in pharmaceutics and systems biology is promising for the future. Finally, the department takes part in the writing of the Dutch national "Masterplan", which rolls out the future for Dutch mathematics. Department members invest much work into outreach activities.

6.1.9 Balance of Strengths and Weaknesses

The main strength of the institute is the high quality of its members, and the energy they invest in teaching and research. The level of enthusiasm and motivation is high, and the working atmosphere at the institute is excellent, and of a friendly nature.

The institute's main weakness lies in its size: the number of tasks is growing, whereas the available manpower is currently diminishing.

Nevertheless, the institute has taken advantage of all developments in funding of mathematics, as witnessed by its prominent role in the creation of the national mathematics clusters, and it will certainly continue to do so. The "masterplan" for the future of Dutch mathematics that is currently at the basis of discussions for additional government funding has a strong Leiden stamp, with A. Doelman and P. Stevenhagen among the four main authors.

Student numbers have been growing over the last few years, and the influx of foreign master and PhD students is increasing due to assets such as the ALGANT program, Erasmus Mundus exchanges and the brand new master Statistical Science for the Life and Behavioural Sciences. This makes for a healthy student population, and will lead to much higher numbers of PhD theses being defended in Leiden in the near future.

Funding for research has become more uncertain in The Netherlands, and academic steering is currently focusing on quantitative indicators such as student numbers and degree counts that are unfavourable for mathematics. Budget cuts in mathematics will immediately translate into staff cuts, and with the emphasis in the allocation on external funding as a basis for direct government funding, it is easy to end up in a downward spiral. This is however a concern for Dutch mathematics as a whole, and bears no special relation to the Leiden MI.

Assessment of the Committee on Strengths and Weaknesses

While many mathematics institutes have struggled during the past years to retain their size, Leiden was able to grow in the crisis, although it now also seems to have entered a phase of shrink. The Committee is impressed by the academic status that the institute has maintained, largely due to an efficient hiring policy. This allowed the institute to attract not only talented researchers but also an impressive amount of external funding during the assessment period.
This in turn involves a certain risk: success in the VENI, VIDI, VICI grant system relies on a suitable age distribution in the institute which is not always realizable, and a loss of external funding will also result in a loss of basic funding. The Committee shares the hope that the institute will be able to successfully tap other sources of funding (e.g. EU programmes).
While the scientific reputation is excellent, the number of publications and PhD theses has been relatively low over the assessment period. It seems, however, that the increasing number of students will eventually result in more graduate students as is already indicated by a high number of present PhD candidates.

6.2 Assessment per Programme UL

The Committee assessed the two programmes[1] of UL as follows:

Programmes	Quality	Productivity	Relevance	Viability
UL1 Number Theory, Algebra and Geometry	5	4	5	5
UL2 Analysis and Stochastics	5	4	5	5

The detailed assessments per programme follow in the next two sections of this report.

6.2.1 UL1 Number Theory, Algebra and Geometry

Programme number:	UL1
Programme directors:	Prof.dr. P. Stevenhagen (Number Theory and Algebra)
	Prof.dr. B. Edixhoven (Geometry)
Research staff 2008:	15.54 fte
Assessments:	Quality: 5
	Productivity: 4
	Relevance: 5
	Viability: 5

Short description
The research in programme UL1 combines abstract theory with algorithms and applications. It might be viewed as number theory in the broadest sense, ranging from discrete dynamical systems to arithmetic geometry and motives, with a strong emphasis on algebraic methods and a direct interest in the computational aspects of the theory.

The programme also includes cryptology and the history of mathematics. Main themes in cryptology are the applications of number theory and algebra to the design of cryptographic schemes. Foundational issues are considered as well. In the history of mathematics, the emphasis is on the edition and translation of early Islamic mathematical and astronomical texts.

SWOT-analysis of UL1
A strong point of the programme is its excellent academic reputation in its subject fields, as well as the amount of energy and work that the staff puts into its research.

Due to the strong involvement of this programme in teaching, organization and administrative responsibilities, the programme does not have as much time for research as it would like to have. The direction of bachelor and master theses takes a considerable amount of time, outside the regular teaching load of three courses a year.

A further possible weak point is that in comparison with the previous review period, the number of PhD theses has only remained the same (13 PhD theses). However, many master theses of such high quality that they form in fact the start of a PhD programme have been completed under the direction of members of the group. The production of PhD theses will increase in the near future as the result of co-operations in the Erasmus Mundus ALGANT programme, and also as the result of the co-operation with the CWI.

The participation in the DIAMANT cluster clearly was an opportunity in the period under review. The programme hopes that, even more so during the financial crisis, the funding authorities will

[1] In the Self-evaluation of the Mathematisch Instituut of Leiden University, these programmes are called "clusters". For uniformity of presentation we use "programme" in this Research Review.

realise that, in mathematics, results obtained in the past *are* a guarantee for the future, and will be convinced to fund the sectorplan wiskunde.

Fortunately, there seem to be no threats from inside the scientific community. However, a real threat is the decline of government funding.

The research objectives of this programme are adequate. If government funding declines further, cuts will have to be made, though. As the balance between research and teaching needs to be maintained, such cuts will affect essential parts of both research and teaching. At present, the highly motivated research staff has reached the limits of the amount of work that can be expected.

Assessments

This very active group works on various topics of number theory, arithmetic geometry and algebra. Quite a few of the research results are directly or indirectly relevant in cryptology. The group is a funding member of the DIAMANT cluster, coordinates the GTEM network of the European Union, and is in many ways active on the national and international scene.

Quality
The quality of the work is excellent. The work in number theory has an excellent reputation. Some of the results in the area of arithmetic geometry and modular forms are of the highest level.

Productivity
The productivity is very good, but could be improved, in particular the group could supervise more PhD students.

Relevance
The work of the group leaders has been fundamental in the applications of number theory and algebra to cryptology (and to some extent, coding), and this work is continued by the younger ones as well. The outreach activities of the group are very relevant for the society.

Viability
The group is very viable, with very high level senior and junior members.

Conclusions
This group does excellent work and is well integrated in the Dutch and international scientific world. It is very active in every respect: the organization of seminars and workshops, interaction with mathematicians and computer scientists at national and international levels, as well as in scientific management and organization.
It is interesting to note that there are many interactions with computer scientists, but, somewhat surprisingly, not with the Leiden Computer Science department. The Committee thinks that more collaboration between the local computational scientists and the mathematicians, for the development of cryptology, would be an asset for the whole university.

6.2.2 UL2 Analysis and Stochastics

Short description
Research in this programme spans dynamical systems, interacting particle systems, quantum statistics, forensic statistics, queueing networks, Markov decision processes, multivariate statistics, multidimensional data analysis and statistical learning. Much of the research is driven by applications coming from physics, life sciences and telecommunication. Part of the research includes computational aspects. A common activity in the programme is mathematics of the life

Programme number:	UL2
Programme directors:	Prof.dr. A. Doelman (Analysis)
	Prof.dr. R. Gill (Stochastics)
Research staff 2008:	13.95 fte
Assessments:	Quality: 5
	Productivity: 4
	Relevance: 5
	Viability: 5

sciences. A bi-weekly seminar is organised in which all programme members participate.

SWOT-analysis of UL2
A strong point of the programme is the high academic reputation of the research staff members in their respective fields, and the sustained level of their research activity over the years. The research staff is highly motivated. The research fields they work in are thriving.

The programme offers a coherent teaching curriculum, with outreach towards physics and life sciences. The programme draws a large number of bachelor and master theses.

A weakness of the programme is that until 2006, the number of PhD students was relatively low, mainly as a result of under staffing in Stochastics. One expects that the production of PhD theses will increase in the near future, as a result of a substantial investment made in PhD staff, as well as through participation in NDNS and STAR and through cooperation with CWI. Presently the programme has 9 PhD students.

A second point of weakness is that the teaching load, though still fair, will increase due to a drop in the number of staff members.

Among its opportunities the programme counts: stronger ties with CWI, funding opportunities through ERC, extension of NDNS, and participation in STAR. If the government funds STAR, new junior staff can be attracted.

A serious threat is the continuing decline of government funding. As a result of the shift of 100 M€ from academia to NWO, the institute fears that cuts have to be made, both in the tenured and the non-tenured staff.

Assessments

Quality
The quality of this programme is excellent. This is shown by publications in leading journals, invited lectures at respectable or even top class international conferences, the involvement in organizing such conferences, the receipt of important grants, and some prestigious memberships.

Productivity
On average, the number of publications is very good, also in regard of their quality and length. For some tenured staff members the productivity is even excellent, but for some others on the low side. The number of PhD theses is modest, but the number of recent PhD student appointments is very high.

Relevance
The relevance of the programme is excellent because of the many significant applications to other fields outside mathematics, in particular to physics, telecommunication, life sciences and forensic science. Noteworthy is the very active involvement by one of the programme members in the

societal debate on the case of a condemned Dutch nurse. His statistical expertise was extremely relevant in this debate.

Viability
Some excellent hirings have been done in order to strengthen the programme or to fill gaps caused by leaving or retiring tenured staff. Some younger programme members obtained NWO VIDI grants.

Conclusions
This programme is unusual in that it brings together analysis and stochastics. However, this is justified by the prominent place of stochastic analysis within the programme and by the necessity to have programmes of critical size. It has been a wise decision to stop Operations Research in the near future. Given the limited amount of resources, it is unavoidable to make restrictive choices in research directions, and to leave other specializations to sister universities.

Chapter 7

Institute for Mathematics, Astrophysics and Particle Physics (IMAPP) of Radboud University Nijmegen (RU)

7.1 Assessment at Institutional Level RU

7.1.1 Introduction

The Faculty of Science (FNWI) of the Radboud University Nijmegen comprises five research institutes, one of them being the Institute for Mathematics, Astrophysics and Particle Physics (IMAPP). Each of the current three mathematics programmes at Nijmegen, i.e. Algebra & Logic, Mathematical Physics, and Stochastics, is a so-called Department within IMAPP, which also includes Departments of Astrophysics, Experimental High Energy Physics, and Theoretical High Energy Physics. The latter three departments are not part of this self-evaluation, which is limited to mathematics.

7.1.2 Leadership

Subfaculty of Mathematics 1/1/2002-31/12/2004

Director:	prof.dr. F. Keune
Director of Research:	prof.dr. J. Steenbrink (2002-2003), dr. W. Bosma (2004)
Director of Education:	prof.dr. F. Keune

Institute for Mathematics, Astrophysics and Particle Physics (IMAPP) 1/1/2005-31/12/2008

Director:	prof.dr. S. de Jong (Experimental Physics)
Managing Director:	dr. A. König (Experimental Physics)
Executive Board (EB):	prof.dr. S. de Jong (q.q.), dr. A. König (q.q.), prof.dr. N.P. Landsman (Mathematics, deputy director), dr. G. Nelemans (Astrophysics)
Institute Board (IB):	Executive Board plus Heads of Department
Scientific Advisory Board:	Prof.dr. J. Engelen (CERN, Particle Physics) Prof.dr. R. Gill (Leiden, Mathematics) Prof.dr. M. van der Klis (Amsterdam, Astrophysics) Prof.dr. I. Moerdijk (Utrecht, Mathematics)

The FNWI has no Mathematical Institute or equivalent thereof, so that the director of IMAPP is simultaneously the research director of mathematics, nominally as well as practically. He sets IMAPP policy in close consultation with the Executive Board, which includes representatives from astrophysics, particle physics and mathematics, and with the Institute Board, which includes all department heads. The latter, in turn, are expected to consult their group members. In addition, the director periodically talks to all staff members, both privately and, twice a year, in a general IMAPP staff meeting. At any time he is approachable by any member of the institute (including PhD and MSc students). Once agreed, IMAPPs strategy and policy are delineated in a (periodically updated) Strategic Plan. FNWI policy on mathematics is largely drawn from the Strategic Plan of IMAPP, and is confirmed, in broad outlines, in its own Strategic Plan.

The leadership structure of FNWI may be said to be hierarchical at large, but it is flat at the level of the mathematicians themselves. Mathematicians do influence strategy and policy in both a formal and an informal capacity, but at present they are not represented at the executive level. With the recent and planned rejuvenation and strengthening of the mathematics departments, a future ambition is to aspire such presence at various echelons of the Radboud University.

7.1.3 Mission and Goals

It is the mission of the mathematical community at RU to conduct our research, education and outreach with a maximum of professionalism, expertise, and élan. Indeed, the very idea of a University implies that these three aspects of our work are deeply interwoven. In research and in education we hardly see a distinction between pure and applied mathematics, and put special emphasis on the role of mathematics in computer science and the natural sciences. In the interface of research and education we train our PhD students towards independence with an open and critical mind, whilst in our outreach we feel a special responsibility towards increasing enthusiasm for mathematics among schoolchildren. Finally we wish to instill a mathematical way of thinking in those active in other disciplines. (citation from the Self-evaluation 2002–2008 of RU)

Mathematics at IMAPP centres on three interdisciplinary themes: mathematical physics, algebra & logic, and stochastics. There are well-established links between these themes and computer science and physics. The traditional areas of algebra, logic, analysis, geometry and stochastics relate closely to these themes.

7.1.4 Strategy and Policy

In its Strategic Plan for 2009-2013, the Radboud University Nijmegen requires all its programs (i.e. in research as well as teaching) to be both in the top 25% of the country and internationally competitive. The mathematics community shares this ambition, and will do its utmost to achieve it with the limited resources currently available.

This means that while the BSc degree program should give a broad and representative coverage of all of mathematics, at the research level specific choices have been made. These choices directly correlate with:

1. The mathematics departments within IMAPP;
2. The MSc tracks in mathematics offered at Nijmegen;
3. Specific partner institutes within the FNWI.

In close collaboration with these partners, the research ambition is that Nijmegen be an internationally competitive national centre of excellence in:

- **Algebra, logic and computer science** as far as their interdisciplinary boundary is concerned (with the Institute for Computing and Information Sciences at RU);

- **Mathematical physics**, particularly as oriented towards *quantum theory* (with IMAPP itself);
- **Applied stochastics** in the domain of the natural sciences, notably *neuroscience* (with the Donders Centre for Neuroscience at RU).

In the period 2001–2009, the mathematics community at RU went through a series of significant changes. These were partly caused by the historical low point for the number of first-year students who enrolled in the mathematics degree program in 2001: 10, while this was 70 in the peak year 1976. The Faculty Board subsequently seriously contemplated to terminate the degree and reduce mathematics at Nijmegen to an institute for service teaching. Instead, starting in 2004 a Reorganisation took place, during which 3 fte permanent scientific staff, 6 fte temporary scientific staff (i.e. all PhD positions) and 1.4 fte nonscientific staff was cut.

Nonetheless, the mathematics community at Nijmegen currently appears to be thriving. One may identify a number of important factors behind this resurrection:

- The enthusiasm and commitment of the local students and the ensuing combined efforts of students and staff in outreach (culminating in the yearly Mathematics Tournament for 500 schoolchildren from 100 individual schools, but also including numerous other activities). Helped by an impressive new building of the FNWI, this has contributed to a spectacular increase in student numbers since 2005: while enrolment in that year was still low at 10, in the subsequent years 2006, 2007, 2008, and 2009 Nijmegen had 19, 27, 36, and 54 first-years, respectively (well above the national growth level for mathematics).
- The formation of national NWO-funded Mathematics Clusters in 2005 and 2006, specifically DIAMANT and GQT, in which Nijmegen participates.
- Significant rejuvenation (three of the five Chairs remaining after the Reorganisation found new occupants over the review period, the fourth succession being due 1-1-2010).

Assessment of the Committee on Leadership, Mission and Goals, and Strategy and Policy

Mathematics at the Radboud University Nijmegen has gone through a very difficult period, with the threat that only a department for service teaching would remain. The people in charge can be complimented that they have realized a resurrection, almost as a phoenix, showing a great élan, hiring good people, choosing new directions, and establishing fresh collaborations.
Although the research leadership is nominally and practically with the director of IMAPP — during the evaluation period this was not a mathematician — mathematicians have been able to put their mark on leadership, both through the formal channels of IMAPP and in informal ways.
The mission statement is remarkable in that it emphasizes outreach on equal level with research and education. It is even more remarkable that the RU Nijmegen mathematicians have acted accordingly with impressive outreach activities.
The interdisciplinary themes have worked well for focusing and for collaborations, and they have been no obstacle for good mono-disciplinary work also being done.
The choices which were made for the three interdisciplinary themes are all interesting and well motivated, but the implementations are in different stages of progress. Most advanced until now is the Mathematical Physics theme. This was a very natural choice and it has turned out to be very successful. The choice for a theme Algebra, Logic and Computer Science was much influenced by the specialization of the newly hired full professor of algebra. There are good perspectives for making this theme also successful and important steps have already been made, but time has to show that this programme will meet its expectations. Finally, the theme of applied stochastics, notably neuroscience, means a very drastic break with the past activities in financial mathematics, which were ended for sound reasons. The newly hired full professor of applied stochastics will start in 2010, far beyond the assessment period.

7.1.5 Resources

The system for appointment of research personnel is fully described in A.4 of the Self-evaluation.

During the review period the following tenured appointments have been made:

- Prof.dr. N.P. Landsman (2004), Mathematical Physics
- Dr. M.H.A.H. Müger (2006), Analysis/Mathematical Physics
- Prof.dr. M. Gehrke (2007), Algebra/Logic
- Prof.dr. H.T. Koelink (2007), Analysis

Tables 7.1, 7.2, 7.3, and 7.4 display the distribution of research fte's over the various types of research staff for the institute as a whole, and for the Programmes Algebra & Logic, Financial Mathematics, and Mathematical Physics, respectively.
In these staff tables, a full-time tenured researcher is counted as 0.4 fte. For the non-tenured staff a postdoc is counted as 0.875 fte and a PhD student as 0.75 fte.

Table 7.1: Research staff at institutional level

In fte	2002	2003	2004	2005	2006	2007	2008
Tenured staff	6.52	6.02	5.26	5.70	5.39	5.39	5.46
Non-tenured staff	1.21	0.29	2.34	4.96	4.66	3.26	2.91
PhD students	7.63	6.69	6.04	5.89	4.09	3.48	4.75
Total research staff	15.35	13.00	13.63	16.55	14.14	12.13	13.12

Table 7.2: Research staff in the Programme Algebra & Logic

In fte	2002	2003	2004	2005	2006	2007	2008
Tenured staff	2.00	2.00	2.00	2.00	2.00	2.12	2.16
Non-tenured staff	0.00	0.00	0.00	0.00	0.44	1.15	1.75
PhD students	1.88	1.00	0.94	1.50	1.50	1.50	1.75
Total research staff	3.88	3.00	2.94	3.50	3.94	4.77	5.66

Table 7.3: Research staff in the Programme Financial Mathematics

In fte	2002	2003	2004	2005	2006	2007	2008
Tenured staff	1.52	1.39	1.12	1.14	0.99	0.74	0.74
Non-tenured staff	0.00	0.29	1.75	2.19	1.31	0.00	0.00
PhD students	2.75	2.85	2.38	2.23	1.21	0.35	0.00
Total research staff	4.27	4.53	5.25	5.55	3.51	1.09	0.74

7.1.6 Funding Policies

Expenditure of the three mathematics departments is dominated by personnel cost, plus a modest material budget. Until 2005, funding in the Faculty of Science was coupled to staff positions (whether occupied or vacant) occurring in the personnel formation plan of the Faculty. From late

Table 7.4: Research staff in the Programme Mathematical Physics

In fte	2002	2003	2004	2005	2006	2007	2008
Tenured staff	1.60	2.00	1.73	2.20	2.40	2.53	2.56
Non-tenured staff	0.73	0.00	0.59	2.77	2.92	2.12	1.16
PhD students	2.25	2.10	2.35	2.16	1.37	1.62	3.00
Total research staff	4.58	3.70	4.91	7.88	7.45	6.72	6.72

1990s until 2005, the number of faculty positions has been *increasing*, partly because of the spectacular growth in student numbers in Science (which almost doubled between 2000-2005), whilst direct university funding *decreased*. Roughly speaking, the difference was covered by (temporary) grants and other resources different from direct funding by the Ministry of OC&W.
This funding system turned out to be unstable and hence since 2005, only those positions that are actually occupied are funded, whereas vacancies are no longer automatically filled; each vacancy is discussed on a case by case basis by the Faculty Board in terms of merit and possible resources. Current funding for the departments, then, is by definition equal to expenditure, largely consisting of these personnel costs (in particular, no financial manoeuvring room can be created by leaving positions vacant).

In addition to this general policy, since 2003 there has been a major reduction in positions and the corresponding direct funding as a consequence of the Reorganisation started in 2004. Nonetheless, despite increasing overall financial difficulties continuing to emerge as a relic of the above-mentioned funding system, mathematics has been revitalised in a number of ways. In particular, following the reoccupation of the Chair in Analysis by Landsman in 2004 (which was part of the Reorganisation Plan), the Faculty Board has also installed the GQT-Chair held by Koelink (a priori in Mathematical Physics, but in fact in Analysis following a swap with Landsman) and approved the reoccupation of the Chair in Algebra by Gehrke in 2007 as well as the Chair in Applied Stochastics by Redig in 2010. In 2004 Heckman, until then professor of Pure Mathematics on personal title, succeeded Steenbrink on the Chair of Geometry. In the near future, at least two and probably three U(H)D positions, in the latter case also equally distributed over the three mathematics departments, will be reoccupied at the UD-level.

From January 1, 2010, the new financial structure of integral management is scheduled to be in place at the Faculty of Science, with, in particular, an integral budget for IMAPP. This means, for example, that funding left from vacancies may be used to cover other expenditure, as long as the overall budget is respected. However, a realistic outlook on national politics suggests that direct university funding will continue to drop in the foreseeable future (i.e., at least until 2013). This creates a particularly difficult situation for mathematics, since despite the above-mentioned appointments, the IMAPP director considers current direct funding for the totality of the three mathematics departments within IMAPP to be at a minimum level necessary for proper functioning.

Given the downward trend in direct funding, it is clear that more funds need to be raised from external sources. Fortunately, in view of the rejuvenation of the department and the relatively low external funding level at present, there is a clear prospect for this indeed to happen. The target is to have at least one externally funded PhD student or postdoc per fte permanent scientific staff, i.e. at least 13, active at any time. To this effect, staff is actively encouraged to develop and submit proposals for funding, principally to NWO (but also to the ERC). Such an increase in PhD students and postdocs would also slightly reduce the teaching load in the permanent scientific staff.

Finally, with the move to the impressive new Huygens Building of the Faculty of Science in 2007,

housing facilities have markedly improved during the review period (though office space is actually more limited). Available computing infrastructure is sufficient and well maintained. There is an excellent library in the Faculty of Science, with active support by the librarians, among other things also in peer review analyses.

Tables 7.5 and 7.6 give details on the funding and expenditure, both in k€ and in %, during the period 2002–2008. Table 7.7 gives the breakdown of the funding over the three research programmes.

Table 7.5: Funding and expenditure at institutional level, in k€

	2002	2003	2004	2005	2006	2007	2008
Funding:							
Direct funding	765	692	566	534	471	477	521
Research funds	55	63	232	454	485	381	415
Contracts							
Other							
Total	820	756	798	989	955	858	935
Expenditure:							
Personnel costs	783	710	735	925	867	774	853
Other costs	37	45	62	63	88	85	82
Total	820	756	798	989	955	858	935

Table 7.6: Funding and expenditure at institutional level, in %

	2002	2003	2004	2005	2006	2007	2008
Funding:							
Direct funding	93	92	71	54	49	56	56
Research funds	7	8	29	46	51	44	44
Contracts							
Other							
Total	100	100	100	100	100	100	100
Expenditure:							
Personnel costs	96	94	92	94	91	90	91
Other costs	4	6	8	6	9	10	9
Total	100	100	100	100	100	100	100

Table 7.7: Distribution of funding over research programmes

In %	2002	2003	2004	2005	2006	2007	2008
Programme AL	33	30.5	28	26	31	39.5	41.5
Programme FM	33	36.5	35.5	31	23	10.5	8
Programme MP	34	33	36.5	43	46	50	50.5
Total	100	100	100	100	100	100	100

A few trends are immediate from these tables. First, external research funding, virtually absent before 2003, has increased markedly during the review period. This phenomenon has various

sources, the main ones being the STW-project in financial mathematics held by Van Zuijlen between 2003 and 2007, the Pioneer project of Landsman in mathematical physics between 2004 to 2008, and the initial funding of Koelinks Chair by the GQT-cluster from 2006 onwards. In addition, a number of PhD students and postdocs were funded by NWO. Second, as is also clear from Table 1, Algebra & Logic and Mathematical Physics have grown at the expense of Financial Mathematics (the former exclusively through non-tenured staff, at least in terms of numbers).

Assessment of the Committee on Quality of Resources, Funding Policies and Facilities

Research staff is small, but it has reached already a modest workable size also because of exterior funding, notably by having the Chair of Mathematical Physics prefinanced by money from the GQT-cluster. The number of PhD students was small, also because of the past plans to reduce the institute. It is rising now by some university funding and by increasingly successful efforts to obtain exterior funding. Attempts to get exterior funding are much encouraged by IMAPP, but its success rate is less than desirable. This has to do with the low percentage of granted proposals for NWO and for EU research funding, a general complaint of Dutch mathematicians. A new flow of cluster money after the present five-year periods of the clusters is heavily needed by this institute. Researchers of the RU contribute very actively in drafting continuation proposals for GQT and DIAMANT.
Facilities are good in general.

7.1.7 Academic Reputation

IMAPP has provided an overview with awards, memberships, (guest) editorships, invited lectureships, appointed professorships, fellowships, (co)organisation of conferences, visiting professorships and other academic achievements of the members of its three mathematics programmes.

An indication of the reputation of IMAPP as a whole, as well as of its scope, was the stellar lineup of speakers at the IMAPP-Symposium on October 13, 2006. This symposium, which was attended by about 500 people, featured theologian Hans Küng (*The Origin of the Cosmos*), mathematical physicist Roger Penrose (*Before the Big Bang*), experimental high-energy physicist Jos Engelen (*Experimental Exploration of the Terascale*), astronomer Rashid Sunyaev (*Clusters of Galaxies, Cosmic Microwave Background and Cosmology*), theoretical high-energy physicist and Nobel Laureate Gerard 't Hooft (*The Origin of Quantum Mechanics*), and mathematician Don Zagier (*Relations between Quantum Theory, Geometry and Number Theory*).

7.1.8 Societal Relevance

Within IMAPP and the FNWI, the director and the Dean foster collaboration between different departments and disciplines, respectively. For example, during the review period Landsman and Gehrke were attracted at least in part to strengthen the link between mathematics and physics and between mathematics and computer science, respectively. Similarly, hiring Redig in 2010 has been partly motivated by the goal of relating mathematics to neuroscience.

Although physics research is well represented in the FNWI, its focus is largely phenomenological (within IMAPP) and even technological (within IMM, the Institute for Molecules and Materials IMM). Nonetheless, IMAPP seems uniquely positioned, not just in The Netherlands but perhaps even in the world, to forge ties between mathematicians and physicists in the search for the origin of the Higgs mechanism. The (so far hypothetical) Higgs boson is a cornerstone of the Standard Model of elementary particle physics (and hence, at least from a reductionist perspective, of all of physics), and it is IMAPP's policy that every single resource should be used to understand it. Within IMAPP, the Department of Theoretical High Energy Physics is a major player in understanding Higgs phenomenology in collider physics (Wim Beenakker, Ronald Kleiss), whereas

the Department of Experimental High Energy Physics is directly involved in the actual search for the Higgs at Fermilab (Sijbrand de Jong) and CERN (Nicolo de Groot). On the mathematics side, the Department of Mathematical Physics has considerable expertise in applications of non-commutative geometry to physics. The FNWI's recent application for funding from the so-called *Sectorplan* for Dutch physics includes a proposal for starting research this direction as a collaboration between the three IMAPP departments just mentioned, to be strengthened by a new interdisciplinary Chair in theoretical physics. Walter van Suijlekom (currently holding a VENI-grant) is expected to play a crucial role in this endeavour, which, taking place within a single institute, would be unique in the world and would reconfirm the coherence of IMAPP.

Assessment of the Committee on Academic and Societal Relevance

While it is not so difficult to close an existing programme, it is much more difficult to build new ones. The RU groups are well on their way in realizing this heavy task. The quality of the research staff is very good and provides together with the scope of expertise a solid basis for outreach activities. This is not easy for a small institute, but the results so far are very promising. Academic relevance outside the own specialization is apparent for mathematical physics because of the interaction with physics, and for the new professor of algebra because of the interaction with computer science and logic. The programme of financial mathematics had some a priori relevance because it was receiving funding from STW. The new emphasis by applied stochastics on neurosciences will make it potentially relevant there. Some outreach activities highly contribute to societal relevance, including writing novels inspired by science history, addressing philosophical questions, and advising about the mathematical teaching programme on Dutch high schools.

7.1.9 Balance of Strengths and Weaknesses

SWOT-analysis of the three mathematics departments at large:

Strengths

- Three well-positioned principal research themes
- Élan brought by new appointments
- Spectacular rise in student enrolment

Weaknesses

- Overall size since Reorganisation of 2004
- Education program for PhD students

Opportunities

- Nationally unique centre in algebra-logic-computer science triangle
- Reorientation of stochastics towards the natural sciences
- Connection of mathematical physics to high-energy physics
- Increase of funding from NWO and ERC
- National education program for PhD students

Threats

- Continuous decrease of direct funding
- Termination of mathematics clusters

- Strain of staff members due to heavy workload

Assessment of the Committee on Strengths and Weaknesses

The main threats and weaknesses follow the general trends in Dutch mathematics: poor funding possibilities from "tweede geldstroom" and still too few students, although the growth in student numbers has been spectacular.
A special threat for this restarted and rejuvenated mathematical research group is the amount of time to be spent in outreach activities and in teaching. This puts research time under pressure and, in general, status is built on successful research. This aspect needs, certainly in this phase of rebuilding the mathematics programmes, special attention. It holds especially for the younger staff in the programmes. Their success in research is mandatory for success in obtaining additional funding.
The university should pay attention to these aspects and should further protect the involved groups during their rebuilding phase.

7.2 Assessment per Programme RU

The Committee assessed the three programmes of RU as follows:

Programmes	Quality	Productivity	Relevance	Viability
RU1 Algebra & Logic	3	3	4	4
RU2 Financial Mathematics	–	–	–	–
RU3 Mathematical Physics	4	4	5	5

The detailed assessments per programme follow in the next three sections of this report.

7.2.1 RU1 Algebra and Logic

Programme number:	RU1
Programme director:	M. Gehrke
Research staff 2008:	5.66 fte
Assessments:	Quality: 3
	Productivity: 3
	Relevance: 4
	Viability: 4

Short description
Algebra has its roots in the study of arithmetic and the solution of equations but, in its modern abstract form, it is a powerful mathematical setting for understanding computation in a much wider sense – including logical deduction and the algebraic study of geometry. For this reason, modern algebra has had a profound impact on many domains of mathematics, including functional analysis, geometry, topology, and logic, as well as on neighbouring fields such as physics and computer science.

Logic, in particular non-classical logic, is an area of national strength and tradition for The Netherlands. The interdisciplinary edge between algebra, logic and computer science is one of the modern frontiers of applied mathematics and is also an active source of many innovations, exciting problems, and worthwhile applications. The Netherlands, with its rich tradition also in algorithmic algebra, is a region of particularly high concentration of such activity and the Algebra & Logic group is well placed to take a leading part in future developments.

The research strengths of the Algebra & Logic department in Nijmegen lie in the algebraic study of the interplay between logic, computation, and geometry, and as such the group has natural overlaps both with computer science and mathematical physics. Gehrke's work focuses on topological methods in algebra and algebraic logic with applications to the foundations of computer science. Bosma and Souvignier mainly focus on algorithmic aspects of number theory and group representations, with applications in computer algebra, cryptography and crystallography. Van den Essen works in affine algebraic geometry, while Veldman's work is in intuitionistic mathematics.

SWOT-analysis of RU1:

Strengths:

- critical mass in a timely and important research area
- historical positioning within Dutch mathematical research
- embedding in DIAMANT cluster
- links and overlap with interests of ICIS groups
- appeal of subject area to Master students

Weaknesses:

- external funding
- period of low research output
- number of PhD students

Opportunities:

- revitalisation of research efforts
- joint Master in Mathematical Foundations of Computer Science
- increasing number of Master and PhD students
- fresh initiatives at the interface of logic and algebra
- Dutch logic cluster
- succession of Henk Barendregt (2012)
- bridge between algebraists and computer scientists within DIAMANT
- joint interests with new Chair in Applied Stochastics (2010)

Threats:

- strain on staff members due to a number of re-orientations
- termination of DIAMANT
- fragmentation of logic community

Assessments

Quality
The group has produced good results in the areas of computational algebra and number theory, as well as in logic. During the review period, the quality has risen.

Productivity
The productivity was low but has risen recently. There is still room for improvement. In particular, the number of PhD theses is low, but some PhD theses are expected to be completed immediately after the assessment period.

Relevance
The work is mostly relevant within the areas of logic, algebra and number theory. The integration in the Dutch mathematical community is good. Collaboration with computer science has been reinforced. One of the group members was founding developer of the Magma computer algebra system.

Viability
Over the review period the group has become much more dynamic and viable. The situation is still not entirely stable, but there is a definite improvement.

Conclusions
This group is doing increasingly good work, and it holds promise for future development. It is important to keep the teaching load at a reasonable level, and to continue to develop the scientific dynamism, such as the organization of a weekly seminar and collaboration with computer scientists, logicians and mathematicians at RU Nijmegen and elsewhere. These collaborations are in particular important because of the size of the group.
The recent arrival of a new professor gave new dynamism to this group. For instance, the teaching load was reduced to a reasonable level, and this allows the researchers of the group to become more productive. It is to be noted that the work of the group in logic has expanded quite considerably, with the ambition to form a nation-wide network in this area.

7.2.2 RU2 Financial Mathematics

Programme number:	RU2
Programme director:	M.C.A. van Zuijlen
Research staff 2008:	0.74 fte
Assessments:	Quality: –
	Productivity: –
	Relevance: –
	Viability: –

Short description
The research area of the department includes mathematical statistics, probability theory and financial mathematics, with an emphasis on financial mathematics. The mission of the group was to develop and analyze models for financial processes and to be active in consulting in order to apply stochastics in other disciplines. Much effort has been made in order to apply stochastics in statistical auditing.

SWOT-analysis of RU2:

Strengths:

- Broad orientation in stochastics
- Expertise in statistical models for auditing
- Broad network in the financial industry
- Nice combination of theory and practice
- International orientation and cooperation

Weaknesses:

- Very small number of permanent staff
- Over-dependence on temporary external funds

Opportunities:

- Reorientation of applied stochastics towards (neuro)biology
- Embedding in national Stochastics cluster
- Embedding in national Biomathematics program

Threats:

- Lack of critical mass
- Lack of funding of Stochastics cluster

Assessments

In 2010 this programme will be refocused on Applied Probability, in particular interacting systems, with particular emphasis on applications from physics, biology, and neuroscience.
The Committee refrains from grading the past for that reason.
This does certainly not imply, however, that the Committee has concerns over the past period. The Committee is afraid that scores for the programme to be closed may influence the reputation of the newly formed programme.

Quality
During the main part of the period evaluated, this was an active programme with fine production in highly ranked journals, and in collaboration with respected scientists the world over.

Productivity
Also productivity was good. An increase can be anticipated with the reorientation made, and new hiring.

Relevance
The past focus on auditing was highly relevant.

Viability
It makes no sense to comment on the viability of a programme to be terminated in less than a month. Such a viability would, by definition, be very low. The programme starting in 2010 is as viable as such a small group can possibly be, both on account of its own strength, the collaboration envisaged with other RU groups, and the generally good and active atmosphere.

Conclusions
The new programme, starting in 2010, is well chosen. The collaborators will be embedded in an open and enthusiastic environment in Nijmegen, well connected to other research in The Netherlands and abroad.

7.2.3 RU3 Mathematical Physics

Programme number:	RU3
Programme director:	G.J. Heckman
Research staff 2008:	6.72 fte
Assessments:	Quality: 4
	Productivity: 4
	Relevance: 5
	Viability: 5

Short description
Mathematical physics was created as field of science by Isaac Newton, notably with his *Principia* of 1687. A second landmark for mathematical physics was Joh(an)n von Neumann's *Mathematische Grundlagen der Quantenmechanik* from 1932. In these works, mathematics and physics showed mutual purpose and uniformity of method, and results were presented that were fundamental and innovative for both disciplines.

The research in RU3 primarily involves structures that originated or matured in the context of quantum mathematical physics in the tradition of von Neumann, such as representation theory, operator algebras, and non-commutative geometry. However, one also works on topics in classical mathematical physics, like symplectic geometry and the theory of integrable systems. Expertise in the theory of special functions and its connection with representation theory lies in between these categories. The mathematical study of symmetry is common to most of these topics.

The aim of RU3 aim is to cover mathematical physics from a broad point of view, including all of the four traditional disciplines of mathematics, viz. Analysis, Algebra, Geometry, and Stochastics. One aspires to be the leading mathematical physics group in The Netherlands. Internationally, one aims at excellence within its areas of specialization. In the near future, RU3 intends to make a particular effort in leaning towards physics (notably particle physics), especially within the setting of IMAPP.

SWOT-analysis of RU3:

Strengths:

- Expertise in all core disciplines (algebra, analysis, geometry, stochastics)
- Overlapping research interests of staff members
- Rejuvenation of staff due to new appointments in group
- Nationally unique strength in operator algebras & quantum theory
- Prominence in special functions & representation theory
- Embedding in GQT cluster

Weaknesses:

- Disappearance of algebraic geometry
- Meagre interest from MSc students (especially in mathematics)
- Lack of contact with theoretical physics (locally and in general)

Opportunities:

- Opening towards high-energy physics (initially at IMAPP)

- Opening towards logic and computer science
- Increased collaboration between group members
- Structural collaboration with foreign groups (e.g., Münster)
- Increased presence in mathematics degree program

Threats:

- Termination of GQT-cluster

Assessment

Quality
The leading figures are excellent mathematicians who have made important contributions to their respective fields. The new additions are promising. The importance of the group's research has been acknowledged by many research grants, invited talks and appointments in commissions.

Productivity
When stating that the productivity is very good, the Committee took into account not only the number of scientific publications and of PhD degrees transferred, but also the impressive amount of external funding the group was able to attract over the past four years and the many successful efforts in outreach programmes.

Relevance
This is a programme of exceptionally high relevance: The group plays a central role at the interface of mathematics and physics and eventually aims at understanding the foundations of our universe. Its members are part of many committees and outreach programmes that further mathematics and mathematics education.

Viability
The group obtained a considerable boost with the arrival of a mathematical physics group from Amsterdam and then actually shifted focus from geometry to mathematical physics.
The new and envisaged hirings seem good additions for the future. Under these circumstances viability seems excellent.

Conclusions
The programme has been largely established during the period of this assessment. The group now is firmly embedded in IMAPP; it has a solid structure and excellent prospects for the future. It has been very successful in its attempts to attract students to Nijmegen. The efforts in outreach programmes and in initiatives for mathematics education are admirable. Scientific productivity seems to have suffered a little from this, but the hope is that this will improve over the next years. During the review period, the arrival of the mathematical physics group from Amsterdam was the driving force behind the successful efforts to keep mathematics alive in Nijmegen. The coherence of the group now is good. The members are well integrated in IMAPP; they are mathematically very active and full of energy.

Chapter 8

Mathematical Institute of Utrecht University (UU)

8.1 Assessment at Institutional Level UU

8.1.1 Introduction

The precise date of establishment of the Mathematical Institute of Utrecht University is not known, but it certainly existed in 1949. The primary administrative structure in which the Mathematical Institute is embedded is the Faculty of Science. Until 2005 the Mathematical Institute was part of the *Faculty of Mathematics and Computer Science*, together with the Institute for Information and Computing Sciences and the Freudenthal Institute for Mathematics Education (in primary and high school). In April 2005, a new *Faculty of Science* was formed and the Faculty of Mathematics and Computer Science ceased to exist. The Faculty of Science is divided into six Departments, one of them being the Department of Mathematics.

The Department of Mathematics consists of the Mathematical Institute and the Freudenthal Institute for Science and Mathematics Education. The Department has a Board that takes care of the daily management. The members are the Department Head, Institute Chairs, Research Director of the Mathematical Institute, Director of Studies, and one student. The Department has a Council (consisting of 5 Faculty members and 5 students) that gives advice to the Department Board and the Faculty Council.

8.1.2 Leadership

The Mathematical Institute is responsible for the bachelor and master programs in mathematics, and for the research in mathematics. The Mathematical Institute has a Chair (up until now the same person as the Head of the Department) who is responsible for the resources.

Chairs of the Mathematical Institute:

until January 1, 2005: *Henk van der Vorst*

January 1, 2005 - October 1, 2006: *Odo Diekmann*

October 2006 - January 1, 2010: *Frits Beukers*

Heads of the Department of Mathematics:

April 15, 2005 - September 1, 2005: *Jan van Leeuwen*

September 1, 2005 - October 1, 2006: *Odo Diekmann*

October 2006 - January 1, 2010: *Frits Beukers*

Directors of Research

Until January 1, 2004: *Hans Duistermaat*

January 1, 2004 - October 1, 2006: *Odo Diekmann*

October 1, 2006 - October 1, 2007: vacancy

October 1, 2007 - January 1, 2009: *Eduard Looijenga*

January 1, 2009 January 1, 2010 : *Frits Beukers*

8.1.3 Mission and Goals

The Mathematical Institute has the task to develop and propagate mathematical content and culture. Its research programmes advance mathematical insight at the highest level. Its knowledge is disseminated through publication, application and education.

The Mathematical Institute firmly believes that in order to function and to make progress, modern society needs a sufficient number of experts who are capable of developing and creatively using highly sophisticated, maybe not yet existing, mathematics. Such mathematicians can deal with the ever increasing number of situations where standard techniques of calculation are not sufficient. The challenges arise in science, technology, medicine, economics and government.

The Mathematical Institute is inspired either by the problems themselves, or by the autonomous development of abstract mathematics as a discipline in itself. Therefore, it wants to cover a wide spectrum of mathematics; it believes that aspiring mathematicians need to experience at close hand the unity in diversity that is so characteristic for this discipline. The programmes derive their inspiration either from structures and phenomena in science and scientific computation or from the realm of abstract mathematics itself, i.e., the emphasis may differ, but *mathematics is seen as a unity*, whose sub-fields benefit from one another and can inspire each other.

The Mathematical Institute has a strong tradition in encouraging an *open and extrovert attitude towards mathematics*, with many public talks, seminars, and informal discussions, and a very active and successful general colloquium. It has the ambition to be *competitive on an international level*, in particular, to have research programmes *of a quality comparable to the best institutes in Europe*.

8.1.4 Strategy and Policy

The Mathematical Institute wishes to cover a broad range of research represented by a faculty of high quality. In the tradition of the Mathematical Institute, applied mathematics is intimately tied to pure mathematics. In accordance with its mission statement, it encourages the practice of publicly announcing all talks and seminar sessions.

The breadth which is aimed for by the Institute is counterbalanced by its deliberate choice to underrepresent (or not to cover at all) some parts of mathematics. This is done for different reasons: some parts may be considered to be sufficiently represented elsewhere in The Netherlands, or they may be too remote from the rest and therefore in danger of being isolated.
Within the fields chosen to be represented, the quality of research is regarded as being more important than the specific sub-field to which it belongs.

There is also a continuous, but gradual process of shifts in emphasis, with new directions being taken up at the expense of others. This process is less deliberate, but rather the result of a natural evolution and a result of what is believed to be a healthy attitude towards mathematics. For

instance, arithmetic-algebraic geometry, which was represented by F. Oort (who retired in 2000), returned in a different guise, in connection with Mathematical Physics, with the appointment of G. Cornelissen (2007). Another such example is the retirement of D. Siersma (in 2008), a singularity theorist, versus the appointment of I. Moerdijk (in 2002) on a chair of algebraic topology. This year (2009) saw the appointment of R. Fernandez on the institute's chair in Stochastics, who clearly represents a different direction of research than his predecessor (R. Gill).

It has always been the goal of the Department of Mathematics to be financially healthy, and it has been successful in realizing this goal during the whole review period. During this period, however, a decrease in direct university funding resulted in a few "encouraged early retirements". The effect on the department far exceeded the mere decrease in the represented fields. A case in point are the positions in Numerical and Pure Analysis, which are still vacant, leading to a drop in research fte in the analysis group from 6.2 to 3.8 in the period under review. In 2005, J. Hogendijk succeeded H. Bos on the Chair of History of Mathematics. Hogendijk was already a full-time member of the Institute and the position he left vacant has not been filled, so the programme in the History of Mathematics currently has only one (!) member.

The "Algebra, Geometry and Logic"-programme was able to mitigate such effects by attracting a large amount of external funding, through the GQT-cluster and by its success in the Innovational Research Scheme of NWO. The Institute's strategy is to encourage applying for such external funding at all research career levels.

Assessment of the Committee on Leadership, Mission and Goals, and Strategy and Policy

An important departmental reorganization took place in 2005, with the creation of a new Faculty of Science and the removal of the Faculty of Mathematics and Computer Science. Mathematics is one of the six departments of the Faculty of Science, and the Mathematical Institute is part of that department, the other part is the Freudenthal Institute. This modification does not seem to affect much the activities and orientations. It is recommended to explore extensively the opportunities, and to be careful to obtain a fair allocation of resources. Concerning education, the department is naturally in charge of all the programmes in mathematics, but not of teaching mathematics in all departments. There is however a trend towards this status. Also, a significant increase of the enrolment of students in mathematics has been observed in the recent years. The new allocation system of the teaching load called "Midas", introduced in 2006, may start to have effect in 2010. All these elements are positive, provided it leads to an increase of resources and it allows more time for research. The Committee has appreciated the good mix between pure and applied mathematics, and recommends strengthening this orientation. A new Director will be in charge as of January 2010. He knows the Institute very well, being a part of it, and having exerted the same responsibility in the past.
The necessary reinforcement of the Institute is of course a major challenge. This means maintaining the level in the programme "Algebra, Geometry and Logic" , helping the recently hired Head of the programme "Stochastics and Decision Theory" to carry a successful momentum, and recruit quality scholars for the programme "Mathematical Analysis". The programme "History of Mathematics" deserves also a specific attention. To sum up, the Committee has the feeling that the strategy and orientations are correct, but to achieve the goals, strong efforts and forceful actions are needed.

8.1.5 Resources

Recruitment and selection The Mathematical Institute considers the quality of research to be more important than the area to which it belongs. At the same time, the faculty is expected to take an extrovert attitude, which manifests itself in a willingness to collaborate and to regularly explore new directions of research.

Procuring external research funds has become increasingly important. Newly appointed faculty members must demonstrate this ability; proven ability in fund raising is now a requirement for a promotion. Proven quality in research remains the number one criterion in selection and promotion procedures, but teaching qualifications and a willingness (and ability) to carry out administrative duties are also taken into account. New external vacancies are always advertised in The Netherlands and abroad. In the recent past the response has been overwhelming for some of these (there were about a hundred applications for each of the two recent vacancies for assistant professor).

Postdocs In practice, a postdoc position can be generated in three ways.

- As a result of an award obtained by the postdoc in question, e.g. NWO VENI or Marie Curie. If there is a good fit, the Institute is happy to accommodate such a postdoc.
- Selection by a member of staff who has been awarded a VIDI, VICI, ERC grant, or other NWO grants, e.g. Open Competition.
- The position arises within a network (e.g., European FP).

Postdocs are offered an attractive research environment and are treated as full members of the Institute. Due to financial constraints, no form of tenure track position can be offered to them, which in recent times has led some of them to decide not to consummate their grants at the Institute.

PhD fellowships PhD fellowships are funded either by the Department or by external sources (usually by NWO).

In the first case there is in general no a priori allocation towards programmes or potential supervisors: A permanent hiring committee reviews the applications and then makes a proposal to the Institute Chair, based on merit, quality and availability of candidates, taking into account the balance between programmes. The number of such fellowships is now rapidly decreasing and may even disappear in the near future.

In the case of outside funding, the position is awarded to the intended supervisor and the selection is then the latter's responsibility; in this case the permanent hiring committee is willing to assist if so desired.

PhD students For new PhD students, an explicit training plan is drawn up for the first year, including courses and seminars to take part in. Hereafter, it is evaluated in the performance and appraisal meeting. Throughout the rest of their graduate studies, the candidates participate in courses and seminars on an advanced level, often in the national context of the KNAW/ERCOM-research school "the Mathematical Research Institute (MRI)". The MRI offers "Master Classes" (not to be confused with the national Mastermath programme) at the graduate level, and sponsors seminars and formal and informal national workshops for graduate students (such as the PhDays in numerical analysis).

There are several local seminars and national *Intercity Seminars* in which PhD students actively participate. These seminars are especially important as a training device, because they involve the whole process of learning, internalizing and presenting new material. It is common for PhD students to see their supervisor weekly for at least one hour.

From the above, it is clear that there is a large informal training structure but no institutionalized training programme for PhD students. The Institute expects that the Utrecht Graduate School of Natural Sciences will start to play a role in this in the near future.

Promotions As a rule, vacant chairs and new positions are advertised, and every mathematician can apply. Internal promotions from Assistant Professor to Associate Professor level 2, and from Associate Professor level 2 to Associate Professor level 1 are decided by the Department Board.

The selection for internal promotions from Assistant to Associate Professor is made by an ad hoc committee, which then makes a proposal to the Department Board. Budgetary restrictions do not allow the Institute to realize internal promotions for all candidates who deserve them.

Tables 8.1, 8.2, 8.3, 8.4, and 8.5 display the distribution of research fte's over the various types of research staff for the Institute as a whole, and for the four Programmes Algebra, Geometry and Logic; Analysis; Stochastics; and History of Mathematics, respectively.
In these staff tables, a full professor is counted as 0.4 fte, associate and assistant professors as 0.5 fte, postdocs as 1.0 fte, and PhD students as 0.85 fte.

Some trends in the tables: The tenured staff and total staff research fte decrease by 25%, the "Algebra, Geometry and Logic"-programme is stable (because of its success in external funding), "Analysis" and "History of Mathematics" research fte is cut by half, and "Stochastics" tenured research fte decreases by about 10 % (taking into account the recent hiring of a new Chair).

Table 8.1: Research staff at institutional level

	2003	2004	2005	2006	2007	2008
Tenured staff	14.10	14.35	13.81	12.88	11.93	10.70
Non-tenured staff	9.44	12.87	14.06	10.69	7.41	6.63
PhD students	23.03	22.11	21.21	21.17	19.54	20.67
Total staff	46.57	49.33	49.08	44.74	38.88	38.00

Table 8.2: Research staff Algebra, Geometry and Logic

	2003	2004	2005	2006	2007	2008
Tenured staff	4.3	4.6	4.6	4.28	4.43	4.65
Non-tenured staff	5.78	6.70	6.78	5.47	5.72	5.85
PhD students	6.10	6.95	8.57	8.46	9.70	10.47
(Sub)total staff	16.18	18.25	19.95	18.21	19.85	20.97

Table 8.3: Research staff Analysis

	2003	2004	2005	2006	2007	2008
Tenured staff	6.20	6.20	6.43	6.15	5.25	3.80
Non-tenured staff	3.18	2.61	2.31	1.50	1.00	0.73
PhD students	12.08	10.23	8.64	8.79	7.15	7.65
(Sub)total staff	21.46	19.04	17.38	16.44	13.40	12.18

8.1.6 Funding Policies

Funding The Mathematical Institute has been financially healthy during the review period. However, as direct funding is diminishing, it has had to make cuts on staff (permanent and temporary) and consequently research time.

The Institute has worked hard to get funding from other sources. It has been quite successful in obtaining well-funded research grants: 9 VENI awards (7 of which were consummated), 3 VIDI's,

Table 8.4: Research staff Stochastics

	2003	2004	2005	2006	2007	2008
Tenured staff	2.80	2.80	2.38	2.10	1.90	1.90
Non-tenured staff	0.15	3.23	3.97	3.05	0.64	-
PhD students	3.29	3.40	3.25	3.47	2.41	1.70
(Sub)total staff	6.24	9.43	9.60	8.62	4.95	3.60

Table 8.5: Research staff History of Mathematics

	2003	2004	2005	2006	2007	2008
Tenured staff	0.80	0.75	0.40	0.35	0.35	0.35
Non-tenured staff	0.33	0.33	1.00	0.67	0.05	0.05
PhD students	1.56	1.53	0.75	0.45	0.28	0.85
(Sub)total staff	2.69	2.61	2.15	1.47	0.68	1.25

one VICI, an Academy Professorship, two Marie Curie fellowships, and the benefits that come from its involvement with the GQT cluster.

This is a sign of recognition of the quality of the Institute, but the funding that arises from it is temporary and it cannot be taken as a stable source of income. To elaborate on this: such awards presuppose that candidates are at a certain stage of their career, hence a certain age distribution within the faculty is necessary for an institute to take optimal benefit of the awards. Moreover, each such award is given to a person once only. The granting of awards also depends on factors beyond the Institute's control, such as the budget of the funding agency.

The number of PhD students funded from NWO *Open Competition* grants that started in a given year during the review period fluctuated as 8, 4, 1, 1, 3 and 1. The instability in these numbers is a major point of concern, now that internally funded PhD support is dwindling.

The institute notes that, apart from the incidental cluster-award (here, mainly GQT), NWO has no funds *exclusively* dedicated to mathematics: in order to obtain the above-mentioned awards, the Institute had to compete in an arena which included computer science and astronomy.

Budgetary Outlook To explain the funding trends, one needs to briefly discuss the recent changes in Dutch university funding. A stated goal of the Dutch Government is to convert a large part of the basic structural research funding of Universities into conditional funding for limited periods. This is based on the belief that this is beneficial for the Dutch research climate and will help researchers to meet the goals set in the Lissabon declaration. The transition to a system of (partly) conditional funding started some time ago, but until recently the process was gradual. The process has suddenly been accelerated because of the recent decision to transfer a yearly tranche of 100 million Euros (over all universities and subjects) to conditional funding. This decision was made before the advent of the current financial crisis. The plan is to channel the money back to the universities by increasing the budgets of the current funding schemes, but the effects of such an increase are not yet noticeable.

The adverse effects of this operation are felt at every level of Dutch academia and the Mathematical Institute is no exception. It may be that the difficulties will be amplified by another round of cuts originating from the present financial crisis. The Institute's funding prospects are so uncertain that there is presently no sensible way of drawing up a budgetary outlook for the next five years. The Institute expects that the financial difficulties will have a particularly negative

effect on its employing of new (tenured) faculty members, because such new contracts may involve a commitment for decades on the part of the university.

Since everything appears to be in a flux, the Institute currently takes the ad-hoc attitude of trying to attract as much external funding as possible, while waiting for the fruits of the Institute's drastic increase in freshmen. The Institute plans to form an internal strategic committee to propose novel ways to deal with the situation.

Table 8.6 gives details on the funding and expenditure, both in k€ and in %, during the period 2003–2008. Table 8.7 gives the breakdown of the funding over the four research programmes of the Institute.

Table 8.6: Funding and expenditure at Institute level, in k€/ %

	2003	2004	2005	2006	2007	2008
Funding:						
Direct funding	2,463/*74*	2,594/*67*	2,602/*65*	2,644/*66*	2,083/*60*	2,093/*58*
Research funds	681/*20*	912/*24*	1,098/*28*	1,070/*27*	1,236/*35*	1,310/*36*
Contracts	208/*6*	361/*9*	273/*7*	269/*7*	160/*5*	219/*6*
Other	0/*0*	0/*0*	0/*0*	0/*0*	0/*0*	0/*0*
Total	**3,351/100**	**3,867/100**	**3,973/100**	**3,983/100**	**3,479/100**	**3,622/100**
Expenditure:						
Personnel costs	2,852/*78*	2,980/*79*	3,245/*81*	3,031/*73*	2,492/*74*	2,598/*77*
Other costs	827/*22*	775/*21*	765/*19*	1,113/*27*	862/*26*	767/*23*
Total	**3,679/100**	**3,755/100**	**4,010/100**	**4,144/100**	**3,354/100**	**3,365/100**

Table 8.7: Distribution of funding over research programmes

In %	2003	2004	2005	2006	2007	2008
Programme Algebra, Geometry and Logic	43	39	39	39	49	55
Programme Analysis	36	35	39	41	36	32
Programme Stochastics	15	20	18	17	13	10
Programme History of Mathematics	6	6	4	4	2	3
Total	100	100	100	100	100	100

Assessment of the Committee on Quality of Resources, Funding Policies and Facilities

These topics present serious challenges and uncertainties. The Mathematics Institute has kept a healthy situation, but at the expense of reduction of research staff, and reliance on external funding to mitigate the decrease. This cautious and dynamic attitude must be commended. The Institute is not responsible for the environment and has adapted to it. It should continue its efforts towards external funding, together with obtaining support from the Faculty and the University to share the risks in the long term. Education is a part of the deal. Interdisciplinary actions are certainly a good way to proceed. This concerns particularly the programmes Analysis and Stochastics which have suffered from a decline, while having the potential to work on interdisciplinary topics. The domain of History of Mathematics has probably to be addressed at the level of the Country. The Netherlands has undoubtedly an excellent record, which should be maintained. The Committee has particularly appreciated the fact that History of Mathematics and more generally History of

Science has an important impact on modern issues, like the interest of youngsters and relations with other cultures.

8.1.7 Academic Reputation

The Mathematical Institute has provided an overview with awards, memberships, (guest) editorships, invited lectureships, appointed professorships, fellowships, (co)organisation of conferences, visiting professorships and other academic achievements of the members of its four mathematics programmes.

8.1.8 Societal Relevance

Department members offer mathematical assistance with problems that arise in society. An example is the annual week long *Wiskunde met Industrie* (Mathematics with Industry), held in Utrecht in 2007, where six companies submitted mathematical problems to about 60 mathematicians. Another example was the involvement of Richard Gill, then at Utrecht, with the abuse of statistics in the notorious court case of a nurse, Lucia de B., suspected of murdering several of her patients.

The department also stimulates public awareness of the central role which mathematics plays in society. It frequently participates in outreach activities aimed at students and teachers of high schools and elementary schools, at Junior College, via Epsilon publishers and "Beta onder de Dom". Some faculty members are very active in curriculum issues in high school, through the cTWO-committee and the Mathematics-D study path.

Sometimes, department members feature in newspaper articles, radio programs, or (more rarely) television programs.

Assessment of the Committee on Academic and Societal Relevance

The Committee has no concern about the Academic quality of the Mathematical Institute. A sufficient number of elements substantiate this position. Not only numerous awards have been granted to members of the Institute, and international recognition is clear from the ranking evaluations, but also the quality is assessed by the high level of external funding, and the fact that the Institute is the central node in the GQT research cluster. In Analysis and in Stochastics the consequences of the retirement and leaving of excellent scholars have to be watched carefully to avoid any decline in academic reputation and societal relevance. The Institute has done an excellent job in outreach and public awareness. Also it has a record of excellent contacts with industry, as well as involvement in societal problems. The main threat again lies in the capability of keeping momentum and maintaining its excellent research spectrum. Especially applied mathematics is under threat because of the recent retirements. Funding is necessary to restore the balance between pure and applied mathematics.

8.1.9 Balance of Strengths and Weaknesses

SWOT-analysis of the Mathematical Institute at large:

Strengths

- Despite its modest size (approx. 25 tenured faculty members, representing 10 research fte), the faculty of the Mathematical Institute covers a wide range within the central parts of mathematics, from pure to applied. It benefits from the attitude to see mathematics as a whole, rather than drawing lines between sub-disciplines.
- The Institute believes that the quality of its research staff is *uniformly* high, with publications in top journals, an intricate international network of collaborations with institutes of the

highest renown, and many scientific invitations. The Institute has a good international reputation: it has a prominent position in various rankings (e.g., CHE). Vacancies in general attract a lot of applications.

- The Institute offers an attractive setting for the education of PhD students and for hosting visiting scholars. This is witnessed by the fact that it has attracted many postdocs.
- The Institute has been able to attract a considerable amount of external funding (from 20% to 35% over the review period).
- The Institute is attractive for students: The number of freshmen has tripled over the review period. This creates a very dynamical atmosphere, with a larger number of strong students on their way to a research career.

Weaknesses

- The programmes *Analysis* and *History of Mathematics* are presently understaffed. Their research fte was cut by half during the review period.
- The amount of time that each of the research staff members can spend on research is gradually decreasing. The reasons for this are:
  - Mentoring and teaching obligations (cf. the increase in the number of students, but a decrease in research staff; and the length of the teaching period).
  - The decreased quality of support (computer, lecture room management and library) has forced the staff members to spend much more time dealing with problems in these areas. Also the administrative load per researcher has increased.

This is confirmed by the following observed *trends* in the review period: the number of freshmen has increased by a factor 3, the number of tenured research staff has decreased by approximately one third, and the number of academic publications fluctuated and decreased by approximately one fifth (the research output per research fte is stable).

Opportunities

- By 2010 the MIDAS allocation system of the Science Faculty will begin to alleviate the enormous increase of the staff's teaching obligations, due the dramatic raise in the number of students during the past few years. This will not only increase the total number of researchers, and thus reinforce the research programmes, it should also allow the faculty to regain research time.
- The Institute expects to profit from national initiatives in mathematics, related to the national Masterplan for Mathematics and the national Graduate School in Mathematics. In particular, possibilities are offered in conjunction with the fourth research cluster STAR in Stochastics.
- The Masterplan also advises to let mathematicians teach all university mathematics courses (including service courses in other departments). This is also the goal of the Faculty of Science. It will increase the Institute's income from teaching.
- The new Faculty of Science provides good opportunities for strengthening cooperation with other departments, e.g. for starting interdisciplinary projects, especially in the field of Scientific Computing.
- the Institute expects to be able to capitalize further on its strong group connected to Geometry and Physics.

- Possibilities for attracting external funding have broadened, especially on a European level. This could be used to countervail the Institute's decrease in PhD positions.
- The Institute is an attractive place for post-docs, and it hopes to continue to attract very talented young people for a post-doc to Utrecht.
- The Institute has and will use internal committees to develop new strategies to deal with some of the problems. For example, an advisory committee on monitoring and teaching strategies led to the implementation of some measures to deal with increased teaching obligations.

Threats

- The above "Opportunities" provide strategies to deal with some of the weaknesses, but most of them also depend on one uncertain factor: It is hard to predict the evolution of funding from different sources. Due to the reasons already given, it should be clear that the Institute finds it difficult to make a sound financial plan for the future:
  - Direct funding has gone down, and the future trend is not clear. If direct funding continues to decrease, this will threaten the range of the Institute's research programmes, and the total research time and output.
  - External funding for personal grants (e.g., NWO Innovational Research Scheme, ERC) has gone up, but for a small institute such as this, there is also a threat related to this: Such external income fluctuates (for example, for reasons of career stage distribution), and the end of a larger personal grant has an immediate impact on the viability and critical size of a group. There is no statistical evening out, as is the case in larger research groups.
  - External funding for projects (e.g., NWO Open Competition) did not increase, and competition for such grants has become much fiercer.

  It is financially attractive to use external funding to increase the number of PhD positions. In fact, this has been advocated by administrations in Utrecht and elsewhere. However, in the light of the above threats it does not appear to be realistic at present.
- An important aspect of having the mathematical library locate in the Mathematical Institute is that it is used by many scientists and students for very quick reference: One can briefly consult a book within minutes. During the review period, it was proposed to move the math collection to the central library, half a mile away from the Mathematics building. This idea was abandoned after it met strong opposition from faculty members and students. An electronic security system has now been installed, which allows for borrowing and returning books and journals without the intervention of library staff. But the threat remains that in the near future financial reasons cause the central library to decide otherwise, thus affecting the research efficiency.

Assessment of the Committee on Strengths and Weaknesses

The Institute has performed a lucid analysis of its strengths and weaknesses. Its quality and reputation represent its major assets. The uncertainties due to the funding situation in The Netherlands are a major threat. It is not clear to the Committee to what extent the situation of this Institute is more serious than for other institutions. What is clear is that the risks are higher than in the past. The Committee has perceived some discouragement. This may have come simply from the candid statement of difficulties. It encourages the Institute to discuss clearly the risks with the Dean and the University Authorities at large. A common sharing of the risks and an assertive attitude towards the opportunities is the way ahead. Naturally, this begins internally. It is the responsibility of the Dean and the University at large to realize that the Faculty of Science becomes a win-win situation for the mathematicians.

8.2 Assessment per Programme UU

The Committee assessed the four programmes of UU as follows: The detailed assessments per

Programmes	Quality	Productivity	Relevance	Viability
UU1 Algebra, Geometry and Logic	5	4	5	5
UU2 Mathematical Analysis (applied, pure, numerical)	5	5	5	4
UU3 Stochastics and Decision Theory	4	3	4	3
UU4 History of Mathematics	4	4	5	n.a.

programme follow in the next four sections.

8.2.1 UU1 Algebra, Geometry and Logic

Programme number:	UU1
Programme directors:	F. Beukers, E.J.N. Looijenga, I.M. Moerdijk
Research staff 2008:	20.97 fte
Assessment1:	Quality: 5
	Productivity: 4
	Relevance: 5
	Viability: 5

Short description
The programme is unique in the sense that it covers almost all kinds of "Geometry" one can imagine, nurtures the interaction between these, and the interaction with neighbouring fields such as Logic, Number Theory and Physics. This broadly cast spectrum transpires in all of its activities, from undergraduate education to core research. The programme considers it of vital importance to maintain its breadth and depth in both research and education.

Utrecht has a very strong tradition in algebra, geometry and related fields (algebraic and arithmetic geometry, algebraic groups, commutative algebra and K-theory, number theory, singularities, logic), especially in viewing the sub-disciplines as parts of a larger continuous spectrum of mathematics. Thus, its tradition is also to foster interaction rather than subdivision. This explains why the distribution of specific expertise over programme members may evolve with time. On top of that there are shifts in emphasis over the years, in some cases under the influence of newly appointed faculty or postdocs. This ensures that the Institute's research stays mainstream and up-to-date.

SWOT analysis of UU1
Strengths
UU1 is a very broad programme with very active research subgroups/chairs and many esteemed visitors. It is very active in graduate education (e.g., MRI Master Classes). It is successful in attracting external funding, post-docs, young faculty members and talented students. During the review period, the programme was able to maintain the level of its total research fte. The programme has become specially strong in the study of the relation between various kinds of geometry and physics.

Weaknesses
No finances can be dedicated to an increase in permanent faculty, despite the doubling of external research income. For this same reason, there are difficulties in internal promotion of excellent faculty members.

Opportunities
To capitalize further on the strong 'geometry and physics'-programme (keeping the programme broad enough to include links to number theory and logic) within local, national and international initiatives.

Threats
In accordance with the Institute wide analysis, the future funding could lead to a decrease in research time.
A more programme specific issue is the following: The total research fte for the whole programme was stable during the review period, but for some research subgroups, such as logic, is has varied greatly. The effect is somewhat mitigated by national initiatives and international collaboration, but remains a point of concern: If the research fte of a subgroup becomes critical it threatens the broadness of the UU1 programme.

Assessments

Quality
The quality of the research output of the members of this programme is outstanding, many of their articles having appeared in journals of the highest reputation. Another indicator of the significance of the research is the high number of prestigious research grants which went to members of the group.

Productivity
The number of publications is high, taking into account their lengths and also the rank of the journals in which they are published. The number of PhD students is very good.

Relevance
The relevance of the work of this group is excellent within mathematics and modern mathematical and theoretical physics. The first point is shown by the international reputation of members of the group, the latter point by joint projects and seminars with physicists.

Viability
The group has managed to attract excellent young researchers to fill the gaps left by retirements.

Conclusions
The group of researchers in this programme covers a wide field of mathematics from algebraic, complex, and differential geometry to algebra and category theory. Quite a part of the research has strong ties with modern directions and developments in mathematical and theoretical physics. Lie theory and global analysis provide an interesting link to the research group in mathematical analysis. The quality and significance of the research is excellent, as confirmed by the reputation of the journals, in which the results are published, and by the international academic recognition of the members of the research group.
This programme has been successful in attracting external funding for its PhD students. In the current uncertain NWO funding climate, it may be hard to maintain this high level of external funding. The department and the university should consider pre-financing PhD positions for which NWO grants are in the review stage. Also young staff has been very successful in obtaining research funding, but some may no longer be eligible for some of the grant opportunities. Perhaps EU funding could be pursued more vigorously.

8.2.2 UU2 Mathematical Analysis (Applied, Numerical, Pure)

Programme number:	UU2
Programme directors:	E. van den Ban, R. Bisseling, O. Diekmann
Research staff 2008:	12.18 fte
Assessments:	Quality: 5
	Productivity: 5
	Relevance: 5
	Viability: 4

Short description
This programme has three sub-programmes:

- Applied analysis (AA),
- Numerical analysis and scientific computing (NA),
- Pure analysis (PA).

Applied Analysis (AA)
The applied analysis sub-programme covers theoretical analysis of parameter-dependent dynamical systems generated by various types of differential and difference equations, applications of dynamical systems theory to research problems, and the development of numerical methods and computer tools for the analysis of dynamical systems.
The goal of the sub-programme is to apply the dynamical systems theory to study the nonlinear evolution of natural and artificial systems. This often requires new insights leading to the development of new dynamical systems theory, as well as new numerical methods and computer software.

Numerical analysis and scientific computing (NA)
The field of numerical analysis and scientific computing aims at developing new algorithms and mathematical methods for computing in a wide range of application areas. An explicit part of the mission of NA is therefore to interact with other disciplines, apply its methods in those disciplines, and derive interesting problems from them. A prime example is computational physics; other examples are computational chemistry and biology. A quickly developing field of application is bio-informatics and bio-mathematics. Another part of the mission is to interact with industry, as a possible employer of the UU2 alumni, as a source of challenging problems, and as a potential domain of application. Industry often poses hard problems, where an analytical approach alone does not suffice and a numerical approach is required as well.

Pure analysis (PA)
The general mission of the pure analysis programme is to advance the deeper understanding of phenomena of analysis. This is often most fruitful in specific situations arising from geometry, symmetry, dynamical systems, and applications.
Research themes that have been pursued within the programme are Lie groups and symmetric spaces, their harmonic analysis and associated representation theory; connections with partial differential equations and distributions (van den Ban), and with symplectic geometry (van den Ban, Duistermaat).
Another line of research has been the investigation of dynamical systems, in particular Hamiltonian ones; reduction of these systems through symmetries; stability of approximate symmetries, bifurcations (Cushman, Duistermaat, Hanßmann).

SWOT analysis of UU2
Strengths
A point of strength is the unique combination of pure, applied and numerical analysis. Another strength is intensive collaboration via national and international networks.

The whole analysis group benefits from an increasing number of students graduating from the master's programme Mathematical Sciences and the master's programme Scientific Computing, which forms an excellent potential reservoir of PhD candidates. Since September 2008, the Scientific Computing programme is a 2-year programme, and this has a positive impact on the quality of the students.
A point of strength related to the above is the active participation of the analysis group in the national master programme Mastermath: Currently (in 2009) six courses are given in which Utrecht analysts are involved. Participation in the Mastermath programme exposes students to UU2's mathematical research and leads to more interactions between researchers at a national level.
A strong point of the NA group is the importance that scientific computing has in society and the good fit of Utrecht expertise to current developments. The multi-core revolution, with parallelism on a chip driving the design of new algorithms and mathematical software tools has given research into parallel algorithms a new stimulus.
The NA group has recently been strengthened by promoting Bisseling to full professor (for 5 years) in Scientific Computing, and by promoting Sleijpen to associate professor, giving the field a higher profile. The group has obtained two PhD students (aio's, starting in September 2007 and September 2009, respectively), through internal funding by the department. This shows a willingness of the mathematics department to invest in scientific computing.

Weaknesses
All sub-programmes suffer from a low number of tenured faculty members. In the period from 2003 to 2008 the total number of tenured faculty in the analysis programme has decreased from 12 to 8. The chairs of NA and PA, having become vacant because of retirements, have not been reoccupied so far.
At present, the analysis group is too small in view of the many teaching requirements, including the supervision of a large number of master theses. All three sub-programmes have 2 or 3 permanent staff now, with a large teaching load. Small sub-programmes such as AA, NA, PA are in constant danger of being overburdened by teaching and administration duties. To prevent this, special attention must be given to the overall distribution of such duties.

Opportunities
For the AA sub-programme, opportunities continue to arise for applications of Dynamical Systems Theory in the Life Sciences (ecology, epidemiology, systems biology) and the Earth Sciences (climate modelling, geophysics). One observes the following trends in applied analysis: (i) increased attention for modelling issues; (ii) the design and use of advanced computational tools (especially for bifurcation analysis) based on general abstract theory; both of these trends are reflected in the development of the Utrecht AA sub-programme. Additionally, possible future research subjects include: nearly integrable geometry, resonance phenomena, non-holonomic mechanics, synchronous and self-organized motion of underwater vehicles, renormalization analysis of resonance accumulation, branching of codim 1 global bifurcations from codim 2 local bifurcations, multiparameter bifurcations of Filippov systems, bifurcation analysis of biochemical and genetic networks in periodic environments.
For the NA sub-programme, the multi-core revolution has great potential for research in parallel scientific computing. A breakthrough in simplifying parallel programming would have huge effects. Combining Utrecht expertise in iterative solvers and parallel computing would be particularly promising. The current green trend in society will increase the demand for computational modelling; mathematics is an enabling technology here, with scientific computing at its forefront. The recent initiative in Computational Science by KNAW is an opportunity at the Dutch national level. For the NA sub-programme, European funding will become more important with the recent start of personal ERC grant programmes as another opportunity.
For PA, the research themes are mostly curiosity driven. Opportunities arise from developments in the field. An example of this is the connection of the current line of research on Radon transformation for symmetric spaces with recent questions in the field of representation theory.

Threats
The largest threat to the whole analysis programme is the reduction of funding for permanent staff. A period of cost cutting heavily affected the analysis programme: the research capacity of permanent faculty went from 6.20 in 2003 to 3.80 fte in 2008, and will drop to 3.30 fte by October 1, 2009. The delay in appointing a fourth member for the NA sub-programme threatens its survival. The upcoming retirement of a member of the PA sub-programme also threatens the vitality of this sub-programme very seriously.
Another threat to the NA sub-programme (and more generally to all computer-using mathematicians, such as those developing ODE software in the AA sub-programme) is the way Utrecht University considers computing, as merely administrative, whereas for scientific computing the availability of friendly, productive programming environments is essential. (A prime example is the invention of the Google search machine, which was done at the Stanford mathematics department, with a programmer-friendly computer environment.) The replacement of the open-source environment Linux by Microsoft Windows, which is dominant in administrative applications and many university offices, will not only increase costs for the department, but will also hinder its research in many areas of scientific computing. The open-source software developed by the NA sub-programme, such as the Mondriaan package, will be much harder to maintain in a non-Unix environment. It will also be much harder to attract the best and brightest among the math students, who are often accomplished programmers of contest-winning quality and who are very discerning in picking their working environments. A clear distinction should be made between office automation and research computing.

Assessments

Quality
The programme has published its results in the best mathematical journals and has developed excellent software. The quality of its work is internationally acknowledged; during the assessment period it had world class players in its ranks.

Productivity
The programme has managed to publish an impressive number of articles in refereed journals and has promoted 21 PhD students. In addition, it has organized many international mathematical conferences and developed software and algorithms of general interest.

Relevance
The relevance comes on the one hand from the numerical analysis part of this programme whose software packages, tools and algorithms have immediate applications in engineering, chemistry and biology, on the other hand from the applied analysis part that develops models for infectious diseases. Finally the work of the pure analysis part is relevant for other theoretically oriented groups.

Viability
The programme has lost important researchers through (early) retirements and leaving, so there is a certain risk for the future: Especially the applied part has suffered. There seems to be, however, a consensus in the department to hire new chairs in analysis and numerical analysis, and with that the programme should be able to maintain its high profile.

Conclusions
This has been a very strong programme over the review period. Although at first glance the research interests differ considerably, the programme has worked very well and kept a very high international profile. It is now important to fill the gap left by the loss of three important researchers.

8.2.3 UU3 Stochastics and Decision Theory

Programme number:	UU3
Programme directors:	R.D. Gill (2003–2006)
	E. Balder (ad interim 2006–June 2009)
	R. Fernandez (as of July 2009)
Research staff 2008:	3.60 fte
Assessments:	Quality: 4
	Productivity: 3
	Relevance: 4
	Viability: 3

Short description
The aim of this programme is to perform high-level research in a variety of areas of probability theory, statistics, optimization, mathematical economics and ergodic theory, emphasizing connections between them and to the main body of mathematics, and with a view to applications in science and technology.
With the departure of Gill in 2006, quantum probability is no longer a research theme in Utrecht; as of July 2009, it is replaced by statistical physics, which is the research area of the new programme leader Roberto Fernandez.

SWOT analysis of UU3
In the period 2003-2005, the group consisted of 6 permanent members. In 2005, the group lost Andreas Kyprianou, a very active member at national and international level. In 2006, the chairperson, Richard Gill, left the group. His departure had an enormous impact on the group in terms of direction and leadership. Since July 1, 2009 the group has a new chair, Roberto Fernández, whose expertise lies in statistical physics. It is expected that the group will benefit considerably from his new leadership.

Strengths
Points of strength are the diversity of the group, covering a spectrum of research areas that is exceptionally wide for a group of its size, and its internationally recognized members. The group has strong ties with other stochastics groups in The Netherlands via the joint program SFM, and has strong ties with industry via consultancies and internships of master students.

Weaknesses
In the period under review, it has been difficult to produce PhD theses for a combination of reasons:
(1) lack of funding from primary and secondary sources,
(2) in some cases, finding suitable candidates has turned out to be difficult (for instance in 2004, Gnedin's NWO funding for a PhD had to be used for a postdoc position because of the lack of suitable candidates.)
The small size of the group, in comparison to other stochastics and operations research groups in The Netherlands is also experienced as a weakness.

Opportunities
Stochastics and Operations Research have a multitude of applications. Because of that they flourish as domains of active research worldwide and offer job opportunities in a variety of academic contexts. This means that there is opportunity to initiate new interdisciplinary projects with other departments (such as Physics, Biology and Computer Sciences) as well as a considerable potential to attract PhD students and postdocs.
UU3 expects that the newly created national mathematical cluster "Stochastics, Theoretical and Applied Research" (STAR) will certainly offer new opportunities to the group, once STAR gets

NWO funding. Apart from expanding and intensifying its existing collaborations both here and abroad, it will help UU3 to support young talented postdocs and promising PhD students.

Threats
The threats mentioned for the institute as a whole (lack of career opportunities, increased teaching burden) apply to UU3 in full. In fact, what is considered as an opportunity in the item above (namely, the current job market for Stochastics and Operations Research) might just as well turn out to have the effect of more people leaving the group. This makes UU3 quite vulnerable, because expertise in important areas of probability, statistics and operations research is often carried by a single person.

Assessments

Quality
This is a very good programme, which has changed focus and size during the assessment period.

Productivity
Productivity is good but was extremely good during the first half of the assessment period.

Relevance
Throughout the period, research has been stimulated by questions from outside of pure mathematics, though obviously personnel changes have caused variation here as well.

Viability
The programme has now been refocused through a new hiring, so viability seems good, at least for the near future.

Conclusions
This programme has suffered severely from staff losses, only partly compensated by a new hiring. Still those remaining have done a very good job. An increase in productivity is anticipated because of the new hiring.
Utrecht should make a very serious effort to restore this programme to its old glory. A solid and broad programme in statistics and probability is mandatory for a large university and is a necessity for the proper education of the largest mathematical students population in The Netherlands. An increase can be anticipated.

8.2.4 UU4 History of Mathematics

Programme number:	UU4
Programme directors:	H.J. Bos (until 2005)
	J.P. Hogendijk (since 2005)
Research staff 2008:	1.25 fte
Assessments:	Quality: 4
	Productivity: 4
	Relevance: 5
	Viability: n.a.

Mission and Research Area
The *mission* of this programme is to study the development of mathematics in a relevant historical setting. The approach is based on primary sources and focused on the mathematical content in its historical development and context. The emphasis on mathematical content reflects the programme's position in the Mathematics Department. Interest also goes to the reasons why and to the kind of people by whom particular areas in mathematics were studied at a given place and time. The programme's research often involves cultural and institutional aspects, as well as the history of sciences such as astronomy, although these are not the main point of departure. Whenever possible, the programme tries to use the history of mathematics in order to improve the reputation of mathematics as a whole among a wide audience.
This programme specializes in *two areas* of the history of mathematics. *History of mathematical sciences in antiquity and the middle ages, with special emphasis on Islamic civilization* is the area in which the current group leader has worked for 25 years, combining his training in mathematics and oriental languages. Internationally, the field is developing rapidly, in line with the growing interest in Islamic countries in their own scientific heritage. After the retirement of Bos in 2005, his research area *Conceptual history of early modern mathematics (1550-1750)* has been reoriented towards *History of mathematics in The Netherlands between 1550 and 1850.* The important role of The Netherlands in the history of mathematics in the 16th and 17th centuries is insufficiently known on an international level because many relevant sources were written in the Dutch language, which researchers in other countries usually cannot read. It is considered as our national duty to explore this heritage, which contains opportunities for research at all levels (from BSc to PhD). The eighteenth and first half of the nineteenth century have been included because this is the period in which the (then) old-fashioned seventeenth-century style of mathematics and mathematics education slowly died out in The Netherlands. The programme's research on mathematics in The Netherlands fits into the national research program *The Low Countries as a historical laboratory, a research programme on the circulation of scientific knowledge and practice, 1600-2000,* which is being developed by the Belgian-Dutch Society for the History of Science and Universities (`www.gewina.nl`).

SWOT analysis of UU4
Strengths
All members of the group have the required combination of mathematical and linguistic skills. The position of the group in the Mathematics Department and the connection to the Descartes Institute for History of Sciences and Humanities are ideal. The group has an extensive international network; good relationships (perhaps unique) with the Islamic world; and good interdisciplinary relationships inside and outside the University of Utrecht.

Weaknesses
Bos retired in 2005, and was succeeded by Hogendijk, so the Chair in history of mathematics was preserved. Hogendijk was already a member of the department, and the position which he left vacant was not filled, so the size of the group was decreased dramatically. The previous QANU Assessment of UU4 mentioned that it is "promising that the group now consists of two senior

members and two PhD students, in addition to a temporary NWO-paid researcher". Unfortunately, this is no longer the case.
Also, Hogendijk's 0.2 fte professorship in Leiden (2004-2009), which was spent on teaching the history of mathematics, has led to a reduced output in terms of publications during the review period. The recruitment of PhD students and/or postdocs is not commonplace because of the combination of mathematical and linguistic skills that is required.

Opportunities
The Department has extended the contract of Wepster until Dec. 31, 2011, and it has recently promised to make a part-time tenured position in the history of mathematics, which will become available in 2012. There are also good prospects for further cooperation in the two research areas of UU4 with institutions in The Netherlands and with Islamic countries and Islamic institutions. If time permits, UU4 would like to create a national network of teachers of the history of mathematics at professional colleges where mathematics teachers are being trained.

Threats
The group will be in danger as long as only one of its members has a tenured position. The possibility of receiving NWO-funding for projects is dependent on the resources made available to NWO. During the review period, a project on the relationship between Jewish and Islamic mathematics was well refereed but could not be funded by NWO because of a limitation of resources. A rejection of this kind is especially serious for small research groups. The network of the group has been negatively affected by the closing of departments specializing in the history of pre-modern science, such as the Department for History of Natural Sciences at the J.W. Goethe-University in Frankfurt.

Assessments

This very small group works on the history of mathematics in the antiquity and the middle ages, with special emphasis on Islamic civilization. It is internationally well-known and recognized in this area. Another research interest is the history of mathematics in The Netherlands between 1550 and 1850. The group is very active and enthusiastic, and has contacts with other institutions in The Netherlands, in particular in Leiden. It is the only place in The Netherlands, where history of mathematics is represented on the full professor's level.

Quality
In particular the work on the history of mathematics in the Islamic civilization is of very high quality, and it is highly recognized at the international level. Memberships of editorial and scientific boards are further indications of very good quality.

Productivity
The productivity is very good given the small size of the group.

Relevance
History of mathematics has a large potential for reaching people outside mathematics. These possibilities are fully exploited by this group. Extremely relevant is also that history of Islamic mathematics provides a bridge to the Islamic world, in particular to scholars and students in Iran.

Viability
The group is very active. However, it is very small, and very much depends on the activities of the professor. The group is vulnerable just by its small size. Therefore, it is not appropriate to give an explicit mark for viability.

Conclusions
This group does very high quality work, and is well integrated in the Dutch scientific life. It brings

interesting contributions both to culture and science. We encourage Utrecht University to realize a new part-time tenured position (as already promised). It is difficult to assess the viability of such a small programme, which is unique in the Dutch mathematical landscape. Given this uniqueness and the strong dependence of its leader, it is as viable as can be.

Appendix A

CVs of the Committee Members

Prof.dr. W. (Werner) Ballmann is professor of mathematics at the University of Bonn (since 1989), and scientific member and director of the Max Planck Institute for Mathematics in Bonn (since 2007). He studied mathematics at the University of Bonn, where he obtained his PhD in 1979 and his "Habilitation" in 1984. He fulfilled a research scholarship at the University of Pennsylvania (1980–1981) and was associate professor at the University of Maryland (1984–1986) and at the University of Bonn (1986–1987). In 1987–1989 he was professor at the University of Zürich. His research interests are in Riemannian geometry, Dirac operators, Brownian motion, Alexandrov spaces, and Tits buildings.

Prof.dr. E. (Eva) Bayer-Fluckiger is professor at the Ecole Polytechnique Fédérale de Lausanne (EPFL), Switzerland, after being Directeur de Recherche at the CNRS, France. Her first work was in differential topology, PhD at the University of Geneva in 1979. She then turned towards algebraic number theory and algebra. She was a member of the IAS, Princeton, visitor at IHES, MSRI, MPI Bonn, and the Renyi Institute in Budapest. She belonged to several evaluation committees, for instance of congresses (ECM, ICM), to panels of the EU, and she was also a member of the executive committee of the European Mathematical Society. She is editor of several mathematical journals, and editor in chief of Commentarii Mathematici Helvetici.

Prof.dr. A. (Alain) Bensoussan is Ashbel Smith Professor and the Director of ICDRiA at the University of Texas at Dallas. He is also Chair Professor of Risk and Decision Analysis at the Hong Kong Polytechnic University. He is Professor Emeritus at the University of Paris Dauphine and has an extensive research background in stochastic control, probability and stochastic processes. Professor Bensoussan served as: President of the National Institute for Research in Computer Science and Control (INRIA) from 1984 to 1996; President of the French Space Agency (CNES) from 1996 to 2003; and Chairman of the European Space Agency (ESA) Council from 1999 to 2002. He is a member of the French Academy of Sciences, French Academy of Technology, Academia Europae, and International Academy of Astronautics. His distinctions include IEEE Fellow, SIAM Fellow, Von Humboldt award, and the NASA public service medal. Professor Bensoussan is a decorated Officer of Légion dHonneur, Commandeur Ordre National du Mérite and Officer Bundes Verdienst Kreuz.

Prof.dr. P. (Peter) Jagers is a professor of Mathematical Statistics at the Chalmers University of Technology, Gothenburg, Sweden. He is also the First Vice President of the Royal Swedish Academy of Sciences. His research concerns applied probability, in particular branching processes and their use in biology (stochastic population dynamics), and point processes. He has also written about statistical inference. He was elected Member of the International Statistical Institute in 1976, Fellow of the Institute of Mathematical Statistics (IMS) 1984, Fellow of the Royal Swedish Academy of Sciences 1989, and Fellow of the European Academy of Science 2001. He obtained the degree of Doctor Honoris Causa from the Bulgarian Academy of Sciences in 2000 and was the

President of the Bernoulli Society 2005–07. Presently he is a Member of the Fraunhofer Society, Vice Chair of the Curatorium of the Fraunhofer ITWM, and Chair of the Fraunhofer-Chalmers Centre for Industrial Mathematics.

Prof.dr. T.H. (Tom) Koornwinder is retired professor of analysis at the University of Amsterdam (1992–2008). He obtained his MSc at Leiden University and his PhD in 1975 at the University of Amsterdam. He worked as a researcher, later senior researcher at the Mathematical Centre (CWI) in Amsterdam during 1968–1992. He was director of the Korteweg-de Vries Institute for Mathematics at the University of Amsterdam during 1997–2002. Within analysis his scientific interests are more in particular special functions, Lie groups, quantum groups, computer algebra and their interrelations. In 1992 he introduced a family of orthogonal polynomials associated with root systems which are now called Macdonald-Koornwinder polynomials. He is in the editorial board of several journals, including Constructive Approximation.

Prof.dr. E. (Elmar) Schrohe is professor of mathematics and director of the Institute for Analysis at Leibniz University Hannover, Germany. He studied mathematics and physics at Johannes Gutenberg University, Mainz, where he obtained his PhD in 1986 and his 'Habilitation' in 1992. From September 1992 to 1996 he worked in the Max Planck research group 'Partial Differential Equations and Complex Analysis' at Potsdam University; from May 1994 on as deputy director. He continued his work in Potsdam as a professor in the field of analysis until 2003, when he accepted a position at Leibniz University Hannover. His research interests include partial differential equations on manifolds with boundary and singularities, operator algebras, and non-commutative geometry. He is speaker of the Graduiertenkolleg 'Analysis, Geometry and String Theory', a program sponsored by DFG that focuses on research at the interface of mathematics and theoretical physics and presently involves 21 researchers and 14 PhD students.

Prof.dr. S. (Sebastian) van Strien is professor of mathematics at the University of Warwick, UK. He studied at the University of Groningen, and obtained a PhD in Utrecht in 1982. From 1982 to 1992 he first was assistant professor and next associate professor at Delft University of Technology. From 1992 to 1996 he was Professor at the University of Amsterdam. His research field is dynamical systems. During the last 15 years his work has focused on low dimensional dynamical systems, including one-dimensional and holomorphic dynamical systems. Recently he is also publishing on dynamics associated to game theory.
He is managing editor of the journal "Ergodic Theory and Dynamical Systems", editor of several other journals, and coordinator of the EU FP6 training network CODY. He is corresponding member of the Royal Netherlands Academy of Arts and Sciences (KNAW).

Prof.dr. H.A. (Henk) van der Vorst (1944) is retired professor in applied mathematics at Utrecht University (1990–2006). He received his PhD in 1982 at the same university on numeric solutions of very large linear systems of equations. In 1984–1990 he held a position at Delft University of Technology. In 2006–2007, he was international Francqui professor at the K.U. Leuven. He has made some well-known contributions to algorithms for the solution of very large linear systems of equations: ILU and ICCG, Bi-CGSTAB, GMRESR, as special cases of so-called Krylov methods, and Jacobi-Davidson algorithms for eigenproblems. The publication on Bi-CGSTAB (1992) was, according to ISI, the world most cited mathematical paper of the 1990s.
He studied the convergence behaviour of the Conjugate Gradients method and the convergence of eigenvalue approximations in the Lanczos method. He also contributed to new parallel algorithms: truncated Neumann series preconditioning, incomplete twisted factorizations, and the so-called "vdv" ordering. He was involved in the Templates projects for linear problems and eigenproblems.
He is member of the Royal Netherlands Academy of Arts and Sciences (KNAW), NacTi (Netherlands Academy of Technology and Innovation, Ridder in de Orde van de Nederlandse Leeuw, holder of the Holst Memorial Lecture Award (November 2007), and, as of 2009, SIAM fellow.

Dr.ir. H.J.J. (Herman) te Riele obtained his MSc Mathematical Engineer at Delft University of Technology in 1970 and his PhD in mathematics at the University of Amsterdam in 1976. Since 1970 he has been employed with Centrum Wiskunde & Informatica Amsterdam. From 1972–1975 he was head of the consultation and project programming group and from 1974–1987 deputy head of the department of Numerical Mathematics. From 1984–1996 he was research leader of the project "Large-scale Computing" and since 1997 he is research leader of the project "Computational number theory and data security". In 1995 he was visiting professor at University of Technology, Sydney and visiting research fellow at Macquarie University Sydney, Sydney University, and The Australian National University, Canberra. In 2001 he was visiting researcher at the Mathematical Sciences Research Institute, Berkeley, USA in the "Algorithmic Number Theory Program". Since 2003 he is member of the Board of the Royal Dutch Mathematical Society (Koninklijk Wiskundig Genootschap), during 2003–2006 as secretary. During 2006–2009 he was scientific secretary of ERCOM (European Research Centers on Mathematics), a Committee of the European Mathematical Society consisting of Directors of 25 European Mathematical Research Centres. He has been secretary of the Local Organizing Committee of the Fifth European Congress of Mathematics, Amsterdam, July 14-18, 2008, and chair of the Organizing Committee of the "37ste Nederlands Mathematisch Congres" (VU University Amsterdam, 2001).

Appendix B

Schedule of the Meetings

Dates: November 16–20, 2009
Location: Pietershof, Achter St. Pieter 200, Utrecht

Nov. 16		
08:30–08:50	Meeting with Rector Magnificus of UU, prof. Hans Stoof (at Heidelberglaan 8, Utrecht)	
09:00–10:00	Committee Meeting, Introduction	

Nov. 16	**RUG**	**interviews with:**
10:00–11:00	Committee Meeting, Prepare RUG	
11:00–12:00	Meeting with institute management RUG	Palstra (dean), Broer, Petkov
12:45–13:30	RUG1 Dynamical Systems, Algebra, Geometry, Math. Physics	Broer, Vegter
13:30–14:15	RUG2 Systems, Control and Analysis	Van der Schaft, Trentelman
14:15–15:00	Interview with PhD students	Fiaz, Heijne, Kerber, Ruszel, Sterk
15:00–16:00	Committee Meeting, Conclusions RUG	
16:00–16:30	Informal closure with representatives from RUG	

Nov. 16	**UvA**	**interviews with**
16:30–17:30	Committee Meeting, Prepare UvA	
19:30–20:30	Meeting with institute management UvA	Noordam (dean), Wiegerinck
20:30–21:15	UvA2 Analysis (pure, applied and numerical)	Stevenson, Wiegerinck
21:15–22:00	UvA3 Stochastics	Klaassen, Mandjes
Nov. 17		
09:00–09:45	UvA1 Algebra, Geometry and Mathematical Physics	Van der Geer, Opdam, Reshetikhin
09:45–10:30	Interview with PhD students	Ivanovs, Reis da Silva
10:30–11:30	Committee Meeting, Conclusions UvA	
11:30–12:00	Informal closure with representatives from UvA	

Nov. 17	**RU**	**interviews with:**
13:00–14:00	Committee Meeting, Prepare RU	
14:00–15:00	Meeting with institute management RU	Kuijpers (dean), De Jong (dir. IMAPP), Landsman
15:00–15:45	RU3 Mathematical Physics	Heckman, Koelink, Landsman
16:00–16:45	RU1 Algebra and Logic	Gehrke, Bosma
16:45–17:30	RU2 Financial Mathematics	Hendriks, Maassen, Redig
17:30–18:15	Interview with PhD students	Caspers, Coumans, Naaijkens, Van Pruijssen, Wolters
18:15–19:15	Committee Meeting, Conclusions RU	
19:15–19:45	Informal closure with representatives from RU	

Nov. 18	**UU**	**interviews with:**
09:00– 10:00	Committee Meeting, Prepare UU	
10:00– 11:00	Meeting with institute management UU	Bliek (dean), Hogendijk, Beukers
11:15– 12:00	UU4 History of Mathematics	Hogendijk, Wepster
12:45– 13:30	UU2 Mathematical Analysis (applied, numerical, pure)	Bisseling, Diekmann, Van den Ban
13:30– 14:15	UU1 Algebra, Geometry and Logic	Looijenga, Moerdijk, Beukers
14:15– 15:00	UU3 Stochastics and Decision Theory	Dajani, Fernandez, Balder
15:00– 15:45	Interview with PhD students	Dopper, Venselaar, Babenko, Yzelman
15:45– 16:45	Committee Meeting, Conclusions UU	
16:45– 17:15	Informal closure with representatives from UU	

Nov. 19	**UL**	**interviews with:**
09:00– 10:00	Committee Meeting, Prepare UL	
10:00– 11:00	Meeting with institute management UL	Verduyn Lunel (dean), Stevenhagen, Edixhoven, Bakker
11:15– 12:00	UL1 Number Theory, Algebra and Geometry	Lenstra, Stevenhagen, Edixhoven
12:45– 13:30	UL2 Analysis and Stochastics	Doelman, de Jeu, Gill
13:30– 14:15	Interview with PhD students	Daems, Stolk, Worm, Avena
14:15– 14:45	Committee Meeting, Conclusions UL	
14:45– 15:15	Informal closure with representatives from UL	

Nov. 20	**VU**	**interviews with:**
09:00– 10:00	Committee Meeting, Prepare VU	
10:00– 11:00	Meeting with institute management VU	Van Mill (dean), Meester
11:15– 12:00	VU3 Geometry	Van Mill, Dijkstra, Notbohm
12:45– 13:30	VU1 Analysis	Hulshof, Ran, Rink
13:30– 14:15	VU2 Stochastics	Meester, Van der Vaart, Koole
14:15– 15:00	Interview with PhD students	Joosten, Mramor, Trevisan, Valkenburg, Zaal
15:00– 16:00	Committee Meeting, Conclusions VU	
16:00– 16:30	Informal closure with representatives from VU	

Appendix C

Explanation of the SEP-scores

Excellent: 5	Work is at the forefront internationally and will most likely have an important and substantial impact in the field. Group is considered an international leader.
Very Good: 4	Work is internationally competitive and is expected to make a significant contribution; nationally speaking at the forefront in the field. Group is considered international player, national leader.
Good: 3	Work is competitive at the national level and will probably make a valuable contribution in the international field. Group is considered internationally visible and a national player.
Satisfactory: 2	Work that is solid but not exciting, will add to our understanding and is in principle worthy of support. It is considered of less priority than work in the above categories. Group is nationally visible.
Unsatisfactory: 1	Work that is neither solid nor exciting, flawed in the scientific and or technical approach, repetitions of other work, etc. Work not worthy of pursuing.

Quality is to be seen as a measure of excellence and excitement. It refers to the eminence of a groups research activities, its abilities to perform at the highest level and its achievements in the international scientific community. It rests on the proficiency and rigour of research concepts and conduct; it shows in the success of the group at the forefront of scientific development.

Productivity refers to the total output of the group; that is, the variegated ways in which results of research and knowledge development are publicised. The output needs to be reviewed in relation to the input in terms of human resources.

Relevance is a criterion that covers both the scientific and the technical and socio-economic impact of the work. Here in particular research choices are assessed in relation to developments in the international scientific community or, in the case of technical and socio-economic impact, in relation to important developments or questions in society at large.

Vitality and feasibility: This dual criterion refers to the internal and external dynamics of the group in relation to the choices made and the success rate of projects. On the one hand, this criterion measures the flexibility of a group, which appears in its ability to close research lines that have no future and to initiate new venture projects. On the other hand, it measures the capacity of the management to run projects in a professional way. Assessment of policy decisions is at stake, as well as assessment of project management, including cost-benefit analysis.

Appendix D

Preliminary assessment forms

Preliminary assessment form for Institutes
(only for internal use by the Committee)

Institute:

Reviewer:

Note: the scores are only intended for the discussion of the Committee. The final report will not contain scores for the Institute-level, only an assessment in words. It may therefore be useful to write down verbal comments/questions already at this stage.
(There is a separate assessment form for the Programme-level)

Possible scores: 5 = Excellent, 4 = Very good, 3 = Good, 2 = Satisfactory, 1 = Unsatisfactory

How do you evaluate the institute with respect to:

1. *Leadership*
2. *Mission and goals*
3. *Strategy and policy*
4. *Adequacy of the resources*
5. *Funding policies*
6. *Facilities*
7. *Academic reputation*
8. *Societal relevance of the institute*
9. *Balance of the strengths and weaknesses of the institute*

Overall assessment of the institute

Remarks:

Preliminary assessment form for Programmes
(only for internal use by the Committee)

The final report will only contain *overall* scores for Quality, Productivity, Relevance and Viability

Programme:

Reviewer:

Possible scores: 5 = Excellent, 4 = Very good, 3 = Good, 2 = Satisfactory, 1 = Unsatisfactory

Research Programme (management aspects)

How do you evaluate the Programme with respect to:

1. *Leadership*
2. *Mission and goals*
3. *Strategy and policy*
4. *Adequacy of the resources*
5. *Funding policies*
6. *Facilities*
7. *Academic reputation*
8. *Societal relevance*
9. *Balance of the strengths and weaknesses*

Remarks:

Quality

How do you evaluate the quality with respect to:

1. *originality of the approach and ideas*
2. *significance of the contribution to the field*
3. *coherence of the Programme*
4. *publication strategy*
5. *prominence of the Programme director*
6. *prominence of the other members of the research group*
7. *quality of scientific publications (scientific impact)*
8. *quality of other results*

Remarks:

Productivity

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

1. *number of PhD theses*
2. *number of scientific publications*
3. *number of professional publications*
4. *other results (if applicable)*
5. *distribution of published output within the group*

Remarks:

Relevance

Considering the stated mission of this Programme, 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*

Remarks:

Vitality and feasibility; viability

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

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

Remarks:

Appendix E

List of abbreviations

AIO	PhD student (Assistent in Opleiding)
CWI	Centrum Wiskunde & Informatica Amsterdam
DIAMANT	NWO Cluster ***D***iscrete ***I***nteractive & ***A***lgorithmic ***M***athematics, ***A***lgebra & ***N***umber ***T***heory
ERC	European Research Council
EURANDOM	European Institute for Statistics, Probability, Stochastic Operations Research and its Applications
FMNS	Faculty of Mathematics and Natural Sciences of RUG
FTE	full-time equivalent
GQT	NWO Cluster ***G***eometry and ***Q***uantum ***T***heory
ICIS	Institute for Computing and Information Sciences of RU
IMAPP	Institute for Mathematics, Astrophysics and Particle Physics of RU
IMM	Institute for Molecules and Materials of RU
ITFA	Institute for Theoretical Physics of UvA
IWI	Institute of Mathematics and Computing Science of RUG
KNAW	Royal Netherlands Academy of Arts and Science
MRI	Mathematics Research Institute
NDNS+	NWO Cluster ***N***onlinear ***D***ynamics of ***N***atural ***S***ystems
NWO	Netherlands Organisation for Scientific Research
RUG	Groningen University
RU	Radboud University Nijmegen
Spinoza award	Biggest Dutch award in science (NWO): 2.5M euro
STAR	NWO Cluster ***S***tochastics – ***T***heoretical and ***A***pplied ***R***esearch
VENI	NWO Innovational Research Incentive for researchers who have only recently completed their doctorates; maximum of 250K euro
VICI	NWO Innovational Research Incentive for senior researchers; maximum of 1.5M euro
VIDI	NWO Innovational Research Incentive for researchers who have completed their doctorates with a maximum of 8 years; maximum of 800K euro
UL	Leiden University
UU	Utrecht University
UvA	University of Amsterdam
VSNU	Vereniging van Universiteiten (Association of Universities in The Netherlands)
VU	Free University Amsterdam