The Research Council of Norway

Research in Mathematics at Norwegian Universities

An evaluation

Evaluation
Division for Science

The Research Council of Norway

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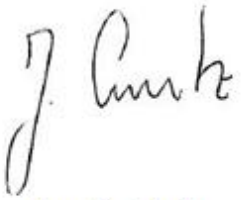
To the Research Council of Norway

The members of the Evaluation Committee for Research in Mathematics in Norwegian Universities hereby submit the following report.

The views presented in this report are the consensus among the members of the Evaluation Committee. The report represents an agreed account of the assessments and recommendations.

Aline Bonami



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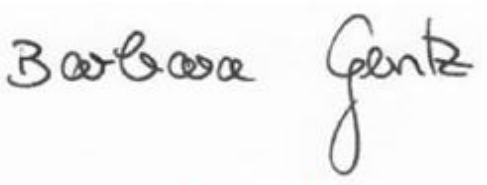

Barbara Gentz

Paul Linden

Cheryl Praeger

Holger Rootzén

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1 Findings and Recommendations

1. Mathematical sciences research and education is vital to the high-tech and engineering industry of Norway. However, there is evidence that Norway is not investing enough in science and technology, of which the mathematical sciences are an essential part.

2. Research in the mathematical sciences at Norwegian universities remains at a very high, international level. Since the last evaluation in 2002, applied mathematics and statistics have seen positive developments, and are now strong. However, there are also signs of decline in some of the other areas where less work of the very top quality is produced.

3. The mathematical sciences face a serious depletion problem with many retirements coming up but not enough young mathematicians in the 'pipeline'. Many more graduate students and post-docs are needed.

4. In order to develop a clear career structure in academia, the Committee recommends the creation of career development posts that can bridge the gap between a post-doc position and tenure.

5. Women remain seriously under-represented within the mathematical sciences. It is particularly concerning that the proportion of women amongst younger mathematicians is not increasing. Decisive action is needed to ensure that Norwegian mathematics does not miss many opportunities in future by not being able to attract and support women in their careers.

6. The level of collaboration between mathematicians in different universities is generally good and benefits from the grant support by the RCN. However, this support is not always sufficient.

7. Present programme-driven research initiatives favoured by funding agencies are not always a good fit for the mathematical sciences, especially the more theoretical parts. The RCN is strongly encouraged to enlarge substantially its portfolio for investigator-driven basic research able to support also individuals and small research groups.

8. It is generally considered that mobility enhances research productivity. Tools for every stage of the career should be developed to encourage mobility between Norwegian universities and those abroad, as well as between universities and industry. Academic careers should favour mobility.

9. The mathematical sciences form an infrastructure for other sciences and technology. An increase in funds for mathematical research and education – both in schools and at universities – is now urgently needed to ensure that also in future the R&D capabilities underpinning Norway's industry are adequately served.

2 Introduction

2.1 Mandate and the Review Process

This report was commissioned by the Research Council of Norway (RCN) and presents an evaluation of research in Mathematics in Norwegian Universities with particular focus on the period 2006-2010. The detailed terms of reference and the mandate for this review are provided in full in Appendix C.

The main objectives and the process of this review are given here in summary.

Objectives

The primary goals of this report are to:

- Provide a critical review in an international context of the strengths and weaknesses of research in Mathematics in Norwegian universities; at the national level, at the level of departments, and at the level of research groups (but not of individuals).
- Identify research groups that have achieved a high international level of quality or that have the potential to reach such a level.
- Identify areas of research that need to be strengthened in order to ensure that Norway in the future will have the necessary competence in areas of national importance.
- Examine to what extent research in mathematics meets the demands of interdisciplinary research and future societal challenges.
- Assess the degree of national and international mobility; between different research groups as well as between universities and industry.
- Assess to what degree the previous evaluation from 2002[1] has been used by the institutions in their strategic planning.
- *For the institutions*, provide advice and recommendations that can be used to enhance their own research standards and strategies.
- *For the RCN,* provide an improved knowledge base that can be used by the RCN in its role as a funder of research in Mathematics and as an adviser on research policies to the Norwegian Government.

Process

The Committee's evaluation was carried out on the basis of:

- Fact sheets with information about the departments and research groups.
- Self-evaluations provided by the departments and research groups.
- Assessment of publications and citations.[2]
- Hearings conducted between the Evaluation Committee and the participating departments and research groups.

All fact sheets, a description and the schedule of the hearings can be found in Appendix D.

1 Evaluation: Research in Mathematics in Norwegian Universities and Colleges. The Research Council of Norway, 2002.

2 Including NIFU: Evaluation of Mathematics – Publication and Citation Analysis, Dag W. Aksnes. However, the report was delayed and the Committee did not have the opportunity to examine systematically the NIFU report in the light of its own findings, or vice versa.

2.2 Participants of the Evaluation

The relevant departments and other research bodies were invited to participate in this evaluation by the RCN in October 2010. All of the university colleges and contract research institutes contacted opted out. While some of these research units had already been included in other evaluations, others did not respond. It should be noted that there are more than 100 mathematicians working at these places and not included in this report.

The participating institutions are the following eight departments at seven different universities:

Department of Mathematics and Natural Sciences at the University of Stavanger

Department of Mathematical Sciences at the University of Adger

Department of Mathematics at the University of Oslo

Department of Mathematics at the University of Bergen

Department of Mathematical Sciences at the Norwegian University of Science and Technology (NTNU)

Department of Mathematics and Statistics at the University of Tromsø

Norwegian University of Life Sciences:

- Department of Mathematical Sciences and Technology
- Department of Chemistry, Biotechnology and Food Chemistry.

2.3 Key Figures

The Committee was provided with fact sheets, included in Appendix D of this report, giving an overview of basic factual information on the departments and research groups. These data were collected by all participating institutions simultaneously with a deadline in May 2011. They are taken to represent a fair and unbiased snapshot of all participating departments and groups at the time. All staffing and graduate numbers quoted in this report are taken from these fact sheets. It should be noted that these numbers sometimes differ from those presented in the self-evaluations or, several months later, during the hearings.

2.4 Previous Evaluation

The previous evaluation of research in Mathematics in Norway was carried out at the request of the RCN in 2001-2002. It led to a set of recommendations, which have been taken into consideration during the present evaluation, and which are commented on in the context of some of the participating institutions in this report.

2.5 Grading

For the assessment of the research groups, a grading system has been applied that, in keeping with the mandate, focuses on the following aspects:

- Quality of international publications
- Level of productivity
- Membership of editorial boards
- Applications for national and international grants

- Leadership
- Organisation of conferences
- Training of post-docs and students at master and doctoral level
- Teaching of undergraduates

The grades are given according to the scale presented schematically below.

Excellent = 5

Research at the international forefront. Original research of international interest and published in internationally leading journals. High productivity.

Very good = 4

Research with a high degree of originality but nonetheless falling short of the highest standards of excellence. A good publication profile with mainly publications in internationally leading journals. High productivity and relevance to international research within its subfield.

Good = 3

Research at a good international level with publications in internationally and nationally recognised journals. Research of relevance both to national and international research developments within its subfield.

Fair = 2

Research that only partly meets good international standards. A modest international publication profile. Limited contribution to research.

Weak = 1

Research of insufficient quality and low productivity. Few international publications. Little original research and little relevance to the field.

As the grade descriptions reflect, the most important criterion was the quality of publications together with the level of productivity. In practice, the various grades used are not as clear-cut as presented above. Where a group is heavily burdened by other obligations, such as teaching or administration, the Committee has tried to take such circumstances into consideration. When different criteria suggest different grades, a compromise grade was set. In some cases mixed grades are given. Specifically:

- If two grades are separated by a slash (/), this indicates mixed grades within the group; e.g. 4/2 indicates some parts of the group activity are given grade 4, other parts grade 2.
- If two grades are separated by a dash (-), this indicates a grade between the two; e.g. 3-4 indicates a grade somewhere between 3 and 4.

2.6 The Evaluation Committee

The Evaluation Committee (the Committee) consisted of the following experts, whose profiles may be found in Appendix B:

Professor Aline Bonami
Laboratoire MAPMO
University of Orléans, France

Professor Joachim Cuntz
Mathematical Institute
University of Münster, Germany

Professor Björn Engquist
Department of Mathematics
University of Texas at Austin

Professor Barbara Gentz
Faculty of Mathematics
University of Bielefeld, Germany

Professor Paul Linden
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University of Cambridge, UK

Professor Cheryl Praeger
School of Mathematics and Statistics
University of Western Australia

Professor Holger Rootzén
Mathematical Statistics
Chalmers University of Technology, Sweden

Professor Ulrike Tillmann (Chair)
Mathematical Institute
University of Oxford, UK

Anne Pearsall (administrative staff member, Mathematical Institute, University of Oxford) was Secretary to the Evaluation Committee.

Terje Strand PhD (Division for Science of the Research Council of Norway) presented the instructions to the Institutions and to the Committee, made all the practical arrangements and facilitated the hearings and meetings in Oslo.

3 Evaluation at the National Level

3.1 Assessment of Research

3.1.1 Quality of research

Norway has a strong tradition in mathematical research and has produced some world class mathematicians including Hendrik Abel (1802-1829) and Sophus Lie (1842-1899). Since the last evaluation in 2002, the Abel Prize has been established on the occasion of Abel's 200th birthday. Each year the Abel Prize ceremonies and Abel Lectures, as well as the Abel Symposia and Abel Committee meetings put Norway in the limelight of mathematics around the world. Thanks to the great efforts of the mathematical community, these and other events associated to the Abel Prize have been highly successful for the last ten years.

The excellent quality of Norwegian mathematicians was already pointed out in the report of the first evaluation committee in 2002. This present evaluation again shows that a majority of the research groups are of an internationally recognised high standard. A bibliometric analysis carried out by NIFU[3], a draft of which was available to the Committee, seems to confirm this view.

The Committee however noticed signs of decline at the top end of the research output in some areas. While this is difficult to quantify, with the exception of the Emmy Noether Lecture no other invited lecture was given at any of the last three International Congresses of Mathematicians (ICM) by a mathematician included in this evaluation. In contrast, the previous evaluation reported three speakers at the ICM in 1998 alone[4]. The ICMs are held every four years and are a landmark event of the subject, especially for the more theoretical parts. There also seems to be a decline in the number of papers published in the very top journals.

3.1.2 Capacity and Age Structure

There are 168 tenured mathematicians included in this report. This presents a 10% increase since 2002, a slightly higher increase than that of the total population of Norway during the same time span. There is now one mathematician at university for every 29000 inhabitants.

A major concern of the 2002 evaluation committee was the problem of renewal. The Committee is pleased to observe that the replacement of retiring professors by younger people has been managed successfully in many cases. Nevertheless, the situation today remains precarious. As will be pointed out in the next chapter, whole research groups are likely to discontinue because of the retirement of the core members. Though it can be an opportunity for a department to build up a new group and change research direction, it is often easier to attract, and more effective to hire, excellent young people into a vibrant and internationally established research group.

The age of the permanent staff is relatively evenly distributed (Table 1). However, for the 41 mathematicians over 60 years old, and who will retire in the next decade, there are only 44 under 35 years old who may replace them. Given that a fair number of post-docs are expected to prefer jobs in industry and teaching, it is anticipated that there will be a severe shortage of suitable home grown candidates for the tenured positions that will become available in the next decade. The reservoir of excellent young research mathematicians educated in Norway is extremely limited.

3 NIFU: Evaluation of Mathematics – Publication and Citation Analysis, Dag W. Aksnes.
4 Note that Denmark, Finland and Sweden each had a speaker at the ICM 1996 and ICM 2010.

Institution	Total [1]	Women	Women %	≤ 30	31-35	36-40	41-45	46-50	51-55	56-60	61-65	≥ 66
Stavanger	12		0%		1	1	1	1	2	1	2	3
Agder [2]	12	2	17%		2		2	3	2	2		1
Oslo	65	8	12%	7	8	8	8	5	9	7	11	2
Bergen [3]	35	3	9%	3	5	5	5	6	3	3	1	4
NTNU	58	9	16%	6	8	9	6	6	2	8	6	7
Tromso	20	2	10%	1	2	3	2	2	5	2	2	1
UMB	9		0%		1	1	2		2	2	1	
Total	**211**	**24**	**11%**	**17**	**27**	**27**	**26**	**23**	**25**	**25**	**23**	**18**
Women	24			2	3	6	4	3	2		1	3

(1) These numbers exclude any prof II or associate prof II.

(2) One emeritus was submitted but is excluded here.

(3) This includes five part-time people submitted.

Table 1: Age (and gender) distribution of tenured staff and post-docs per university and age interval in number of persons as of 01.01.2011.

3.1.3 Subfields

Before dividing mathematics into subfields and referring to the traditional and convenient divisions between pure and applied mathematics, mathematical sciences and statistics, it is important to remember that there is an underlying and underpinning unity of mathematics. Synergies between different branches of mathematics appear unexpectedly and lead often to important breakthroughs. Examples of such developments in the recent past include graphical statistics, the use of persistent homology in data analysis, Voevodsky's homotopy type theory - a visionary mix of topology and logic/computer science, and the fruitful interactions between analysis and mechanics.

Norway is a small country and the Committee recognises that not every subject can be represented. In this context it is noted that number theory, mathematical physics, and probability are areas particularly under-represented. The only group in number theory is about to be discontinued and mathematical physics is represented only in the work of a few individual researchers.

The geography of the country, the long distances and its sparse population clearly put further constraints on any research community. Despite this, there are several examples where the groups at different universities function essentially as one. One prominent such example is the topology group which is spread over the departments in Bergen, Oslo and Trondheim. Summer schools bring algebraists together from the different universities and, in many cases, professor IIs connect research groups within Norway and abroad.

Analysis

During the last 40 years an outstanding area of excellence in Norwegian mathematics was the field of operator algebras. This field is still represented at an excellent level at Oslo and Trondheim, even though the focus of the field has changed. While traditionally it was considered to be a field in analysis, in recent years it has developed into a more interdisciplinary subject within mathematics. It now has close connections to algebra, topology, geometry, ergodic theory and recently also to number theory. These new developments are well represented in the groups at Oslo and Trondheim.

Classical and complex analysis is represented in all centres in Norway. The largest group is at Trondheim and functions very well, playing a world-leading role in function theory in connection with problems coming from signal processing. Highlights of their research concern sampling and interpolation. Original methods have been developed to tackle and solve old problems, and these new methods are now considered as central to the development of new mathematical tools for signal and image analysis (with wavelets, compressed sensing, etc.). There is a researcher in Stavanger working on the same theme, and there are also some connections with Bergen.

There is also very good activity in pluri-potential theory, which is currently centred at Oslo and which will also be developed at the highest level in Trondheim with the arrival of an international leader in this area.

Classical/harmonic analysis traditionally has a strong interaction with many areas of analysis, from parts of differential geometry to PDE and applications. This kind of interaction is functioning well in Trondheim and in the smaller universities, where analysts tend to develop contacts, mainly with PDE groups. Of course some harmonic or real analysis is also developed within PDE groups. The small group in Tromsø deserves to be mentioned for its work on differential equations and differential geometry.

Algebra & Algebraic Geometry

There is excellent research activity in the areas of Algebra and Algebraic Geometry in Norway, with research groups in Trondheim, Oslo, Bergen, and within the Pure Mathematics group in Tromsø. World-leading research centred around non-commutative algebras and commutative algebra is conducted in Trondheim, a major recent highlight being the work on cluster categories and cluster tilted algebras. A strong research focus is maintained on the representation theory of finite dimensional algebras and related topics, with explorations of connections to other branches of high current interest, such as hereditary and triangulated categories, representation dimension, and Hochschild homology and cohomology. Homological methods have also been used to study commutative Noetherian local rings, in particular answering a long-standing open question concerning support varieties for modules.

There has been a long tradition in algebraic geometry in Norway, which continues to be a field that is particularly well represented by an internationally visible and diverse group in Oslo, as well as by smaller groups at Bergen, Trondheim and Tromsø. The topics studied range from classical projective geometry, to deformation theory with applications in Calabi-Yau varieties, symplectic manifolds, and moduli spaces. Theoretical and algorithmic work is done on enumerative algebraic geometry problems. There is additional focus on combinatorial mathematics, arising from work in algebraic geometry (in Oslo), and also from work on error correcting codes and cryptology (in Tromsø).

Strong links are evident between algebraists and algebraic geometers in different locations, especially between the groups in Oslo and Bergen. The four research groups organise annually an international summer school and a national algebra meeting. Some researchers have had a significant involvement in the Centre of Mathematics for Applications (CMA). Others have developed rather natural links with members of topology research groups, in at least one case resulting in a joint publication.

Most groups are successful in attracting and training masters and PhD students, and have strong international collaborations.

Topology and Geometry

Norway has excellent and internationally visible research activity in the broad area of algebraic topology with centres at Oslo, Bergen and Trondheim. Researchers have been very successful in attracting grants from national and international sources. Through this several conferences and a visitor programme have been organised. Collaboration between the three centres is supported by an RCN project, ‘Topology'. Research topics and highlights include Galois theory for 'brave new rings', a geometric approach to elliptic cohomology via 2-vector bundles, the constructions of a higher topological cyclic homology, and the constructions of a homotopy theory of C*-algebras.

There is an even age distribution amongst the algebraic topologists, and several good PhD students and post-docs have been trained. Unfortunately, some excellent young people have already been lost from research due to the lack of early career positions.

There is also some research undertaken in the area of differential geometry by some broad and strong members of the pure mathematics groups in Tromsø. Other areas in geometry and topology are at the moment less, or not at all, represented in Norway. There are however good links to and overlap in interest with the research groups in algebra and algebraic geometry, which have resulted in joint publications.

An extension of the activities into the study of manifolds could link the existing research in geometry and topology, and build bridges to activities in analysis.

Partial Differential Equations

The research in partial differential equations in Norway is outstanding. The leading groups are very well known and respected internationally. Non-linear hyperbolic conservation laws have been in focus for quite some time but lately other types of partial differential equations have also been studied. Examples are Hamilton-Jacobi, Yang-Mills, Navier-Stokes and Einstein equations. Recently there has also been substantial progress in equations related to geometry and to stochastic differential equations. The contributions consist of a healthy mix of topics, from abstract questions regarding existence to specific properties with importance for computations. There are also good connections to groups in harmonic analysis and real analysis.

The research is often inspired by applications. A good example is the relevance of non-linear hyperbolic conservation laws to oil reservoir modelling. Other sources for research in differential equations have been general fluid mechanics, electro-magnetics, finance, biology and medicine.

The links between the groups in partial differential equations and those in applied and computational mathematics are overall very strong. These two groups are at some universities even joined into one.

There is some activity in partial differential equations that was not covered in this evaluation, the group in homogenization at Narvik being the most prominent example.

Computational Mathematics

The field of computational mathematics was developed relatively early in Norway. Development in numerical methods for ordinary differential equations is a good example that became internationally well established a long time ago. This field has very successfully evolved into the study of geometric integrators and methods for stochastic differential equations. Numerical analysis of partial differential equations is now a highly prominent field that has been developed hand in hand with the mathematical analysis of these equations. This collaboration is a Norwegian success story. Research in finite element methods and in methods for non-linear conservation laws are good such examples. Analysis of geometric algorithms and numerical approximation theory are also well developed. The coupling of this computational research in the Norwegian mathematics departments to numerical linear algebra and high performance computing is perhaps not as developed as in other Scandinavian countries.

The mathematics departments now host most of computational mathematics. In the previous evaluation some of the groups were still part of computer science. There are however very important computational groups at SINTEF and Simula research laboratories, which are not covered in this evaluation.

Mechanics

Mechanics is well represented in the major centres in Norway. There are prominent groups in fluid mechanics in Oslo and Trondheim, and a smaller activity in Bergen. The research includes theoretical, computational and experimental fluid mechanics and covers a range of applications of relevance to the off-shore industry, renewable energy, climate and environment. These groups have impacts on the international scene especially in the off-shore applications. The groups in Oslo and Trondheim are well supported and seem stable. In Bergen there has been a reduction in activities in oceanography and related topics.

Solid mechanics is restricted to a relatively small group in Oslo, which provides an important educational function.

Stochastics

Statistics in Norway has a very extensive network of cooperation with other disciplines. It provides important input to industry, in particular, and to engineering and medical research. Norwegian research also covers a broad range of central areas in theoretical statistics. Highlights include exciting new ideas in computational and spatial statistics, extensive work in time series analysis, and contributions to model choice and model averaging. In particular there is a large, active and internationally well-founded statistical environment in Oslo. In addition to the statistical group at the faculty of Sciences at Oslo University, which is reviewed here, statistics at the Norwegian computing centre and at the medical faculty are also important parts of this environment. The latter two are not included in this review. The research centre SFI^2, which is partly included here, has a pivotal role for the Oslo environment. NTNU has a broad, active, and successful statistics group.

There is a strong group in stochastic analysis in Oslo and also some interest in stochastic analysis in the Differential Equations and Numerical Analysis Group in Trondheim. However, apart from this, there seems to be very little research in probability theory in the Norwegian universities.

3.2 Research Environment and General Recommendations

3.2.1 Importance of Mathematics for Industry and Mobility

To quote the 2008 OECD report on Mathematics in Industry[5],

"Industrial innovation is increasingly based on the results and techniques of scientific research. That research, in turn, is both underpinned and driven by mathematics. […] From the point of view of industry, mathematics is an enabling technology. It provides a logically coherent framework and a universal language for the analysis, optimization, and control of industrial processes. Because it is an enabling technology, its contributions are rarely visible in the final product that industry delivers. Nevertheless, the economic impact is real, and many companies – old, as well as new – have achieved a competitive advantage through the judicious use of mathematics. "

The interest in industrial mathematics started early in Norway, in connection with big national companies. More recently, mathematicians are involved in many multi-disciplinary projects. They have developed many collaborations with application oriented research institutes such as the Norwegian Research Center for Offshore Wind Technology and the Norwegian Fishery Research Institute amongst others. This answers partially a requirement of the 2002 report: "encouraging collaboration between mathematics and other sciences" and implies a real impact of mathematics in technology. The same report states that "many interesting opportunities go unexplored", speaking of links with industry. The Committee is pleased to report that a considerable effort has been made during the last decade by some departments, in particular in CMA, SFI², and at NTNU.

On the other hand, the Committee does not have the feeling that the necessity of closer contacts between the academic and the industrial worlds was taken on board, as it is at the moment in most European countries. While it is mentioned by the department of mathematics of NTNU that one third of their doctors in Mathematics get jobs in private companies, many colleagues see the industrial sector as "poaching" the mathematics students with high salaries. A much better reaction would consist of trying to promote doctorates in mathematics inside the non-academic world.

Since the last evaluation, and mainly since 2006, there has been a considerable effort in many European countries in view of industrial mathematics. It is in particular valid in Germany with the Fraunhofer Institute, in the UK with the Knowledge Transfer Network for Industrial Mathematics (KTN) and more recently in France with the creation of a new agency last autumn. It has also been the object of two reports of OECD[6]. In 2011, a book called "European Success Stories in Industrial Mathematics" was published by Springer under the auspices of the European Science Foundation and the European Mathematical Society. It contains the description of 132 collaborations between mathematics and industry. The fact that none of them involves Norway can be taken as a significant indicator of the fact that, probably, the Norwegian mathematical community is absent from these discussions at the European level. Yet Norway has its own agency, SINTEF.

Recommendation:

In these international reports, new mechanisms are proposed with the view of fostering collaboration between mathematics and industry: internships for PhD students or researchers, modeling weeks, and so on. All of them may help to foster mobility between the academic world and companies. They may also help promote doctoral diplomas in the non-academic world.

5 http://www.oecd.org/dataoecd/47/1/41019441.pdf
6 http://www.oecd.org/dataoecd/47/1/41019441.pdf and http://www.oecd.org/dataoecd/31/19/42617645.pdf

3.2.2 The Nature of Mathematical Research

Mathematics is very much a people intensive activity. Any investment is primarily an investment in people, not machines or expensive laboratories.

For mathematicians, discussions and interactions at conferences (or, equally important, the chance encounters on the corridor of one's own department) are often the source of new ideas and a short cut to solutions. It is very difficult to know from where the next breakthrough will come.

Unlike many other academic disciplines, mathematicians do not normally work in larger research teams. A common research project can be helpful but is not necessary for a successful research group, as long as there is a common research interest and critical mass. Many collaborations happen between individuals often at different international institutions.

Recommendation:

All this makes it difficult to steer the research activities from the outside, and it is often the best strategy simply to support those individuals with a good track record of high quality research.

3.2.3 Funding

Though higher than the OECD average, the expenditure on R&D and innovation per capita in Norway is significantly less than that of Sweden, Denmark and Finland. Furthermore it is important to note that R&D investment is low relative to GDP. While in 2008/09, Sweden and the USA invested circa 3.6% and 2.8% respectively, Norway spent less than 1.9% of its GDP on R&D[7]. The private sector as a whole seems particularly reluctant to invest in R&D[8].

For funding purposes, Mathematics is part of the Natural Sciences. In the time period 1993-1995 there was a steep decline in R&D expenditure on the Natural Sciences which only recently has recovered back to the level of funding of 1993. Furthermore, in the time period 1985-2007 the funding for Social Sciences nearly tripled and that of Medicine & Health nearly quadrupled, whilst the funding for the Natural Sciences did not even double. Both Social Sciences and Medicine & Health now receive more funding than the Natural Sciences in Norway[9].

Governmental research funding in mathematics at universities in Norway has two routes. One is through the RCN and the other is directly through the central funding of universities. Some departments have successfully attracted additional funds from industry and the European Research Council (ERC) with the result that a high proportion of their funding comes from sources other than university funding (Table 2). This reflects the high quality of the research undertaken at these places. But the Committee also noted a high variance between percentages for the administrative cost for the different universities from 2% to 24%. Different accounting systems are likely to be at the source of these differences.

Recommendation:

The Committee suggests, however, that this variance is investigated further to ensure that gross inefficiencies are avoided and that mathematics departments receive 'value for money' from their central administrations.

7 Report on Science and Technology, RCN 2011, pages 11 and 21.
8 Report on Science and Technology, RCN 2011, page 23.
9 Figures supplied by the RCN.

Institution	Total [1]	% External Funding	University Funding	% Non-salary University Funding [2]
Stavanger	7.618	1%	7.532	2%
Agder	17.527	14%	15.117	3%
Oslo	103.992	34%	68.236	24%
Bergen	58.196	37%	36.524	11%
NTNU	89.796	27%	65.348	19%
Tromso	17.184	17%	14.185	2%
UMB	7.190	11%	6.392	18%

(1) in 1000 NOK

(2) This is the percentage of University funding that is not spent on salaries for scientific and technical personnel (including social cost), other costs, and infra structure. Most of this is spent on administration.

Table 2: Expenditure by mathematics departments per university in 2010.

The Committee is concerned about the severe shortage of young research mathematicians educated in Norway. It appears that this is at least partly due to the lack of funding in basic research and more particularly to insufficient financial support for doctoral students and post-docs.

The Committee observed that this lack of funding is seriously obstructing successful research activity in some of the evaluated groups, even in groups with the highest research reputation. The reason seems to lie in the nature of the Norwegian funding system. Generally speaking, it does not seem to offer sufficient support to basic research. It is especially ill-suited for the more theoretical parts of mathematics. Applications for funding for basic mathematical research often only fit into the FRINAT programme where - due to insufficient resources - the success rate even for good applications is very low.[10]

The Committee found that this fact constitutes a serious impediment for maintaining an internationally competitive research level in mathematics at Norwegian universities.

Recommendation:

The Committee urges the RCN to open a new programme to fund investigator-driven basic research. Such a programme should also allow for projects with a time perspective of more than three years. In that way excellent groups could have a reliable source of funding for doctoral students and post-docs over a longer period of time. This would allow them to attract doctoral students and excellent post-docs much more easily.

3.2.4 Mathematics Education

There seems to be an increase of mathematics in popular culture in Norway, helped for example by the programme SIFFER, which is shown four times a week on national TV, and by national newspaper coverage of events such as the Abel Prize presentations.

In contrast, departments report that it is difficult to recruit students into their Bachelor degrees programmes and that those who come are often under-prepared for university study.

Potential mathematics students have to be first educated and attracted to the field in schools. This is best done through good teaching by knowledgeable and enthusiastic teachers. The state of supply of mathematics teachers in Norway is however alarming. An international study in 2007 found that 73% of all Norwegian mathematics teachers were over 50 years old, and 36% over 60.[11]

10 The success rate has recently increased to circa 7% from 5%.

11 TIMSS Advanced 2007

Many teachers of mathematics have not studied the subject at college or university.[12]

This situation will be difficult to change quickly. The Committee acknowledges the herculean efforts performed by some departments and individuals who work hard to increase the visibility of their subject through outreach programmes, where current students and faculty visit schools, while others are involved with teacher training programmes. Another route to attracting students into mathematics at Bachelor or research level seems to remain unexplored so far:-

Recommendation:

The Committee would like to encourage departments in collaboration with the RCN to experiment with preparatory summer schools for pupils and summer research projects for undergraduates.

Educating under-prepared students adequately, once they are at university, presents a challenge. It is important that students of mathematics see the theoretical foundations of their subject early on so that more specialized knowledge can be built on top of these and students are not delayed in their advancement.

Recommendation:

The Committee supports departments that hold the view that every student should have encountered foundational mathematics such as basic group theory and the rigorous definition of limits at the latest by the end of their second year, and if there are suitable students that they should be advised of their options to accelerate to a higher level of mathematics as early as practical.

3.2.5 Career Structure

One factor that makes academic careers in Norway very difficult and sometimes nearly impossible is the lack of career development posts that would bridge the gap between a post-doc position and tenure. Promising post-docs might see themselves forced at the end of their contract to choose between a non-academic job or finding a position abroad because there is no university position open in their field at that moment in Norway.

Conversely, when there are openings, the shortage of excellent young researchers with a proven track-record appears to be severe in some areas. The Committee has become aware of cases where this has led departments to prematurely and overly promote their junior members.

Recommendation:

As a consequence of these observations the Committee strongly urges the RCN to open a new programme offering junior professorships or positions of junior research group leaders. Such positions would typically follow a post-doctoral position, and should involve teaching and research. A typical period of appointment would be four to six years. Some of these positions could be financed jointly by the RCN and the corresponding universities.

In many countries mobility is required at some stage of the career, especially in mathematical communities. It is generally considered that mobility enhances research productivity. It promotes international contacts and topical mobility.

On the other hand, a systematic mobility requirement may divert some candidates from academic careers. An intermediate solution consists of the development of specific tools to encourage mobility.

The lack of mobility between Norwegian universities and universities or research institutions abroad was commented on in the 2002 evaluation report and remains a problem. This is valid for the whole career, from PhD studies to permanent positions.

12 TIMSS 1997: 54% of all mathematics teachers in grade 6.

Recommendation:

A continuous effort should be made to guarantee some mobility in most careers, in particular for universities in more remote locations. A certain number of possibilities are available, such as the funding of travels abroad during the doctoral or post-doctoral studies, sabbatical leaves and professor II positions. This should be systematically developed in departments of mathematics.

Presently RCN funding schemes allow graduate students to spend up to 12 months abroad. The Committee feels however that young researchers would benefit most from their period abroad if they were not already bound to a project but were free to immerse themselves completely into new research activities at an institution other than their home one.

Recommendation:

The Committee therefore recommends that funding structures should be established by the RCN which allow for entire doctoral studies and post-docs to be spent abroad.

3.2.6 Statistical Sciences

The 2002 report was concerned about applied mathematics, and in particular statistics. The Committee has come to the conclusion that research in these areas has generally improved. (See 3.1 and in particular 3.1.5.)

Recommendation:

The Committee recommends continuing the up to now successful efforts directed at the entire spectrum of statistics.

In particular it seems important also to support research in fundamental theoretical statistics. This is a long-term investment which is necessary if Norway is to keep its high level in statistics research.

Recommendation:

The Committee advises departments and research councils to consider strengthening research in probability, both as a foundation for statistics and stochastic analysis, and because of its general mathematical interest.

3.2.7 Gender Imbalance.

Norway is in the fortunate position of having several senior woman mathematicians of high visibility and international status, including the Emmy Noether Lecturer at the last ICM in 2010. Nevertheless, women are under-represented amongst the faculty and student population. The numbers in Table 1 are not encouraging. At the moment little more than10% of all professors, associate professors and post-docs are female. The numbers in each age range are statistically too small to have significance. However, there is an apparent decrease in the number of women from 10/53 down to 5/44 in the age-ranges 35-45 and 25-35, and it is clear that with only 5 women mathematicians below the age of 35 the situation is not likely to improve in the future without special efforts.

The Committee appreciates that most departments consider this a problem, and that some departments have taken steps to improve the situation. It supports initiatives such as in Bergen where women are given extra sabbatical time to prepare for promotion. Often women are called upon to serve on committees beyond what could be considered their expected share. In such cases NTNU has offered support by reducing their workload in other areas or by providing secretarial help. In some departments, professor IIs have increased the visibility of women in a particular research area and provide female students with additional role models.

Still, these measures cannot make up for the low number of younger woman mathematicians in the 'pipeline'. In this context, the Committee notes that the shortage of post-doc positions and early career positions leads to an increased sense of job insecurity, which in turn is a key factor for women in particular to turn to other professions.

Mathematics in Norway is missing many opportunities by not being able to attract and support scientific careers for many more women.

Recommendations:

The Committee strongly recommends that mathematics departments and national agencies such as the RCN take this problem seriously and attack it from all angles. Existing practices that help to create a fair and equal work balance for women and that encourage them to advance their careers should be maintained and applied more universally. Appointment committees for new positions at any level should seek out specifically women applicants and should be encouraged to include these activities in their reports. Universities, possibly in conjunction with funding agencies such as the RCN, should explore the possibility of creating schemes, which have been pioneered in other countries, where departments receive additional funding when women are appointed, or where women are specifically recruited to post-doctoral positions after a break in their careers.

In the long run the greatest effect is likely to come from establishing a clear career structure and creating a greater sense of job stability through increasing the number of post-doctoral and early career development positions. The Committee once again urges departments, in collaboration with universities and research councils, to improve the job opportunities of young researchers in the mathematical sciences.

4 Evaluation of Departments and Institutes

4.1 University of Stavanger - Department of Mathematics and Natural Sciences

Mathematics is one of four sections within the Department of Mathematical and Natural Sciences. The Section of Mathematics comprises three research groups: Analysis, Applied Mathematics and Statistics. There is a heavy teaching commitment within the Mathematics section as it provides a teaching service both to the engineering departments within the faculty and in financial mathematics to the Faculty of Social Sciences. Funding for the department comes almost entirely from the university.

4.1.1 Analysis

Grade 2-3

This group consists of 3 professors and 2 associate professors. The main recent activity concerns pluri-complex analysis and harmonic analysis. Three members of the group are approaching retirement. The two recently recruited members engage in a research area of current interest and are very active with a reasonable number of publications in good international journals.

Recommendations

It is necessary to improve scientific joint activity to be able to attract PhD students or post-docs, possibly in connection with the two other groups. More networking should be encouraged; in particular the collaboration with the Analysis group in Trondheim should be strengthened to compensate for the relative isolation of this small group.

4.1.2 Applied Mathematics

Grade 3-4

This group consists of 2 professors and 1 associate professor plus 1 externally funded professor.

The research of the group is in the fields of mathematical physics, flow in porous media, and elastic wave propagation. The mathematical physics research is mainly in geometrical aspects of relativity. The modelling of flow in porous media is focused on two-phase flow with applications to oil reservoir modelling. The latter is natural for Stavanger with its industrial base in the oil industry. The group has a robust publication record with papers in leading journals. There is, however, a lack of grant funding. The research is individually based rather than a group effort. Contacts outside of Stavanger somewhat offset the lack of local collaboration.

Recommendations

The new PhD programme in maths/physics creates opportunities that should not be missed. It will be crucial to generate funding for the programme and proactive efforts to collaborate with other departments and outside groups, in order to get critical mass in grant proposals, are encouraged. A potential replacement of one retiree should be used to increase the cohesiveness of the group.

4.1.3 Statistics

Grade 3-4

With 1 professor, 1 associate professor, 1 professor II, and 1 externally funded post-doc, the group is very active and carrying out good research. The majority of publications are in medical statistics in collaboration with several university hospitals. The group is well connected within the University of Stavanger. Two students in other departments are co-supervised.

The professor II in the group visits regularly and teaches one course. It is seen very positively that the group was able to organise these regular visits which allow them to profit from the expertise of the professor II.

Recommendations

To provide the group with sufficient external expertise, the opportunity of having a professor II position should be retained. In addition, the group should aim at establishing further international contacts, possibly through sabbatical leaves.

The kind of applied research done within this group may provide funding opportunities. The Committee encourages this group to search actively for such opportunities alongside their present collaboration with university hospitals. This might be in the form of PhD positions or in the form of joint grant applications with researchers from the application area.

4.1.4 Overall Assessments and Recommendations

To address the problem of low student enrolment in Mathematics, the study programme has recently been reorganised, and a new Mathematics and Physics programme has been established at the undergraduate level. At the time of writing the self-evaluations, there were no PhD students within the Section; however a masters programme in mathematics and physics has recently been approved to commence in 2013, along with a PhD programme commencing in June 2011. The Committee is pleased to see this effort at offering a study programme from undergraduate to PhD level.

Recommendations

There seems to be no strategic plan in place for the future of the Section of Mathematics. The Committee advises the section to develop a plan jointly which should deal with future recruitment and questions of group structure. For example the Committee was impressed by the quality of research in Applied Mathematics and encourages the Applied Mathematics and Analysis groups to work together more closely and to consider merging the two groups.

The Committee was surprised by the group structure of the department, which does not correspond with any direction or funding of research activities. The department is strongly encouraged to consider directing efforts in interdisciplinary research towards petroleum engineering to take advantage of local opportunities. In particular the statistics group, which so far is mainly focussing on medical statistics, could benefit from broadening their focus in this way and thus play a more central role at university level. As a consequence, the department could hopefully attract more funding, external as well as from the university, and become more attractive for students.

In a smaller university sabbaticals are particularly important to give researchers an opportunity to keep up with frontline research. The Committee strongly recommends that the university continues to run a generous programme for sabbatical leave to help keep the University in Stavanger an attractive employer for active researchers.

4.2 University of Agder - Department of Mathematical Sciences

The Department of Mathematical Sciences is one of four within the Faculty of Engineering and Science at the University of Agder, which is a product of the merging of Adger College and Kristiansand Teacher College in 1994. The department, which comprises 16 professors and associate professors, is mainly oriented towards mathematics education, and delivers master and PhD degrees in mathematics education, while studies in mathematics at Agder College stop at the bachelor level.

Included in this evaluation is the research group in Mathematics. The groups in Mathematics Education and Teacher Education are not in included.

4.2.1 Mathematics

Grade 2

The Mathematics group of the University of Agder consists of 6 professors, 5 associate professors and 2 professors emeritus, who are still active in research. Of these, three belong to the Department of Engineering, which is on the other campus of the university, and work in applied mathematics, while the others are in the Department of Mathematical Sciences. The group covers a diversity of fields, including history of mathematics, which is an option in the graduate programme within the Mathematics Education group. Conditions for research within the department are not easy: the teaching load is heavy (the mean percentage of time for research is 25 %). Also, research in mathematics cannot develop without teaching or training at the graduate level. On the other hand, the University of Agder is eager to support research in mathematics, which provides an opportunity to improve research in the mathematics group. This is planned in connection with other groups within the university.

The Mathematics group is very heterogeneous. This concerns both the mathematical areas under study and the quality of research. The small group in functional analysis has good research output, as well as an isolated researcher in fluid mechanics. The activity in history of mathematics is of very good quality, with international recognition. The two professors of the Department of Engineering have a very good scientific output; one in control theory and one on the use of special functions in fluid dynamics and aerodynamics.

4.2.2 Overall Assessments and Recommendations

The Committee appreciates that Agder University gives importance to the quality of teaching in mathematics and is interested in having researchers in mathematics involved in the training of teachers in mathematics. The opportunity given to improve research in mathematics at the University of Agder should be seized. It seems reasonable to do this in connection with other groups within the university. Plans for applied mathematics that include colleagues from the Department of Engineering are in the right direction. The possibility of having professor II positions to strengthen links to other more established research centres should be explored.

It is too early to be thinking of a PhD programme in mathematics, but training at the master level should be made possible within the next few years. Available positions should in general be open to all subject areas and advertised in order to attract the best possible candidates.

Present activity in mathematics at Agder University, even though of good quality, is too fragmented to be the sole basis for research in the department in the future. Possible collaboration within the university should be systematically explored.

4.3 University of Oslo - Department of Mathematics

The Department of Mathematics is part of the Faculty of Mathematics and Natural Sciences at the University of Oslo. The department was founded in 1947 and today it is built up around three sections: Mathematics, Mechanics and Statistics. Each of the sections is divided into two or more research groups.

Since 2003 the department has hosted a Centre of Excellence called the CMA (Centre of Mathematics for Applications) and, since 2007, has participated in the Centre for Research-Based Innovation called SFI^2 (Statistics for Innovation). It is currently involved in an application for a further Centre of Excellence for mathematics and statistics in the life sciences in collaboration with the Institute of Basic Medical Research and the Department of Biology.

Over the last 3 years on average 36% of expenditure was externally funded.

4.3.1 Algebra and Algebraic Geometry

Grade 5/3/1

This group comprises 3 professors, 2 associate professors, 1 post-doc plus 1 professor emeritus and 1 externally funded staff member. There are currently 6 PhD students within the group, 3 of which are externally funded. There has been 1 PhD graduation in the last 3 years along with 11 MSc graduations.

The group works on a variety of different problems in algebraic geometry. Excellent work is done in projective algebraic geometry with international impact. There is also very good recent work on Calabi-Yau varieties, symplectic manifolds, and enumerative algebraic geometry. The group is very successful in attracting and training masters and PhD students, and it also has strong international collaborations.

Some members have had a significant involvement in the Centre of Mathematics for Applications, and it has presented a challenge for the research group in terms of research focus and maintaining joint activity within the group. In addition, a heavy administrative commitment has severely restricted research opportunity for one member.

Recommendations

Two recent post-doctoral positions have provided an important opportunity for renewal of this research group, since the last permanent appointment was in 1992. However there is a need to consolidate the group and strengthen its internal collaboration by developing a common research programme. The group has an important networking role among other algebra and algebraic geometry groups in Norway, especially in Bergen and Tromsø. It is strongly encouraged to strengthen these links.

4.3.2 Several Complex Variables

Grade 4

The group consists of 1 professor, 1 associate professor, 1 post-doc and 1 professor emeritus. There are currently no graduate students, and only 1 MSc student has graduated in the last 3 years. However, since 2006 the group has had 3 post-docs.

Research activity is centred on holomorphic approximation, complex geometry and dynamics. The group plans to recruit 2 further post-docs and 1 PhD student to work on a new research project financed by the RCN over the next 5 years.

This is a strong group, with an excellent new recruitment. There is a long tradition in pluri-complex analysis in Norway at the highest level. This is pursued in this group, with connections in other universities, and should be maintained even though the present group is of a sub-critical size.

Recommendations

Given the sub-critical size of the present group, the Committee recommends the creation of a larger group in analysis to include this one.

4.3.3 Geometry and Topology

Grade 5

The group comprises 4 professors plus 3 professors emeritus and 1 externally funded staff member. The group currently has 3 PhD students; 2 others have graduated in the last 3 years along with 3 MSc students.

The main interests of the group lie in algebraic topology and algebraic K-theory with applications to geometric topology, motivic homotopy theory and algebraic geometry. The group is coherent and has overlapping interests with the Algebra & Algebraic Geometry group and, to a lesser extent, with the Operator Algebras group. There are a good number of publications, mainly in very highly regarded journals.

The group took the lead in an RCN Strategic University Programme and is a partner of the national RCN project 'Topology'. The University of Oslo identified the group as one of its 'emerging top-tier research groups'. In addition, its leader led an Outstanding Younger Investigator's (YFF) project. The group enjoys high international visibility and has hosted many post-docs and senior visitors in the past.

Recommendations

Since the last evaluation the group has lost three members through retirement but only one new permanent appointment has been made. The group can clearly attract top researchers from abroad as visitors and as post-docs. It also has excellent scientific and administrative leadership. Further appointments in this area, broadly defined, should be good for the future development of the group, of pure mathematics in the department, and of the subject area within Norway.

4.3.4 Logic

Grade 4

The group has 1 professor and 1 type II professor along with 2 professors emeritus. There are no PhD students in the group at present but there have been 2 PhD and 1 MSc graduations in the last 3 years.

The group's main focus is computability and complexity. The group is small but internally and internationally well connected through seminars with logicians from other departments in Oslo, involvement in Computability in Europe and long visits at foreign institutions. This is the only group in mathematical logic in Norway. At the moment it lacks financial security with one of the two members employed as a professor II.

Recommendations

The Committee encourages the department to find a way to secure the future of the group in the university.

4.3.5 Operator Algebras

Grade 4-5

There are 2 professors and 2 associate professors who make up the group, as well as 2 very active professors emeritus. There are currently 3 PhD students, 1 of which is externally funded, and 2 MSc students have graduated in the last 3 years.

The group builds on a strong tradition of excellence at Oslo in the field of operator algebras. Two recently retired professors have been replaced by two very active and productive younger scientists. The group is internationally highly visible. Members of the group have a leading position in research on topics such as Bost-Connes systems and other noncommutative dynamical systems. The group has a joint RCN-funded project with NTNU and Oslo University College. It also participates in two networks, the Marie Curie Research Training Network "Noncommutative Geometry" (2007–2011) and the NordForsk research network "Operator Algebra and Dynamics" (2009–2012).

Recommendations

The group would benefit from having more post-doc positions. It should continue its efforts to attract third party funding.

4.3.6 Partial Differential Equations

Grade 5

The group consists of 4 professors and 1 associate professor plus 7 externally funded staff members. 6 PhD students graduated in the last 3 years, and at the moment there is 1 PhD student.

The PDE group has greatly benefited from the Centre of Excellence called Centre of Mathematics for Applications (CMA). The centre has provided an environment where research has flourished on the highest international level. There has been intense and successful activity in terms of new recruitment, visitors, post-docs, graduate students and publications in leading journals. The group has now well-established collaboration with many other research units within Norway as well as internationally. The age distribution in the group is healthy.

The research of the group covers several important areas of PDE with, for example, prominent achievements in the analysis of nonlinear hyperbolic conservation laws with applications in fluid mechanics and Hamilton Jacobi equations. There have also been very significant contributions in the numerical approximations of these and other PDEs, primarily by the finite element method. The development and analysis of new finite element techniques are at the forefront of current international development.

Recommendations

The group will have a challenge to maintain the high level of activity when the CMA is phased out. It will be important to find new sources for funding. One possibility is the growing application of mathematics in the life sciences. The group interacts well with other groups within the department but better synergy with the Fluid Mechanics and the Computational Mathematics groups could be beneficial and increase the applied side of the research in the group.

4.3.7 Stochastic Analysis, Finance, Insurance and Risk

Grade 5/4/2

This group includes researchers from both the Mathematics and the Statistics sections. It comprises 6 professors and 2 type II professors, 2 associate professors and 1 type II associate professor plus 7 externally funded staff members. There are currently 11 PhD students, 6 of which are externally funded. 7 PhD students have graduated in the last 3 years, along with 38 MSc students.

The overall impression is one of a good sized, vibrant and internationally visible research group. The group succeeded in associating several professors II from abroad, well established in their respective research areas. It is noted positively that one of them is female and can serve as a role model for PhD students, together with the female associate professor in the group. It is also noted that some members show little research activity during the review period.

The group is actively participating in the CMA, and has a large number of PhD students. There are international research collaborations with several excellent institutions abroad as well as with industry. The group was coordinating an ESF-funded network during the period 2005-2010, and one of the members received an ERC grant.

The group covers three main fields of applications, finance (including finance in energy markets), insurance, and risk. The most visible research activity centres around stochastic analysis and its applications to finance, insurance and energy markets. In this area, the group has an international standing. High productivity with several publications in top journals and high citation numbers support this impression. In particular, stochastic analysis on the borderline between finance and insurance is a direction which is expected to continue to grow in importance. The research in risk is carried out by a smaller part of the group who are well known within their speciality. Publishing of this part of the group is at a reasonable rate.

The creation of this larger group following the previous evaluation was successful and could serve as a model for other smaller groups. It seems also to be a good idea to have finance and insurance in the same group.

Recommendations

The relatively large number of professor II positions allows this group to maintain a high level, international research profile and is a real asset. The Committee recommends continuing the association of internationally recognized scientists to the group through these positions.

The group should continue in its current direction with a strong component in more fundamental research, complemented by applications in finance, insurance and energy markets.

4.3.8 Fluid Mechanics

Grade 4-5

The group consists of 4 professors, 1 type II associate professor, 1 post-doc and 1 technical and administration person, plus 3 externally funded staff members and 2 professors emeritus. There are currently 12 PhD students, of which 9 are externally funded, and in the last 3 years there have been 8 PhD and 11 MSc graduations.

The group is unique within Norwegian mathematics in that it couples experimental and theoretical work. The fluid dynamics laboratory provides facilities for studies of water-based flows and is well-equipped with wave tanks and diagnostic capabilities. The laboratory acts as a focus for the group with research activities covering nonlinear wave theory, tsunamis, multiphase flows, boundary layers and turbulence, marine hydrodynamics, internal waves and ocean models. The group publishes in a range of journals including some in the top journals and the productivity is good. All the professors are active in research and the age distribution is no cause for concern. Highlights of the work are the studies on nonlinear waves, which are at the cutting edge internationally.

While this group is on the applied end of the mathematics spectrum with aspects that are close to engineering, it is both appropriate and valuable that it is in the mathematics department. This gives the group access to mathematically trained students and the group provides a strong link between the department and industry.

The group is well connected, both nationally and internationally. It plays an active role in the academic community by organising and hosting conferences and summer schools and more general outreach programmes into the local community.

Recommendations

While the group is very good, its impact will be improved by a higher percentage of publications in the top journals. It would also benefit from closer interactions with the Partial Differential Equations group.

4.3.9 Solid Mechanics

Grade 3

This group comprises 1 professor and 1 type II professor, 1 associate professor and 1 type II associate professor. There are 5 PhD students, 3 of which are externally funded, and in the last 3 years there have been 1 PhD and 17 MSc graduations.

The research of the group is adequate in terms of quality and productivity. It has good connections with other universities, research institutes and companies in Norway, and these have resulted in several research projects. A steady stream of PhD degrees has been awarded to this group.

However, the main training contribution is in MSc students and the group attracts a large number each year with associated funding which, after various course expenses, is approximately equivalent to the cost of half a faculty member. With one member of the group close to retirement, the future of the research activity and the training of students are in jeopardy.

Recommendations

The Committee recommends that a new recruitment be made to ensure the continuation of this group, so that the research of relevance to Norwegian industry continues and that there are sufficient resources to teach the graduate level students.

4.3.10 Statistics and Biostatics

Grade 5

There are 6 professors in this group, along with 1 type II professor, and 1 associate professor. There are 5 PhD students, 2 of which are externally funded. In the last 3 years, there have been 7 PhD and 12 MSc graduations.

Oslo has a large and internationally highly visible statistical community. In addition to the Statistics and Biostatistics group at the faculty of Mathematics and Natural Sciences, it consists of the Department of Biostatistics at the Medical Faculty and the statistics group at the Norwegian Computing Centre. The community has lively and well-attended seminar series, weekly lunch meetings, and many joint projects and papers. The centre for research-based innovation SFI^2 plays a pivotal role in this. SFI^2 is based at the Computing Centre. The Statistics and Biostatistics group is a key player in SFI^2.

The Statistics and Biostatistics group does very influential work on model selection and model averaging, and has an internationally central position in survival and event history analysis. It has a significant activity in the very topical areas of high-dimensional data analysis and non- and semi-parametric models and makes extensive contributions to state space modelling for time series analysis. Much of the research is motivated by problems from medicine and biology, and the group has many joint projects and publications with researchers from these areas. It has a large network of national and international collaborators.

Recommendations

The group is held in high regard by the international community. However, considering its strength, the self-evaluation gives little indication of post-doc visits and, more generally, there is a lack of fresh blood. If the group's application for a new centre of excellence is successful then this will be taken care of. If not, then the group is encouraged to search for other ways to recruit new researchers.

4.3.11 Computational Mathematics

Grade 4

The group comprises 4 professors, 1 associate professor, and 1 researcher plus 4 externally funded staff members. The group currently has 10 PhD students, of which 8 are externally funded. In the last 3 years

there have been 7 PhD and 38 MSc graduations. 1 further professor, affiliated with the PDE research group, is included here for the purpose of the evaluation.

The Computational Mathematics group was previously incorporated in the Department of Informatics but is now affiliated with the Centre of Mathematics for Applications (CMA). Being part of the CMA has been very good for the group. It has provided critical funding for visitors, post-docs and graduate students. The CMA environment has also helped in integrating this group into the research activities of other groups at the Mathematics Department. The group has a very healthy publication record and a good production of Masters and PhD students.

The research of the group is internationally very well known, for example, in geometric modelling. There is also a high level of research in the development and analysis of optimization methods. The research in numerical methods for partial differential equations is joint with the PDE group.

Recommendations

It will be important to find new sources for funding when the CMA is phased out. The group interacts well with other groups within the CMA but even closer collaboration with the finite element researchers would be helpful. If possible, future recruitment should be coordinated with the PDE group. It would also be beneficial if the relations with the Simula Research Lab could be strengthened in spite of the geographic distance.

4.3.12 Overall Assessments and Recommendations

Since the evaluation in 2002, the department has taken great strides and has developed well. With the help of an active outreach programme, it has been able to double its student numbers. It has benefited greatly from a SUP project that lasted from 2003 to 2006 and from the Centre of Excellence CMA. Research among the groups participating in the CMA at the department as well as the output of PhD theses in these groups, have been boosted significantly. The Committee strongly supports the interaction of the groups in Partial Differential Equations and in Computational Mathematics in that centre. It also sees the connections between the statistics group with the statistics groups at the medical faculty and the computing centre within the SFI^2 project as being important.

On the other hand, it appears that the research groups that were not covered by the big research grants for CMA and SFI^2 (some of them constituting areas of excellence within the department) were hindered in their development by the lack of sufficient financial support for doctoral students and post-doc positions in these areas. The Committee sees the need for additional support in that respect - be it from the university or from the RCN. Without such support, the Committee is concerned that the traditional high standard in some parts of basic research in mathematics at Oslo may not be sustainable.

The Committee is impressed with the clear strategy developed by the department board for the future of the department. The strategic focus groups (Fluid Mechanics, Geometry/Topology, Operator Algebras, Statistics and Biostatistics, CMA) are well chosen. There is however a concern that the corresponding decisions are not always communicated well enough to the members of the department. A strategy benefiting the research in the entire department can only function if it is supported by all the active scientists.

Recommendations

Concerning the structure within the Section of Mathematics, the Committee recommends merging the small, but well-functioning, group in Several Complex Variables with the excellent Operator Algebra group into an Analysis group. With regard to the very small Logic group, the Committee thinks that mathematical logic as a subject should be represented at the University of Oslo. The Committee encourages the department to examine possibilities of a joint appointment with another department, on a permanent basis, for the professor II in that group. The Committee also recommends a closer interaction (possibly in a joint application to the RCN) between the groups in Algebra/Algebraic Geometry, Geometry and Topology and the new Analysis group (Operator Algebras and Complex Variables). The Committee is concerned about the Solid Mechanics group, which has a large number of MSc students but with an

imminent retirement, will only have one faculty member. It is recommended that the department develops a plan for the future of this activity.

At present, general probability theory is not represented in Norway. In order to maintain the high level of research in statistics, the full spectrum from modern probability theory and stochastic processes to theoretical statistics should be covered. Oslo seems to be the natural place in Norway to have more general probability theory and the department might want to consider appointments in this direction, as an important asset for both the Statistics and Biostatistics and the Stochastic Analysis, Finance, Insurance and Risk groups. Such appointments should be beneficial not only for statistics in Norway but also for strengthening further the groups' more fundamental research.

4.4 University of Bergen - Department of Mathematics

The Department of Mathematics is one of eight departments that sit within the Faculty of Mathematics and Natural Sciences. It comprises seven research groups, divided into three areas of Pure Mathematics; Applied and Computational Mathematics; and Statistics. There is a fourth recently formed area, Mathematics Education, which is not included in the evaluation. Over the last 3 years on average 37% of expenditure has been externally funded.

Following the last evaluation, the major part of the numerical analysis group was moved out of the Department of Informatics to form, together with applied mathematics, the group in Applied and Computational Mathematics. This group has since been involved in a Centre of Excellence, the Centre for Integrated Petroleum Research (CIPR), funded by the RCN. The department has also taken steps to strengthen the teaching of Mathematics in Norwegian Schools through the formation of its Mathematics Education group.

4.4.1 Analysis

Grade 4

This group consists of 3 professors. There are currently 2 PhD students within the group and there have been 3 MSc graduations in the last 3 years.

With two new appointments in 2005 and 2008 the group now has three active permanent members. The group is functioning very well and is highly productive in research. It also generates a high level of scientific activity through editorial work and through the organization of conferences, a network and a research semester. Research interests include a wide range of topics in analysis, geometry and mathematical physics. The group compensates for its relatively small size by cooperating with the group in Applied and Computational Mathematics. During the last 5 years the group has obtained 2 FRINAT grants from the RCN.

Recommendations

The group, being rather small, would benefit from having a few post-doc positions.

4.4.2 Topology

Grade 4-5

This group comprises 1 professor and 2 associate professors plus 1 externally funded post-doc. There are 2 PhD students, 1 of which is externally funded, and there has been 1 MSc graduation in the last 3 years.

The group was formed at least in part as a consequence of a recommendation from the 2002 evaluation. It is thus a relatively young group which has developed well into a full research group in less than 7 years. Though the group does not produce a large number of papers they tend to be substantial pieces of work in a sophisticated area and published in highly regarded journals.

The group is mainly interested in algebraic topology. A central theme is algebraic K-theory which naturally leads to stable homotopy theory and homological algebra. The group is coherent without being overly specialized. Each member maintains collaborations with leading researchers abroad and there is a seamless connection with the Algebra and Algebraic Geometry group.

The group has been the coordinator for the two RCN-grants 'Topology' and has organized a summer school in 2011. In addition, the group leader has had heavy administrative duties.

Recommendations

At present there are two graduate students who can be expected to receive good training. The appointment of a post-doc or a series of long term visitors would help the group to reach its significant potential and to mature into an internationally leading group.

4.4.3 Algebra/ Algebraic Geometry

Grade 4-3

There are 2 professors and 1.2 associate professors in this group. Currently there are no funded PhD students. In the last 3 years there have been 1 PhD and 4 MSc graduations and there are 2 more PhD graduations pending.

The group works in commutative algebra, especially Stanley Reisner rings and module categories, and also in algebraic geometry and associative algebras. Most group members are publishing high quality research of international relevance, and are engaged in postgraduate supervision. One member had no opportunity for research due to a heavy administrative load, while another contributes creditably, despite very heavy teaching duties. There is evidence of collaboration between the algebra group and the topology group, with regular attendance at each other's seminars, and a joint publication.

Recommendations

Links to the Topology group are strongly encouraged, as are the links with the algebra groups in Oslo and Tromsø.

4.4.4 Number Theory

This group is too small to be evaluated with a grade. Only 1 member has research publications in the field of number theory during the review period. These are of good quality and of relevance to international research in combinatorial number theory.

Recommendations

Unfortunately, the research group is not viable, and on the retirement of the member, the department has decided that the research group will not be continued, a course of action with which the Committee concurs.

4.4.5 Applied and Computational Mathematics (AC)

Grade 4

There are 8 professors in this group as well as 2 externally funded staff members. The group currently has 6 PhD students, 2 of which are externally funded. There have been 6 PhD graduations in the last 3 years along with 13 MSc graduations.

The Applied and Computational Mathematics group has changed substantially during the last few years with the merging of applied mathematics and the numerical analysis group from the Computer Science Department. There has also been change in the fluid dynamics activities with reduced emphasis on hydrodynamics and ocean modelling and increase in reservoir modelling. The reservoir modelling research is now formally in a separate group.

Applied and Computational Mathematics covers very diverse subjects. There is excellent activity in geometric integration based on numerical Lie group integrators. The study of hydrodynamic and ocean models continues to be of high class, but reduced in scope, and the image processing group is very active. These groups publish in relevant international journals and are invited speakers at main international conferences. There is also research in partial differential equations and numerical linear algebra.

Recommendations

The lack of cohesiveness in the group could be a drawback when funding agencies often prefer applications from larger groups. More focus on candidates bridging the different subgroups should be considered in future recruitment.

4.4.6 Reservoir Mechanics (RM)

Grade 5

This group comprises 2 professors and 2 type II professors, 1 associate professor and 6.4 externally funded staff members. There are currently 6 PhD students, of which 4 are externally funded, and in the last 3 years there have been 12 PhD and 23 MSc graduations.

Two new faculty members have been appointed since the previous review and they have added significantly to the research profile of the group. The research is internationally leading with a large number of high-impact papers, and members of the group have been recognised by receiving prizes and grants. They are part of the Centre of Excellence for Integrated Petroleum Research (CIPR) and the group works well together in a structured and coordinated research environment.

The group has good national and international connections and a strong record of external funding. It graduates a large number of PhD and MSc students and makes a significant contribution to Norwegian offshore industry. Its high visibility ensures a steady flow of overseas visitors.

The group expressed concern about its visibility within the mathematics department as it is at the applied end of the mathematics spectrum, and, in particular, concern about its ability to attract students into its graduate programmes.

Recommendations

The Committee recognises the quality of this group and recommends that it make efforts to link in more closely with the other groups within the department, especially the Applied and Computational Mathematics group. It also needs to develop a plan to ensure the maintenance of its research activities after the closure of the CIPR in 2012.

4.4.7 Statistics

Grade 5/3

This group consists of 3 professors and 1 type II professor, 2 associate professors plus 1 externally funded post-doc. The group is successful in attracting students, with 2 PhD and 23 MSc graduations in the last 3 years and 4 current PhD students; the number of PhD students is appropriate and the number of MSc students very satisfactory.

The main research areas of the group are time series, biostatistics, finance and insurance mathematics. Three of the permanent members of the group are very active and of international standing. The other three members are all contributing to the group's productivity, although not in equal amounts.

The group is aware of the need for strategic planning and has identified two future focus areas. One of them is finance and insurance, the other one biostatistics. On the methodological side, the group intends to concentrate on computational statistics and time series. The professor II in the group contributes to statistical methodology in finance.

The need for faculty in finance and insurance arises since a masters programme is offered which trains students to become actuaries. This programme is very successful with more than 20 students per year. Although the hiring situation for faculty in finance and insurance is not very good, the group is optimistic that they will be able to fill the two positions earmarked for this area with young and competent researchers.

The Committee is pleased to see that a strategic plan is in place, taking into account the needs of teaching as well as the research and hiring questions.

Recommendations

Despite the current worldwide emphasis on applications it is important that, in the larger Norwegian universities, mathematical statistics remains represented and the group should take that into account when it comes to replacing retiring professors.

4.4.8 Overall Assessments and Recommendations

The research activity at the department is overall very good even if it appears to be somewhat fragmented. This might be compensated by collaboration outside Bergen, but the collaboration as measured in terms of joint publications with mathematicians from other Norwegian universities appears much lower than that of the other two leading universities. Participation in topical networks could be a basis for improvements.

The limited field for masters and PhD students is of concern. The department is clearly aware of this and is actively promoting mathematics at local high schools. Other steps for improvement are naturally at the bachelor level. The Committee suggests that a short intensive preparatory course before the first semester would get the students up to speed. In addition, the possibility for students to meet advanced topics earlier in their study should be encouraged.

A strategic plan for replacing retirees would help and this may be most critical in statistics. Geometry could be an area with potential for widening the overall research profile if number theory is phased out. The earlier prominent group in fluid mechanics and ocean modelling is significantly reduced and this leaves a void in interdisciplinary efforts.

The research in the Reservoir Mathematics group is naturally different from what is typical in a department of mathematics. It is, however, very positive for the department to have this group with its connection to the Centre of Excellence in Integrated Petroleum Research, other outside research groups and to local industry. Efforts to facilitate the existence within mathematics for this activity should be made.

Conversely, the Reservoir Mathematics group benefits from its close proximity to the Department of Mathematics. This makes it easier to attract mathematically well-trained students onto its programmes.

4.5 Norwegian University of Science and Technology (NTNU) – Department of Mathematical Sciences.

The Department of Mathematical Sciences sits within the Faculty of Information Technology, Mathematics and Electrical Engineering, one of seven faculties that make up NTNU - a centre for technological education and research in Norway with the Mathematical Sciences central to its main profile. NTNU was established in 1996 following a major restructuring of the University of Trondheim, itself a product of an earlier merger of the Norwegian Institute of Technology and the Norwegian Teachers College. The department is divided into 5 groups. Since January 2011, these groups have been defined as Algebra; Analysis; Differential Equations and Numerical Analysis; Geometry and Topology; and Statistics. The department has extensive teaching duties as it provides a comprehensive teaching service to support various study programmes both outside and within the department. This includes engineering studies and teaching of a highly popular programme in industrial mathematics. Indeed, the department has a strong focus on industrial mathematics and is involved in several major research projects with engineering departments and industry.

Over the last 3 years on average 24% of expenditure has been externally funded.

4.5.1 Algebra

Grade 5

The group comprises 4 professors and 3 associate professors plus 2 externally funded post-docs. There are 12 PhD students, of which 5 are externally funded, and in the last 3 years there have been 7 PhD and 22 MSc graduations.

This research group conducts world-leading research in non-commutative algebra, a major highlight being their work on cluster categories and cluster tilted algebras. In 2007 one of their papers on this topic was identified by Thomson Reuters as a 'Fast Breaking Paper' and has had major impact internationally. Although the main focus of the research group is representations of finite dimensional algebras, several members work across a number of other areas including commutative ring theory, cryptology and information security. The high quality of their research is reflected in the strength of publications (in high quality journals and with strong citations), and international collaborations.

Other quality indicators include invitations to key conferences, including the 2010 ICM, conference organisation, and success in winning external funding.

There is pleasing research strength, evidenced also in newly appointed and promoted group members, which compensates, at least partially, for the loss due to on-going retirement. There is also evidence of extensive collaboration within the research group. Notably, each member has participated in research collaboration with at least one other member leading to joint publication. Moreover, each member supervises at least one PhD student. The group has a good gender balance with 8 women among the 21 members, including the group leader.

Recommendations

The department is encouraged to take the opportunity provided by the coming retirement in 2012 to make a new appointment, which should further strengthen this excellent group by aiming for additional breadth in the algebra research areas covered.

4.5.2 Analysis

Grade 4-5

This group consists of 6 professors and 1 type II professor, 3 associate professors and 1 type II associate professor. There are currently 11 PhD students within the group, of which 3 are externally funded, and in the last 3 years there have been 2 PhD and 24 MSc graduations.

The group is a result of the merger in 2010 of the groups of Functional Analysis and Complex and Harmonic Analysis. Research activities include operator related function theory; harmonic analysis; Dirichlet series; several complex variables; time-frequency analysis and Gabor analysis; spaces of analytic and harmonic functions; geometric function theory; continued fractions and moment problems; discrete models for differential equations; problem of uniqueness and continuation for linear elliptic operators; operator algebras; symbolic and topological dynamics; crossed product algebras and quantum groups. The group has a high international profile with publications in top-level journals, and participation in editorial boards of prestigious journals. It is very active in international projects and has very good international connections.

The group has a leading role in function theory of one and several complex variables, in relation to problems coming from signal processing, such as sampling and interpolation and time frequency analysis. Two researchers in this field are internationally recognized and recruitment of associate professors in this direction reinforces this theme. The representation in operator algebras within this group has also been recognized for many years as being very strong. It is facing evolution after the retirement of leading figures, but remains very competitive, in particular in connection with dynamical systems.

Publication and training activities have been intense within the last ten years. Two weekly seminars are run. Some joint activity between the operator and harmonic analysts would be a plus.

Two new recruitments are scheduled for the beginning of 2012. This promises to be an opportunity to make a major addition to the group in pluri-complex analysis and in this way to further increase the international visibility of the group.

Recommendations

The next recruitments following retirements will be crucial for the group, in particular in operator algebras. Joint activities should be developed in order to enhance scientific life at the group level. The research activity of some individuals is rather weak compared to the group as a whole and should increase within the next few years.

4.5.3 Differential Equations and Numerical Analysis

Grade 5

There are 9 professors in this group, 3 associate professors plus 7 post-docs, of which 5 are externally funded. There are currently 14 PhD Students, 10 of which are externally funded. In the last 3 years there have been 8 PhD and 38 MSc graduations.

This is a large group with healthy production of masters and PhD students and an excellent publication record. The funding situation is good and members of the faculty have been trusted with leading organizational positions within Norway and internationally. There is extensive collaboration with colleagues outside of the university.

There is research at the highest level, for example, in analysis and computations of nonlinear hyperbolic partial differential equations and in numerical methods for ordinary differential equations. In these areas the group is very well known internationally. There is also very good research outside of these core areas related to other classes of partial differential equations, stochastic analysis, mathematical physics and computational mechanics.

Recommendations

The group should exploit its position at one of the leading technical universities in northern Europe to strengthen its applied profile. There are many excellent local departments, research institutes and industries to collaborate with. The group is leading an application for a Centre of Excellence and if this effort does not deliver, vigorous activity to secure funding will be required.

4.5.4 Geometry and Topology

Grade 4/2

This group comprises 3 professors and 2 associate professors. There are currently 3 PhD students and in the last 3 years there have been 1 PhD and 9 MSc graduations.

The group's interest encompasses a broad spectrum of areas from algebraic to differential topology, from applications in physics and biology to the history of mathematics. A result of the fusion of research groups from formerly separate institutions in Trondheim, the group is not very coherent and there is little evidence of collaboration within the group except among the two active algebraic topologists who produced most of the group's quality publications. There are good contacts with researchers abroad and there are joint papers and projects with algebraic topologists in Bergen and Oslo with whom the RCN grant 'Topology' is shared.

Recommendations

Four of the five members are due to retire in the next five years leaving one relatively junior and active member, who deserves support. The Committee recommends that the staff members form a committee to consider the future directions for research and to develop a strategic plan for new recruitments.

4.5.5 Statistics

Grade 5

This group is made up of 8 professors, 5 associate professors, 2 type II associate professors and 3 post-docs, of which 2 are externally funded. In the last 3 years there have been 8 PhD and 78 MSc graduations. There are currently 17 PhD students, 13 of which are externally funded.

Statistics at NTNU includes a world-class group in spatial and computational statistics. Spatial statistics is a central interest for present-day statistics, but for some time now there seems to have been a lack of fresh ideas in this area. The NTNU group, however, has provided one set of such ideas, computational methods centred on nested Laplace approximations. The group also includes well-regarded effort in geo-statistics, and is involved in serious and successful joint work with researchers from several other areas, in particular the oil industry.

The statistics group also does internationally recognized work in population biology and statistical theory, and covers a broad range of reliability related research, biomathematics and biostatistics. It includes very substantial collaboration with biological and engineering research, and with industry, in particular the oil industry. It has a large and well-functioning local, national and international network. It has received several prizes and distinctions; in particular it has had two papers read for the British Royal Statistical Society. Its members have served as editors and associate editors on prestigious international journals. The group has received many external grants and, in particular, is a partner in four large externally supported research centres. It does extensive teaching, ranging from the basic undergraduate teaching to PhD education, and is able to attract good students. During the period 2006-2010 it has produced 12 PhD exams, which seems somewhat modest for a group of this size. However, at present it employs 17 PhD students, so presumably there will be several more PhD exams in the near future. The group has a reasonable number of long-term visitors. It seems financially secure, and in the self-evaluation writes that it has good sabbatical arrangements.

Recommendations

In the self-evaluation the group writes that it “has no strong research leadership”. In view of its obvious success and well-being, the Committee can only recommend that it continues along the path already taken.

4.5.6 Overall Assessments and Recommendations

The elected leaders of the 5 research groups, together with the Deputy Head, and representatives of the students, temporary and administrative staff, form the Advisory Committee for the Head of Department. The department has a strong performance in PhD training, with currently 57 PhD students, of which 31 are externally funded. Teaching loads are reasonable and sabbatical arrangements generous, promoting and supporting a strong research focus.

The department has grown slightly over the last ten years and now comprises 46 permanent staff compared with 42 at the time of the last evaluation. Over the last 3 years an average of 24% of expenditure has been externally funded, and the department predicts a small budget increase in the next decade.

Of the 46 permanent faculty members 19 are over 60, presenting an opportunity for review of the scientific profile of the department. The department has significant research strengths, and is large enough to cover a broad spectrum across the mathematical sciences.

Recommendations

The Committee recommends that the Head and Advisory Committee of the Department, in consultation with members of all research groups, undertake a strategic discussion and review of its scientific profile to take advantage of the opportunity for a number of new appointments in the next decade. The decisions regarding new appointments should be made through a transparent process.

In particular, four members of the Geometry and Topology research group will retire in the next 5 years. The Committee recommends that the department grasp this opportunity to develop new research strength by making an open announcement for a position at the level of professor, with a preference for Geometry and Topology or another field in pure mathematics not already strongly represented in Trondheim. This would give the department the ability to support a high quality appointee with additional appointments.

Regarding the Algebra group, the Committee recommends that the department take the opportunity provided by the retirement of the group leader to make an appointment to strengthen further this group and broaden its research focus.

Regarding the Analysis group, it is crucial to renew research strength, in particular in operator algebras, after the next retirements from the group. Joint activities should be developed in order to enhance the scientific life at the group level.

Regarding the Differential Equations and Numerical Analysis group, the Committee recommends that the department take the opportunity provided by two retirements in the next four years to appoint someone with a more applied focus. This would strengthen its commitment to, and performance in, cross-disciplinary mathematical research. This will also help address a number of issues the department identified concerning student recruitment and their industrial/applied profile.

The department should continue its support of the highly successful Statistics group.

4.6 University of Tromsø – Department of Mathematics and Statistics

The Department of Mathematics and Statistics is one of six that make up the Faculty of Science and Technology which, in its turn, is one of the six faculties that make up the University of Tromsø. The department itself consists of three main research groups in Pure Mathematics; Applied Mathematics; and Statistics. The current structure of the university is the result of a re-organisation in 1998 into faculties and departments, similar to the organisation of the universities of Oslo and of Bergen. In 2009, Tromsø's regional college merged with the University of Tromsø. Funding comes mainly from the university; over the last 3 years on average 15% of expenditure has been externally funded.

4.6.1 Pure Mathematics

Grade 4/3/1

There are 5 professors and 3 associate professors that make up the group along with 2 post-docs and 2 PhD students. In the last 3 years there have been 1 PhD and 8 MSc graduations.

This group is inhomogeneous. Within the group, the two permanent members working in the area of differential geometry/differential equations and related topics are very active and have obtained very good results. This includes, for instance, work on a conjecture of Blaschke and related questions but also work on a large number and a broad range of other interesting problems. These two members have also been central for scientific exchange and cooperation with the rest of the group, and with the group in applied mathematics. Two post-doctoral fellows also contribute to research in these areas. Another focus has been on error correcting codes associated with algebraic curves and Grassmann varieties. Some other members of the group have had only a marginal research output in the reporting period.

Recommendations

The work of the two active members in differential geometry/differential equations deserves strong support. Future appointments in this group should first and foremost give preference to excellence in research, rather than to the representation of a particular field.

4.6.2 Applied Mathematics

Grade 2

This group consists of 2 professors and 1 associate professor plus 1 externally funded post-doc. There are currently 4 PhD students within the group and in the last 3 years there have been 3 MSc graduations.

This is a small group and the research output is low with only the occasional paper in top international journals. One member of the group will retire in 2012.

There is no obvious strategic planning. In addition to grasping opportunities, such as the fortuitous links with a local bank, the group needs to set its own research agenda. There has been little success at winning competitive research funding.

The Committee expressed concern that it appears to be difficult to attract applicants for faculty positions and external visitors. This may be due to the fact that, despite frequent daily flights to Oslo, the university is perceived to be in a remote location. Further, although the members of the faculty have used the generous system of sabbatical leave, the group has little outside visibility.

Recommendations

The Committee recommends that the group use the opportunity provided by the forthcoming retirement to develop a strategic plan for the future of the group. Consideration should be given to the research focus of a new appointment and steps should be taken, such as making contact with international universities, to identify highly-qualified candidates and to encourage them to apply for the position.

4.6.3 Statistics

Grade 4/2

This group comprises 1 professor, 3 associate professors and 1 post-doc, plus 1.2 externally funded staff. There are currently 8 PhD students within the group, of which 5 are externally funded and in the last 3 years there have been 1 PhD and 3 MSc graduations.

Considering the small size of the group, it is able to cover basic research, substantial collaboration with several other areas, PhD training and undergraduate education quite well. The group has some difficulty in recruiting masters students.

The main activity is methodological research in image analysis and so-called scale space methods, along with substantial and successful collaboration with polar research, telemedicine and the local fish industry. In particular, the fish industry collaboration has led to one patent. This part of the group has secured research grants from the RCN and includes two post-docs, which is a good number considering the size of the group. There is a reasonable amount of national and international collaboration.

The remaining part of the group is less active.

Recommendations

The group functions quite well as it is. As stressed in the self-evaluation, it is of vital importance to retain the close relationship with NTNU and, in particular, the professor II position. Efforts should be made to include the less active members into the group's main research.

4.6.4 Overall Assessments and Recommendations

The department includes active methodological research in differential geometry, differential equations and scale-space statistics. It also collaborates with medicine, geoscience and climatology, fishery, and has a recent interest in financial time series. Teaching is an important part of the *raison d'être* of the department, and is taken seriously. Leadership and cooperation in the department seems to be good.

Recommendations

The department is in a remote location, and groups are small, so there is a constant risk of too little contact with the rest of the scientific world. This means that its members should be strongly encouraged to use opportunities for extended stays at other places, in Norway and abroad. Active steps should be taken to encourage high quality applicants from the outside for academic positions. The Norwegian government, the university, the department and department members all have a responsibility to counter isolation by finding sufficient funds for travel and for inviting guests. The Committee believes the department should explore possibilities given by the internet, for example, for virtual participation in seminars elsewhere. It also seems important to use such positions as professor II to build ties with researchers from departments in other universities.

The intellectual environment is already widened by the collaborations with other local science, telemedicine being a good example, and this should continue to have high priority. Similarly, PhD projects should be focused on local issues when possible. Existing highly productive research on differential geometry, differential equations, and scale-space statistical methods should continue to be supported and built upon, in particular in the strategic planning for future appointments.

4.7 Norwegian University of Life Sciences

UMB was established in 2005 when the former Agricultural University of Norway (NLH) was granted university status. The university is located at Ås, approximately 40km south of Oslo. The university has 3800 students and 660 academic staff.

Mathematics research is pursued by two groups belonging to different departments. At the time of the previous review these groups were in the Department of Mathematical Sciences at NLH and split into two subsequently.

Within the next 5 years UMB will merge with the Norwegian Veterinary College to form a new university.

4.7.1 Department of Mathematical Sciences and Technology (IMT) - Applied Mathematics/Computational Biology Group

Grade 3

This group is housed within the Section for Basic Sciences of the Department of Mathematical Sciences and Technology at UMB. It consists of 4 faculty members (3 professors and 1 associate professor), and the section also contains Physics (7 faculty members) and Informatics (3 faculty members). The group has graduated 4 PhD and 5 MSc students since 2008, and currently has 4 externally funded PhD students.

The group in Applied Mathematics and Computational Biology is not in a regular mathematics department but embedded in larger units with other sciences at the Norwegian University of Life Sciences. The research and educational activities are not at the same high level as in some other Norwegian universities with large mathematics departments and must be seen in light of the mission of the university.

The research focus is quite natural for small groups at a university of life sciences. One topic is inverse problems with the application to determine internal structures in a body from ECG recordings. Another area is modelling of signals in neurons and related homogenization analysis.

Recommendations

With groups of this (subcritical) size it will be essential to collaborate with colleagues, for example at the University of Oslo, in order to conduct research at an international level. A future co-location of the groups and with research in veterinary science will open an opportunity to reach a more critical size.

4.7.2 Department of Chemistry, Biotechnology and Food (IKBM) - Biostatistics Group

Grade: 1-2

This group is housed within the Department of Chemistry, Biotechnology and Food Science, a large interdisciplinary department formed by an amalgamation of faculty from the previous Departments of Mathematical Sciences, Chemistry and Biotechnology, and Food Sciences of NLH. The group consists of 4 associate professors and 1 post-doc. It has graduated 2 PhD and 7 MSc students since 2008 and currently has 6 PhD students, 3 of which are externally funded.

According to the self-evaluation the number of published papers has increased during the period 2007-2010. However the self-evaluation also indicates that group members have been unsuccessful in securing sufficient research time and, in fact, both the number of publications and the number of citations are low for the area. International collaboration and recognition seems to be lacking.

Recommendations

Statistical methods have long been crucial for agricultural research. Furthermore, the importance of statistics for the area has increased dramatically during the last few years through the advent of modern gene technology. Meeting the needs in an agricultural university requires both willingness and ability

from statistics to develop and use advanced statistical methods in close collaboration with researchers from many parts of the university. The Committee believes that meeting these needs will require fundamental changes in the way the biostatistics group operates, and recommends that the university invest substantial efforts to achieve this. This issue will become even more pronounced when the agricultural university is merged with the veterinary school.

4.7.3 Overall Assessments and Recommendations

UMB does not award Bachelor or Master degrees in Mathematics but there is a strong demand for service teaching in a range of degree programmes such as a Bachelor and Master in Renewable Energy and Environmental Physics, a Master in Environmental Physics and Computational Biology and a Master in Applied Statistics and Bioinformatics. They also provide mathematics instruction in the teacher-training programme. It is pleasing to note that both groups express very similar mission statements which, to paraphrase, are to provide high-quality teaching and research in mathematics focused on biological and medical applications.

Given this commonality, there is an issue with the current separation of the two groups, which manifests itself on several levels:

Regarding leadership, the group in IMT is well structured and has a clear management plan, while for the IKBM group there is concern about the quality of the leadership at the university, department and group level.

As a result of this the IMT group has identified a clear strategy for development of its research focused around three themes. On the other hand, the IKBM group has not articulated a role for its research in the context of the university or the wider society.

With regard to contacts, the IMT group is well connected both nationally and internationally, while the IKBM group is not, even with relevant activities in Oslo.

There is a plan to merge UMB with the Veterinary School in 2014. This event will have a major impact and it is important to consider the consequences for mathematics research within UMB. It provides an opportunity to consider the current division of the two groups which, although it has coincided with an increase in research output in the review period, may not be the best structure for the future.

Appendix A List of Acronyms and Abbreviations

CIPR	Centre for Integrated Petroleum Research
CMA	Centre of Mathematics for Applications
ECG	Electrocardiogram
ERC	European Research Council
ESF	European Science Foundation
FRINAT	Independent projects in Mathematics and Physical Science
GDP	Gross Domestic Product
ICM	International Congress of Mathematicians
IKBM	Department of Chemistry, Biology and Food Sciences, UMB
IMT	Department of Mathematical Sciences and Technology, UMB
KTN	Knowledge Transfer Network for Industrial Mathematics
MSc	Master of Science
NLH	Agricultural University of Norway
NIFU	Nordic Institute for Studies in Innovation, Research and Education
NTNU	Norwegian University of Science and Technology
OECD	Organisation for Economic Co-operation and Development
PDE	Partial Differential Equations
PhD	Doctor of Philosophy
R&D	Research and Development
RCN	Research Council Norway
SFI^2	Statistics for Innovation
SINTEF	The Foundation for Scientific and Industrial Research
SUP	Strategic University Programme
UMB	Norwegian University of Life Sciences
YFF	Outstanding Younger Investigator

Appendix B Profiles of Evaluation Committee Members

Aline BONAMI

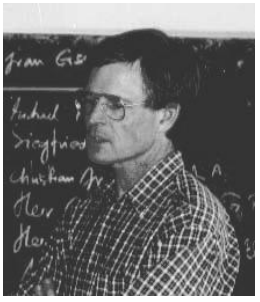
http://www.univ-orleans.fr/mapmo/membres/bonami/welcome.html

Aline Bonami is Emeritus Professor at the University of Orléans, where she has been since 1973. Professor Bonami's interests are in interactions of Fourier analysis with signal processing; probability and partial differential equations.

At present she is a member of the Board of Directors of the Société Mathématique de France and of the Editorial Board of the journal Advances in Pure and Applied Mathematics.

Professor Bonami has held some senior positions; amongst other things, she worked within the French Ministry for Further Education and Research where she was Scientific Director at MSTP for Mathematics; she was co-ordinator of the IHP European Network HARP; founding director of the MAPMO Laboratory, Orleans, and member of the National Committee of CNRS.

In 2001 Professor Bonami was awarded the Petit d'Ormoy, Carrière, Thébault Prize of the French Academy of Sciences. In 2002 she received an Honorary Doctorate from the University of Göteburg, Sweden. In 2005 she was made Commandeur des Palmes Académiques and in 2010 she was made Chevalier de la Légion d'Honneur.



Joachim CUNTZ

http://wwwmath.uni-muenster.de/u/cuntz/cuntz.html

Joachim Cuntz is Professor at the University of Münster, where he has been since 1997. He works in the field of analysis where his research activities are in C*-algebras, operator theory, K-theory, cyclic homology and non-commutative geometry.

Professor Cuntz received his PhD in 1975 from the University of Bielefeld followed by his Habilitation in 1977 from the Technical University of Berlin. Since 1976 he has held a number of senior academic positions in Europe and the USA.

He has served as a member of several national and international committees, including the programme committees for the International Congress of Mathematicians (ICM) and European Congress of Mathematics (ECM) and the Evaluation Committee for the Institut des Hautes Études Scientifiques (IHES). He was a committee member for the previous Evaluation of Research in Mathematics in Norway in 2002. He is also a board member for the Centre for Mathematical Physics at Hamburg. He is editor for various journals including Crelle's Journal, Documenta Mathematica and the Journal of Functional Analysis.

In 1990 Professor Cuntz was an invited speaker at the ICM in Kyoto. He is also the recipient of a number of prestigious awards including an ERC Advanced Investigators Grant in 2010, an Honorary Doctorate from the University of Copenhagen in 2001, the Leibniz Prize in 1999 and the Medal of the College of France in 1997.

Björn ENGQUIST

http://www.ma.utexas.edu/text/webpages/engquist.html

Björn Engquist is the holder of the CAM Chair at the Institute for Computational Engineering and Sciences at the University of Texas at Austin, as well as Director of the Parallel and Scientific Computing Institute (PSCI) at the Royal Institute of Technology in Stockholm. He works in the field of computational and applied mathematics where his research activities are in multi-scale modelling, electromagnetism, and fluid mechanics.

Professor Engquist received his Ph.D. from the University of Uppsala in 1975, following which he taught there whilst also holding a professorship at the University of California. In 2001 he was appointed Michael Henry Stater University Professor of Mathematics at the University of Princeton and also served as the director of the Programme in Applied and Computational Mathematics. He left Princeton in 2005 to take up his position at the University of Texas.

Professor Engquist has authored more than 100 scientific publications, advised 31 PhD students and has been an invited speaker at the ICM in 1982 and in 1998. He is the 2011 recipient of the Peter Henrici Prize and recipient of other numerous distinctions and awards. He is a SIAM Fellow, a member of the Royal Swedish Academy of Sciences and was recently elected to the Norwegian Academy of Science and Letters.

Barbara GENTZ

http://www.math.uni-bielefeld.de/~gentz/

Barbara Gentz is currently Professor of Mathematics at the University of Bielefeld, where she has been since 2006. She works in the field of probability theory where her research interests are in stochastic processes and their applications in the sciences.

Professor Gentz received her Habilitation in 2003 from the Technical University of Berlin, from where she had previously also received her Diploma in 1990. She received her PhD from the University of Zurich in 1996. Since 1990 she has held a series of teaching and research posts in Switzerland and in Germany. She has been at the University of Bielefeld since 2006 where she has been a full professor since January 2008 and where she co-ordinates the ERASMUS programme at the Faculty of Mathematics.

Paul LINDEN

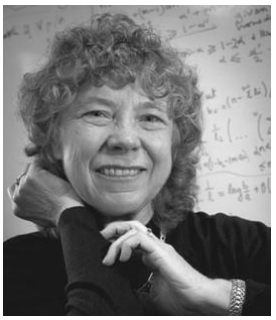
http://www.damtp.cam.ac.uk/people/p.f.linden/

Paul Linden is Professor at the University of Cambridge. He is an expert in fluid mechanics, looking particularly at issues associated with the environment and the processes that affect and are impacted by climate change.

Professor Linden studied in Australia and the UK, receiving his PhD from the University of Cambridge in 1972 followed by post-doctoral research there until 1976. Following his studies he has held a series of senior academic appointments in Cambridge and California and also a number of international visiting appointments. Prior to his return to Cambridge in 2010, he was director of the Environment and Sustainability Initiative and then of the Sustainability Solutions Institute at UC San Diego.

Professor Linden has published over 120 research articles and more than 50 conference proceedings. He has edited 2 books and contributed chapters to at least 8 others. His editorial roles have been for journals concerned with fluid mechanics, such as the Journal of Fluid Mechanics and Visualization in Fluid Mechanics.

Professor Linden is a Fellow of the Royal Society, Fellow of the American Physical Society and Fellow of the Royal Meteorological Society.



Cheryl PRAEGER

http://www.uwa.edu.au/people/cheryl.praeger

Cheryl Praeger is the Winthrop Professor of Mathematics and Director of the Centre for Mathematics of Symmetry and Computation at the University of Western Australia. She is also an Australian Research Council Federation Fellow.

Professor Praeger studied at the University of Queensland, and received her DPhil from the University of Oxford in 1973. She is best known for her work in group theory, algebraic graph theory and combinatorial designs.

At the University of Western Australia, she has held senior academic and administrative positions including Dean of Postgraduate Research Studies 1996-1998 and Deputy Dean of the Faculty of Engineering, Computing and Mathematics 2003-2006. She is also a director of Data Analysis Australia, a leading strategic information consultancy in Australia. She is the author of over 300 research articles, 6 books and over 60 other publications and is a former joint editor-in-chief of the Journal of Algebraic Combinatorics.

Professor Praeger is an Executive Committee member of the International Mathematical Union, foundation board member of the Australian Mathematics Trust, chair of the Australian Mathematics Olympiad Committee, former president of the Australian Mathematical Society and former chair of the Australian Council of Heads of Mathematical Sciences.

Professor Praeger has received honorary doctorates from the Prince of Songkla University in Thailand in 1993, from the Université Libre de Bruxelles in Belgium in 2005, and was an invited speaker at the ICM in 2002. She is a member of the Order of Australia and a Fellow of the Australian Academy of Science.

Holger ROOTZÉN

http://www.math.chalmers.se/~rootzen/

Holger Rootzén is Professor of Mathematical Statistics and leader of the Gothenburg Mathematical Modelling Centre (GMMC) at Chalmers University of Technology in Götheburg. His research ranges from pure probability theory to practical statistics in a broad spectrum of areas. Currently his main research interest is mathematical and statistical theory for extreme episodes in random processes, with a view to solving practical problems and to aiding scientific discovery and technological advance.

Professor Rootzén studied at the University of Lund, receiving his PhD in mathematical statistics in 1974 and becoming an associate professor there in 1976. Following this he had a series of senior academic appointments in Scandinavia and visiting appointments at the University of North Carolina, where he has collaborated on a number of research projects.

Professor Rootzén is currently chairman of the council of the Stochastic Centre in Gothenburg and Node Co-ordinator for the Nordic Network on Statistical Approaches to Regional Climate Models for Adaptation (SARMA). He is a former editor of Extremes and Bernoulli.

Professor Rootzén is a Fellow of the Institute of Mathematical Statistics (IMS), member of the International Statistical Institute (ISI) and an elected member of both the Royal Swedish Academy of Science and the Royal Physiographic Society in Lund.

Ulrike TILLMANN

http://www.maths.ox.ac.uk/people/profiles/ulrike.tillmann

Ulrike Tillmann is Professor of Mathematics at the University of Oxford. She is interested in algebraic topology and its applications, in particular to the study of moduli spaces and quantum field theories.

She received her PhD from Stanford in 1990, followed by a Habilitation from Bonn in 1996. She has held positions at Cambridge and Oxford, becoming Professor of Mathematics in 2000.

Professor Tillmann is a member of the Scientific Advisory Board of the Courant Research Centre (CRC) at Göttingen, the Programme Committee of the International Centre for Mathematical Sciences (ICMS) in Edinburgh, and chair of the EMS-EWM Scientific Committee. She is at present the founding managing editor of the Journal of Topology and member of the editorial boards for the Quarterly Journal of Mathematics, and for Algebraic and Geometric Topology.

Professor Tillmann was an EPSRC Advanced Fellow 1997-2003; an invited speaker at the ICM 2002; a recipient of the LMS Whitehead Prize 2004 and the Bessel Research Award of the Humboldt Stiftung 2008. She is a Fellow of the Royal Society.

Appendix C Terms of Reference for the Evaluation Committee

Evaluation of research in mathematics in Norway 2011

Terms of Reference

I INTRODUCTION

The Ministry of Education and Research has given the Research Council of Norway (RCN) the task to perform subject-specific evaluations. The Division of Science has decided to evaluate research within the area of mathematics in universities, university colleges and relevant research institutes during 2011. An evaluation of research in mathematics was last carried out in 2002.

1. Objective

The objective of the evaluation is to review the overall state of research in mathematics in Norwegian universities, university colleges and relevant contract research institutes. The evaluation should provide knowledge and recommendations for future development of research in mathematics in Norway, and represent a basis for determining future priorities, including funding priorities, within and between individual fields of research.

For the institutions that are to be evaluated, the evaluation will provide knowledge, advice and recommendations that can be used to enhance their own research standards. For the RCN the evaluation will represent an improved knowledge base that can be used in its role as an adviser on research policies to the Norwegian Government.

Specifically, the evaluation should:

- Provide a critical review of the strengths and weaknesses of research in mathematics in Norway, nationally as well as at the level of the departments and individual research groups. The scientific quality should be reviewed in an international context.
- Identify research groups that have achieved a high international quality level or have potential to reach such a level.
- Identify areas of research that need to be strengthened in order to ensure that Norway in the future will have the necessary competence in areas of national importance.
- Discuss to what extent the research done meets the demand of interdisciplinary research and future societal challenges.
- Assess the situation with regard to recruitment of PhD candidates in mathematics.
- Assess to what degree the previous evaluations have been used by the institutions in their strategic planning.

2. Organization and methods

An international Evaluation Committee will be appointed. This Committee will be asked to base its assessments on self-evaluations provided by the departments/research groups, as well as on presentations given in meetings with the involved departments/research groups. Self-evaluations from the institutions will include factual information about the organisation and resources, future plans, CVs, and publication lists of their scientific staff. The Committee should address both the scientific quality of the research done, and quantitative aspects based on bibliometric analyses of the scientific publications produced.

The Committee is requested to present its findings in a written report. A preliminary report will be sent to the departments/research groups included in the evaluations for a check of the factual information. The Committee's final report will be submitted to the Board of the Division for Science for final approval.

II MANDATE

The Committee is requested to evaluate scientific activities with respect to their quality, relevance and international and national collaboration. The Committee is also requested to evaluate the way in which research in mathematics is organised and managed.

The conclusions in the committee's report should lead to a set of recommendations and possible scenarios concerning the future development and prioritization of research in mathematics in Norwegian universities, university colleges and relevant contract research institutes, including challenges related to recruitment and possible reductions in the number of permanent scientific positions.

Specific aspects to be considered and described are:

1. General aspects

- In which areas are Norwegian research in mathematics strong?
  In which areas are Norwegian research in mathematics weak?
- Are there areas within mathematics in which Norwegian research is at the leading edge of the international scientific development?
- Is Norwegian research in mathematics being carried out in areas that are regarded as important and relevant by the international research community?
- Are there any particular differences between Norwegian research in mathematics and research carried out in most other countries?
- Is there a reasonable balance between the various fields of research in mathematics in Norway, or is research absent or underrepresented in any particular field?
- Are any areas overrepresented, in view of the scientific quality or relevance of the research being carried out?
- Is there a reasonable degree of division of labour with regard to research activities among institutions at the national level, or should this aspect be improved?
- Is there an adequate degree of national and international mobility?
- Is the Norwegian research in mathematics relevant to the needs of industry and society?
- Do research groups maintain sufficient contact with industry and/or the public sector?

2. Academic departments

- Are the academic departments adequately organised?
- Is scientific leadership being exercised in an appropriate way?
- Do individual departments carry out their research as part of an overall research strategy?
- Is there sufficient collaboration between research groups within individual departments?
- Are there satisfactory policies in place guiding the recruitment and handling of employees?
- Are the efforts to increase gender balance in academic positions satisfactory?
- In which way have the previous evaluation of research in mathematics (2002) and the associated national strategic plan been used by the departments in their own strategic planning?

3. Research groups (all institutions)

3.1. Strategy, organization and research leadership

- Has the research group developed a satisfactory strategy for its research? Is it implemented?
- Is the size and organisation of the research group reasonable?
- Is research leadership being performed in an appropriate way (e.g. in execution of project management)?
- Is there a reasonable and efficient distribution of tasks and responsibilities within the research group?

3.2. Research activities, staff and scientific production

- What is the scientific quality of the research group as judged by the significance of contributions to its field, prominence of the leader and team members, and scientific impact of their research?
- Is the scientific production, e.g. the number of scientific publications and Ph.D. theses awarded, reasonable in terms of the resources available?
- How is the long term viability of the staff and facilities evaluated in view of future plans and ideas, staff age, facilities, research profile, and new impulses through recruitment of researchers?
- Do the group play an active role in dissemination of its own research and of new international developments in its field to industry and/or public sector?

3.3. Research collaboration (national, international, industry)

- Is there sufficient contact and co-operation with other research groups nationally? In particular, how is the co-operation between academic research groups and the contract research institutes?
- Is the level of contracts and joint projects with external partners satisfactory?
- Is the research group involved in interdisciplinary/multidisciplinary research activities at a satisfactory level?
- Do the research group play a satisfactory role in creating and establishing new industrial activity?
- Is the international network satisfactory, e.g. in terms of contact with leading international research groups, number of guest researchers, and number of joint publications with foreign colleagues?
- Is the group's involvement in international programmes satisfactory?
- Is the participation in international professional committees, peer review, work on standardization, and other professional activities satisfactory?

4. Research infrastructure (RI)

- Describe the current situation for national RI critical to research within mathematics in Norway.
- Describe future needs with regard to modern RI within mathematics in Norway.
- Is there sufficient national co-operation with regard to the use of RI?
- Is the use of international facilities satisfactory, or should utilisation be improved by introducing special measures?
- Is there a sufficient awareness of new RI opportunities in Europe and globally, and are there plans for active participation in such RI projects?

5. Training

- Does scientific staff play an active role in stimulating interest among young people for their field of research?
- Is recruitment to doctoral programmes satisfactory, or should greater emphasis be put on recruitment in the future, including strategies aimed at improving the gender balance?
- Are there sufficient educational and training opportunities for Ph.D. students?

The Committee's written report is expected to address the questions posed above. The assessments and recommendations should be at research group, departmental, institutional (universities only) and national level.

Please feel free to address other relevant aspects of Norwegian research in mathematics that are not addressed above.

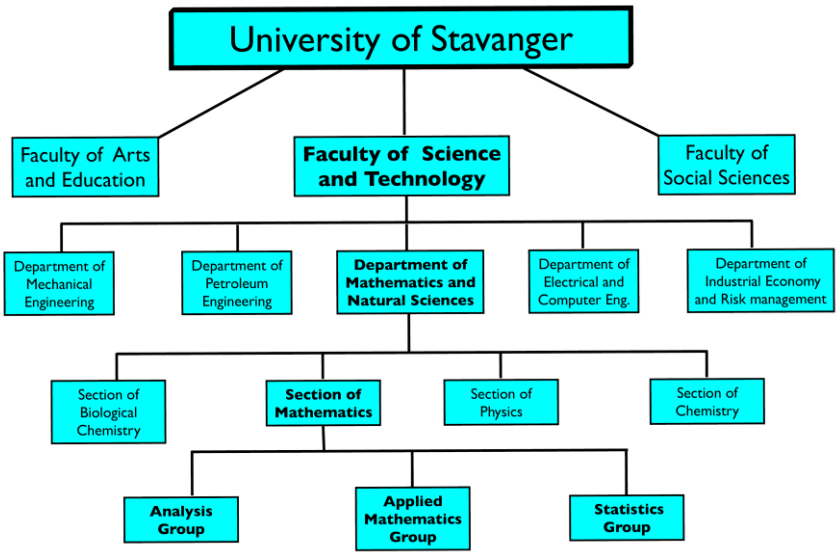
Appendix D Factual Information for Each Institution

University of Stavanger

Department of Mathematics and Natural Science

Section of Mathematics

Organisation chart



Personnel

	Research group/unit Analysis		Research group/unit Applied math.		Research group/unit Statistics		Total	
Positions	**Univ**	**Exter**	**Univ**	**Exter**	**Univ**	**Exter**	**Univ**	**Extern**
Researcher								
Professor	3		2	1†	1.2		6.2	1†
Associate professor	2		1		1		4	
Professor II								
Associate professor II								
Post-doctoral research fellow						1**		1**
Doctoral student(s)								
Technical/adm. position*								
Total	**5**		**3**	**1†**	**2.2**	**1****	**10.2**	**2**

”Univ” = persons financed by the university, ”Extern” = persons financed by external research grants
* Technical/adm.position: Positions supporting research
** Formally affiliated to the Dept. of Electrical and Computer Eng.
†Formally affiliated to the Dept. of Petroleum Engineering.

Graduates

No master or PhD graduates in Mathematics.

R&D expenditure by main source of funding (1000 NOK)

Type of expenditure	2008	2009	2010
University funding*, salaries	6 631	7 342	7 378
University funding, other costs	91	61	118
University funding, instruments and equipment	3	36	36
University funding, total	**6 725**	**7 439**	**7 532**
The Research Council, grants			86
Other national grants (public or private):			
International grants(incl. EU)			86
External funding, total			**86**
Total expenditures	**6 725**	**7 439**	**7 618**
External funding as % of total expenditures			1.1

* University funding: This refers to the institution's input of own resources such as salaries for scientific and technical personnel (included social costs), other costs, and infrastructure.

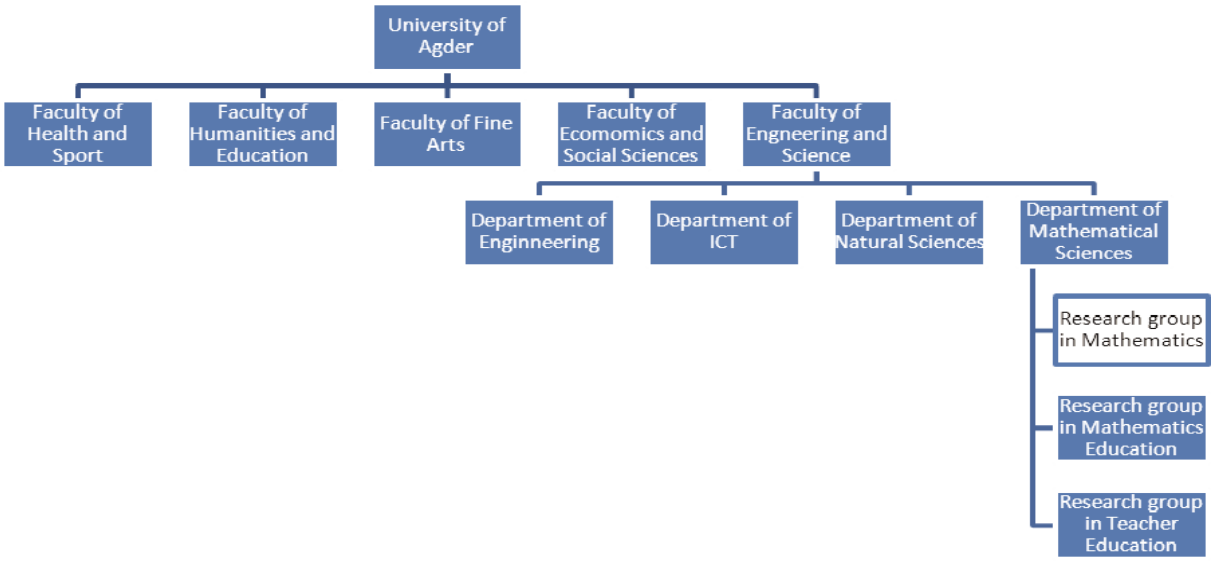
Date of form completion: 29.04.2011

University of Agder

Faculty of Engineering and Science

Department of Mathematical Sciences

Organisation chart



Personnel at the Department of Mathematical Sciences

This table does not include the three researchers from the department of Engineering or the two professors emeritus that are included in the evaluation. The table includes all employees at the Department of Mathematical Sciences.

Department of Mathematical Sciences	**Research group/unit**	
Positions	**Univ**	**Extern**
Researcher		
Professor	7	
Associate professor	9	
Professor II	0,2	
Associate professor II		
Post-doctoral research fellow	1	
Doctoral student(s)	5	
Technical/adm. position*		
Total	**22,2**	**0**

”Univ” = persons financed by the university
”Extern” = persons financed by external research grants
* Technical/adm.position: Positions supporting research

Graduates

The Department has no master or PhD programmes in Mathematics

R&D expenditure by main source of funding (1000 NOK)

Type of expenditure	**2008**	**2009**	**2010**
University funding*, salaries	14 987	14 950	14 634
University funding, other costs	308	269	352
University funding, instruments and equipment	62	131	132
University funding, total	**15 353**	**15 349**	**15 117**
The Research Council, grants	1 611	693	655
Other national grants (public or private):	2 309	1 100	1 094
International grants(incl. EU)	500	550	691
External funding, total	**4 420**	**2 343**	**2 410**
Total expenditures	**19 773**	**17 633**	**17 527**
External funding as % of total expenditures	**22.3**	**13.2**	**13.7**

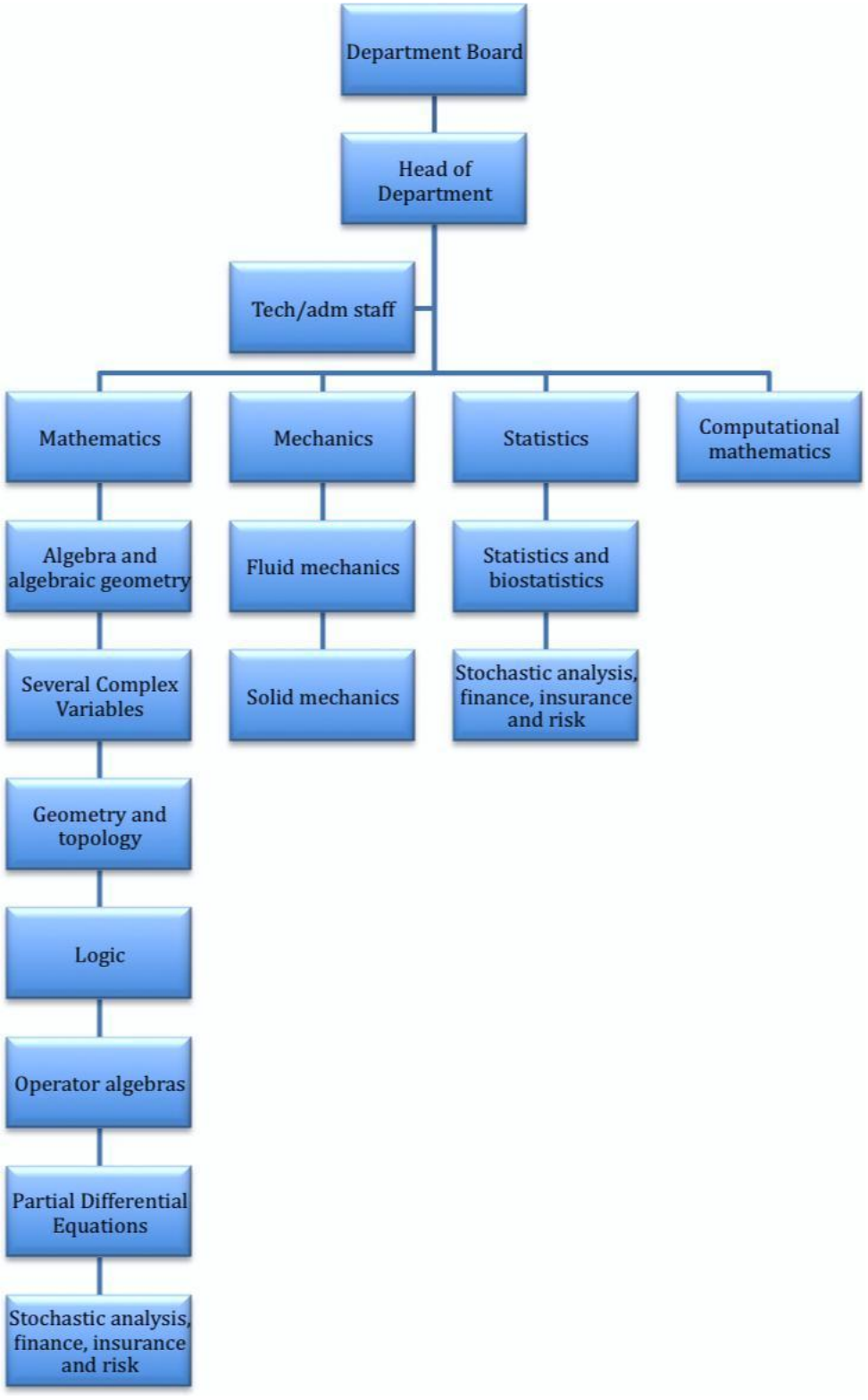
University funding: This refers to the institution’s input of own resources such as salaries for scientific and technical personnel (including social costs), other costs, and infrastructure.

Date of form completion: 06.05.2011

University of Oslo

Faculty of Mathematics and Natural Sciences
Department of Mathematics

Organisation chart



*The research group *Stochastic analysis, finance, insurance and risk* include researchers from both the mathematics- and the statistics-division.
** The research group Computational mathematics is part of the center CMA.

Personnel

	Algebra and algebraic geometry		Several Complex Variables		Geometry and topology		Logic	
Positions	**Univ**	**Extern**	**Univ**	**Extern**	**Univ**	**Extern**	**Univ**	**Extern**
Researcher								
Professor	3		1		4		1	
Associate professor	2		1					
Professor II							1	
Associate professor II								
Post-doctoral research fellow	1	1	1			1		
Doctoral student(s)	3	3			3			
Technical/adm. position*								
Total	**9**	**4**	**3**		**7**	**1**	**2**	

	Operator algebras		Partial Differential Equations		Stochastic analysis, finance, insurance and risk		Solid mechanics	
Positions	**Univ**	**Extern**	**Univ**	**Extern**	**Univ**	**Extern**	**Univ**	**Extern**
Researcher								
Professor	2		4		6		1	
Associate professor	2		1		2		1	
Professor II				3	2	4	1	
Associate professor II					1		1	
Post-doctoral research fellow				4		3		
Doctoral student(s)	2	1	1		5	6	2	3
Technical/adm. position*								
Total	**6**	**1**	**6**	**7**	**16**	**13**	**6**	**3**

	Fluid Mechanics		Statistics and biostatistics		Comp. mathematics		Total	
Positions	**Univ**	**Extern**	**Univ**	**Extern**	**Univ**	**Exter**	**Univ**	**Extern**
Researcher					1	2	1	2
Professor	4		6		4		36	
Associate professor			1		1		11	
Professor II		1	1				5	8
Associate professor II	1					1	3	1
Post-doctoral research fellow	1	2				1	3	12
Doctoral student(s)	3	9	3	2	2	8	24	32
Technical/adm. position*	1						1	
Total	**10**	**12**	**11**	**2**	**8**	**12**	**84**	**55**

”Univ” = persons financed by the university, ”Extern” = persons financed by external research grants

* Technical/adm.position: Positions supporting research

Graduates

	2008	2009	2010	Total
Dr. ing./Dr. scient./Ph.D. graduated				
Algebra and algebraic geometry	1			**1**
Several Complex Variables				
Geometry and topology		2		**2**
Logic			2	**2**
Operator algebras				
Partial Differential Equations	1	4	1	**6**
Stochastic analysis, finance, insurance and risk	2	3	2	**7**
Solid mechanics		1		**1**
Fluid Mechanics	4	2	2	**8**
Statistics and biostatistics	5	1	1	**7**
Computational mathematics	3	3	2	**8**
Total	**16**	**16**	**10**	**42**
M.Sc.graduated				
Algebra and algebraic geometry	4	5	2	**11**
Several Complex Variables	1			**1**
Geometry and topology	1	1	1	**3**
Logic		1		**1**
Operator algebras	1		1	**2**
Partial Differential Equations	2	2	2	**6**
Stochastic analysis, finance, insurance and risk	8	18	12	**38**
Solid mechanics	6	5	6	**17**
Fluid Mechanics	3	4	4	**11**
Statistics and biostatistics	4	3	5	**12**
Computational mathematics	9		5	**14**
Total	**39**	**39**	**38**	**116**

R&D expenditure by main source of funding (1000 NOK)

Type of expenditure	2008	2009	2010
University funding*, salaries	47 517	47 499	52 157
University funding, other costs	19 297	14 521	14 697
University funding, instruments and equipment	1 289	663	1 382
University funding, total	**68 103**	**62 683**	**68 236**
The Research Council, grants	22 903	23 345	22 943
Other national grants (public or private):	10 161	11 239	12 643
International grants(incl. EU)	649	7,431	170
External funding, total	**33 713**	**42 015**	**35 756**
Total expenditures	**101 816**	**104 698**	**103 992**
External funding as % of total expenditures	33	40	34

University funding: This refers to the institution's input of own resources such as salaries for scientific and technical personnel (including social costs), other costs, and infrastructure.

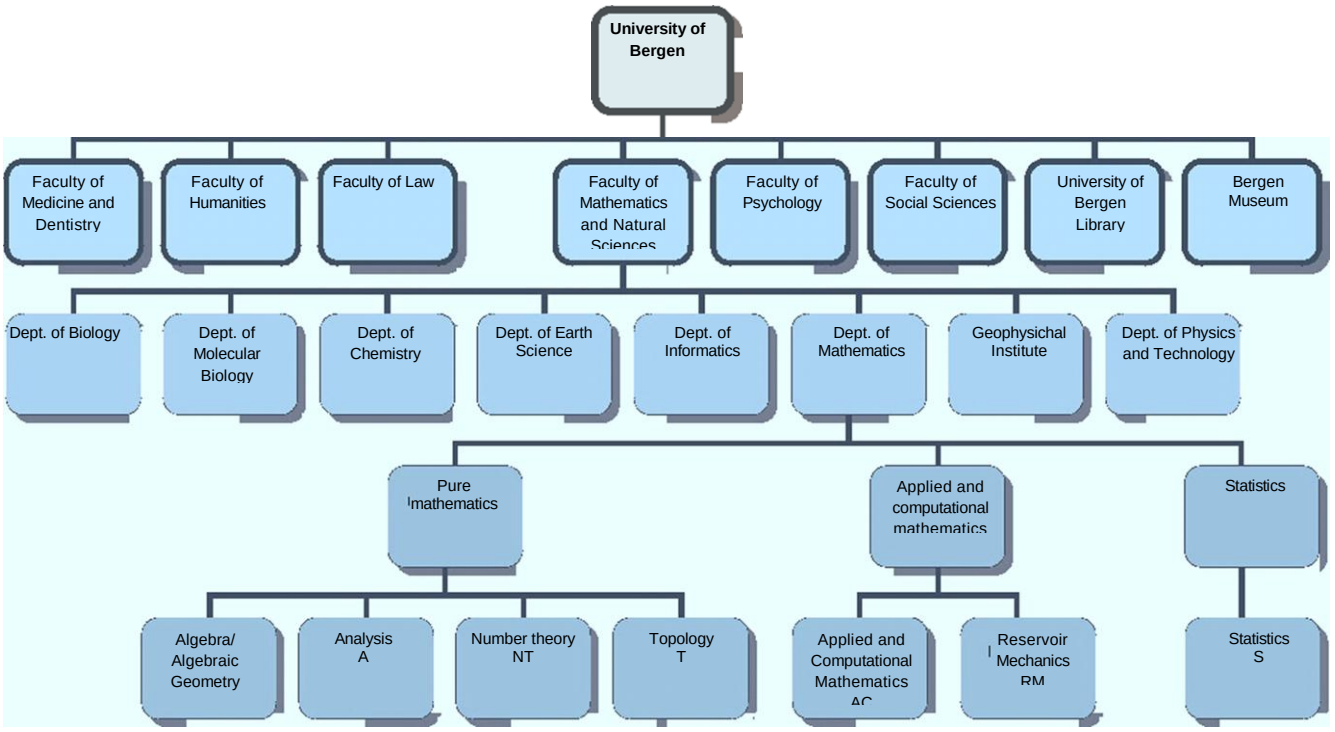
Date of form completion: 05.05. 2011

University of Bergen

Faculty of Mathematics and Natural Sciences,

Department of Mathematics

Organisation chart



Personnel

Main group	**Pure mathematics**								**Applied and Computational mathematics**				**Statistics**			
Research group	Algebra/ Algebraic Geometry		Analysis		Number theory		Topology		Applied and computational mathematics		Reservoir Mechanics		Statistics			
Abbreviation	**AG**		**A**		**NT**		**T**		**AC**		**RM**		**S**		**Total**	
Positions	Univ	Extern	Univ	Extern	Univ	Extern	Univ	Extern	Univ	Extern	Umv	Extern	Univ	Extern	Univ	Extern
Professors	2		3		0.4		1		8*		2		3		**19.4**	
Associate professors	1.2				0.2		2				1		2		**6,4**	
Professor II										1	2	4	1		**3**	**5**
Postdocs/researcher								1		1		2.4		1		**5.4**
Doctoral students			2				1	1	4	2	2	4	4		**13**	**7**
Adm.positions *															**8****	
Total	3.2		5		0.6		4	2	11	4	7	10.	10	1	**49.8**	**17.4**

"Univ" = persons financed by the university. "Extern" = persons financed by external research grants

* Technical/adm.position: Positions supporting research

* Included Head of Department, professor Jarle Berntsen ** Included Head of Department, Jarle Berntsen

Graduates

	2008	**2009**	**2010**	**Total**
Dr. ing./Dr. scient./Ph.D. graduated				
Algebra/Algebraic Geometry (AG)			1	1
Analysis (A)				
Number Theory (NT)				
Topology (T)				
Applied and Computational Mathematics (AC)	2	1	3	6
Reservoir Mechanics (RM)	3	4	5	12
Statistics (S)		1	1	2
Total PhD	**5**	**6**	**10**	**21**
M.Sc.graduated				
Algebra/Algebraic Geometry (AG)	3	1		4
Analysis (A)	1	1	1	3
Number Theory (NT)				
Topology (T)		1		1
Applied and Computational Mathematics (AC)	3	4	6	13
Reservoir Mechanics (RM)	7	7	9	23
Statistics (S)	8	10	5	23
Total M.Sc.	**22**	**24**	**21**	**67**

R&D expenditure by main source of funding (1000 NOK)

Type of expenditure	2008	2009	2010
University funding*, salaries	31 808	33 700	32 400
University funding, other costs	1 837	706	3 049
University funding, instruments and equipment	300	233	1 075
University funding, total	**33 945**	**34 639**	**36 524**
The Research Council, grants	12 179	15 895	15 544
Other national grants (public or private):	2 714	9 439	6 009
International grants(incl. EU)	468	192	119
External funding, total	**15 361**	**25 526**	**21 672**
Total expenditures	**49 306**	**60165**	**58 196**
External funding as % of total expenditures	31	42	37

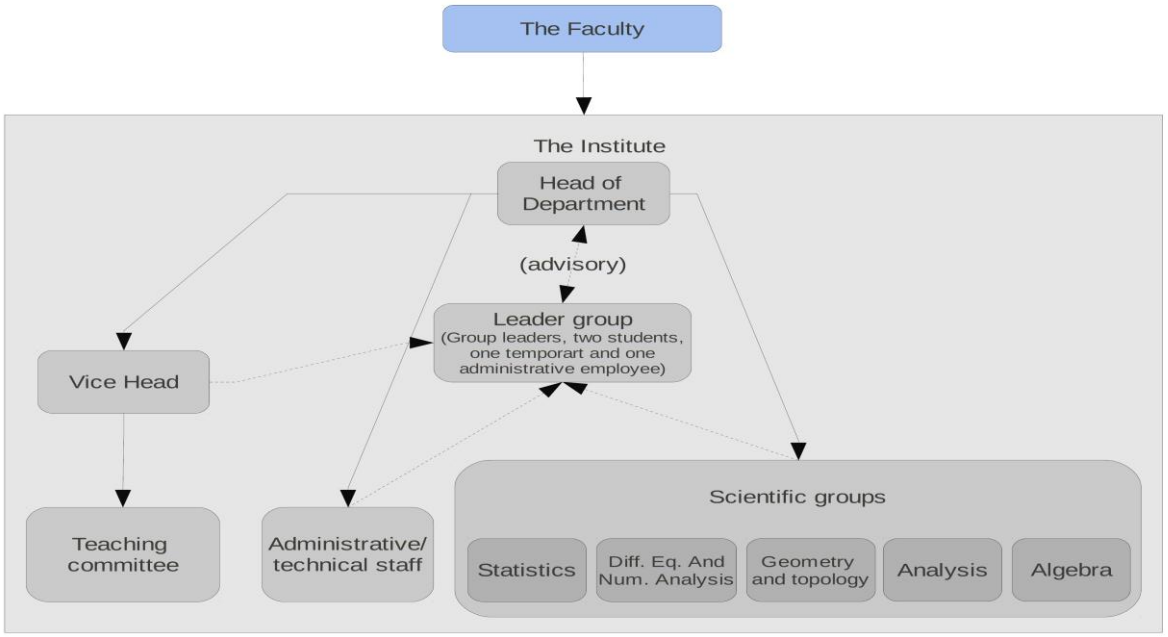
University funding: This refers to the institution's input of own resources such as salaries for scientific and technical personnel (including social costs), other costs, and infrastructure.

Date of form completion: 02.05.2011

Norwegian University of Science and Technology, NTNU

Department of Mathematical Sciences

Organisation chart



Personnel

	B1		B2		B3		B4		B5		Total	
Positions	**Univ**	**Extern**	**Univ**	**Extern**	**Univ**	**Extern**	**Univ**	**Extern**	**Univ**	**Extern**	**Univ**	**Extern**
Researcher												
Professor	4		6		9		3		8		30	
Associate professor	3		3		3		2		5		16	
Professor II			1								1	
Associate professor II			1						2		3	
Post-doctoral research fellow		2			2	5			1	2	3	9
Doctoral student(s	7	5	8	3	4	10	3		4	13	26	31
Technical/adm. position*											4	
Total	14	7	19	3	18	15	8		20	15	**83**	**40**

”Univ” = persons financed by the university, ”Extern” = persons financed by external research grants
* Technical/adm.position: Positions supporting research.

Graduates

	2008	2009	2010	Total
Dr. ing./Dr. scient./Ph.D. graduated				
Research group B1	1	3	3	7
Research group B2	1	1		2
Research group B3	2	3	3	8
Research group B4		1		1
Research group B5	3	4	1	8
Total	**7**	**12**	**7**	**26**
M.Sc.graduated				
Research group B1	5	10	7	22
Research group B2	9	8	7	24
Research group B3	8	20	10	38
Research group B4	1	3	5	9
Research group B5	20	31	27	78
Total	**43**	**72**	**56**	**171**

R&D expenditure by main source of funding (1000 NOK)

Type of expenditure	2008	2009	2010
University funding*, salaries	50 053	51 613	52 883
University funding, other costs	9 109	8 517	9 856
University funding, instruments and equipment	838	710	2 609
University funding, total	**60 000**	**60 840**	**65 348**
The Research Council, grants	13 041	18 718	23 114
Other national grants (public or private):	500	1000	800
International grants(incl. EU)	431	376	534
External funding, total	**13 972**	**20 094**	**24 448**
Total expenditures	**73 972**	**80 934**	**89 796**
External funding as % of total expenditures	19	25	27

University funding: This refers to the institution's input of own resources such as salaries for scientific and technical personnel (including social costs), other costs, and infrastructure

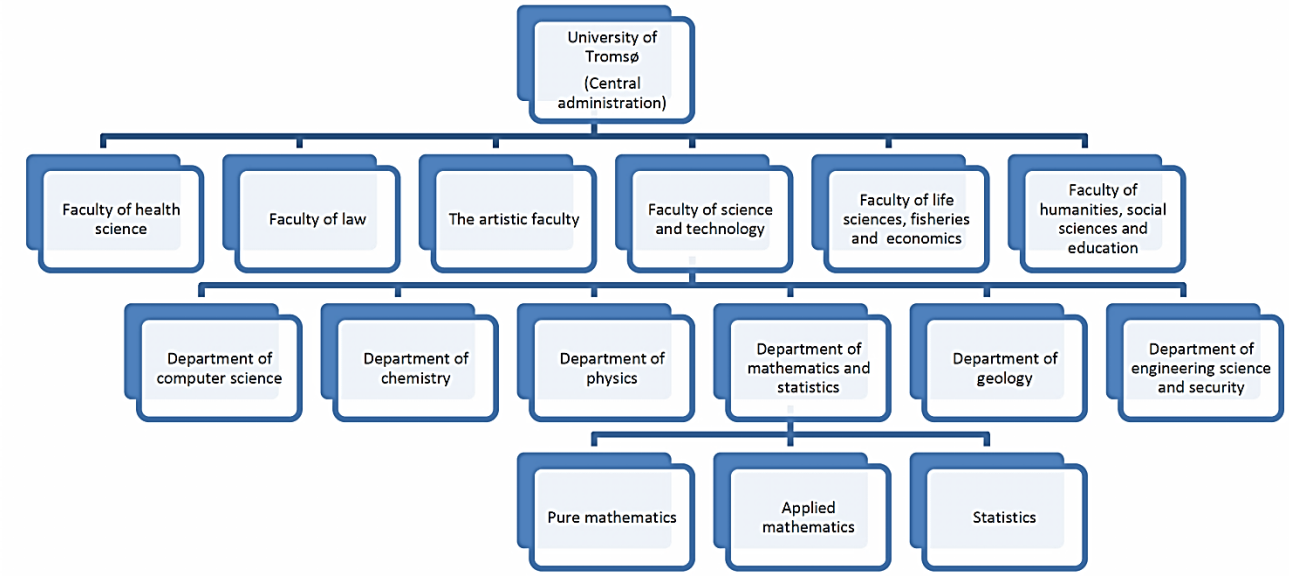
Date of completion: 05.05.2011

University of Tromsø

Faculty of Science and Technology

Department of Mathematics and Statistics

Organisation Chart



Personnel

	Pure mathematics		Applied mathematics		Statistics		Total	
Positions	**Univ**	**Extern**	**Univ**	**Extern**	**Univ**	**Extern**	**Univ**	**Extern**
Researcher						1		1
Professor	5		2		1		8	
Associate professor	3		1		3		7	
Professor II						0.2		0.2
Associate professor II								
Post-doctoral research fellow	2			1	1		3	1
Doctoral student(s)	2		4		3	5	9	5
Technical/adm. position*							0.5	
Total	**12**		**7**	**1**	**8**	**6.2**	**27.5**	**7.2**

”Univ” = persons financed by the university, ”Extern” = persons financed by external research grants

* Technical/adm.position: Positions supporting research.

Graduates

	2008	2009	2010	Total
Dr. ing./Dr. scient./Ph.D. graduated				
Pure mathematics	1			1
Applied mathematics				
Statistics	1			1
M.Sc.graduated				
Pure mathematics	2	2	4	8
Applied mathematics	3			3
Statistics	1	1	1	3
Total	**8**	**3**	**5**	**16**

R&D expenditure by main source of funding (1000 NOK)

Type of expenditure	2008	2009	2010
University funding*, salaries	12 200	14 180	13 920
University funding, other costs	645	306	265
University funding, instruments and equipment			
University funding, total	**12 845**	**14 486**	**14 185**
The Research Council, grants	1 376	2 863	2 999
Other national grants (public or private):	450		
International grants(incl. EU)			
External funding, total	**1 826**	**2 863**	**2 999**
Total expenditures	**14 671**	**17 349**	**17 184**
External funding as % of total expenditures	12	17	17

* University funding: This refers to the institution's input of own resources such as salaries for scientific and technical personnel (including social costs), other costs, and infrastructure.

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University of Life Sciences

Department of Mathematical Sciences and Technology

Research Group in Applied Mathematics/Computational Biology

Personnel

	Research group/unit	
Positions	**Univ**	**Extern**
Researcher		
Professor	3	
Associate professor	1	
Professor II		
Associate professor II		
Post-doctoral research fellow		
Doctoral student(s)		4
Technical/adm. position*		
Total	**4**	**4**

"Univ" = persons financed by the university"Extern" = persons financed by external research grants

* Technical/adm.position: Positions supporting research

Graduates

	2008	2009	2010	Total
Dr. ing./Dr. scient./Ph.D. graduated	2	1	3	6
M.Sc.graduated	1	3	1	5
Total	3	4	4	11

R&D expenditure by main source of funding (1000 NOK)

Type of expenditure	2008	2009	2010
University funding*, salaries	2 611	2 259	2 646
University funding, other costs	548	417	540
University funding, instruments and equipment	90	90	90
University funding, total	**3 249**	**2 766**	**3 276**
The Research Council, grants			
Other national grants (public or private): NUFU	796	804	666
International grants(incl. EU)			
External funding, total	**796**	**804**	**666**
Total expenditures	**4 045**	**3 570**	**3 942**
External funding as % of total expenditures	19.7	22.5	16.9

* University funding: This refers to the institution's input of own resources such as salaries for scientific and technical personnel (including social costs), other costs, and infrastructure.

Date of form completion: 05.05.2011

Norwegian University of Life Sciences

Department of Chemistry, Biotechnology and Food Science
Research group in Biostatistics

Personnel

	Research group/unit	
Positions	**Univ**	**Extern**
Researcher		
Professor		
Associate professor	4	
Professor II		
Associate professor II		
Post-doctoral research fellow	1	
Doctoral student(s)	3	3
Technical/adm. position*		
Total	**8**	**3**

"Univ" = persons financed by the university"Extern" = persons financed by external research grants

* Technical/adm.position: Positions supporting research

Graduates

	2008	2009	2010	Total
Dr. ing./Dr. scient./Ph.D. graduated		1	1	2
M.Sc.graduated	2	3	2	7
Total	2	4	3	9

R&D expenditure by main source of funding (1000 NOK)

Type of expenditure	2008	2009	2010
University funding*, salaries	2 929	2 493	2 623
University funding, other costs	14	481	439
University funding, instruments and equipment	35	94	54
University funding, total	**3 104**	**3 068**	**3 116**
The Research Council, grants	366	10	132
Other national grants (public or private):	2 105		
International grants(incl. EU)			
External funding, total	**2 471**	**10**	**131**
Total expenditures	**5 574**	**3 078**	**3 248**
External funding as % of total expenditures	44.3	0.3	3.8

University funding: This refers to the institutions input of own resources such as salaries for scientific and technical personnel (including social costs), other costs, and infrastructure

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