MATH 2016

A strategy for the development of Department of Mathematical Sciences at the University of Copenhagen
<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Foreword</td>
<td>3</td>
</tr>
<tr>
<td>Values and challenges</td>
<td>4</td>
</tr>
<tr>
<td>Organizational development of MATH</td>
<td>6</td>
</tr>
<tr>
<td>Education</td>
<td>9</td>
</tr>
<tr>
<td>Outstanding research</td>
<td>11</td>
</tr>
<tr>
<td>Strengthened external collaboration</td>
<td>13</td>
</tr>
<tr>
<td>Infrastructure at MATH</td>
<td>14</td>
</tr>
<tr>
<td>Dialogue and communication</td>
<td>16</td>
</tr>
</tbody>
</table>
FOREWORD AND BACKGROUND

With more than 4000 years of history, mathematics is considered the world’s oldest science. Mathematics was taught as a sub-branch of philosophy at University of Copenhagen at the creation of the University in 1479, and became a separate professorship after the re-establishment after the Reformation in 1539.

The Department of Mathematical Sciences as it is today is the result of the development beginning with the creation of the Mathematical Laboratory in 1907. In 1934 the laboratory was upgraded to a Mathematical Department. The mathematical disciplines represented within the Department in its current form began to take shape as a result of the institutional mergers, when the Mathematical Department merged with the Department of Mathematical Statistics in 1997, and with the Laboratory of Actuarial Mathematics in 2000. The Laboratory of Actuarial Mathematics had been established in 1917, and the Department of Mathematical Statistics in 1961. In 2012, the Department was further enriched with part of the staff from statistics and mathematics previously associated to the former Faculty of Life Sciences. In the last decade, the Department has seen a rapid growth, both in education and research:

As regards education, the number of students in the three undergraduate programs has virtually exploded over the last decade. In 2012 there was a total admission of 284, compared to 119 in 2002. This should also be seen in the light of an even higher increase in the number of applicants, resulting in unprecedented entry requirements for all three undergraduate programs.

On the research front, MATH has managed to win and receive multiple large and prestigious grants and prices - including 5 ERC grants, a Center of Excellence, grants from the KU Excellence Programme, the Danish National Advanced Technology Foundation and the KU2016 programme, the Ostrowski Prize 2012, and the Latsis Prize in 2013. This run of successes is partly due to a targeted headhunting of researchers of international excellence, and has resulted in a doubling of the number of employees.

The strategy will be followed by a plan of action, pinpointing the exact initiatives that will transform the strategy into reality. This will include initiatives already launched in 2013 as well as initiatives scheduled until 2016.

The strategy should not and will not stand alone but should be seen in the context of the strategies for the entire University of Copenhagen and the Faculty of Science. We hope the strategy sheds light on the path ahead and serves as a framework for discussions about the ongoing development here at MATH. Enjoy reading!

MATH Management Team

Head of Department
Erik Kjær Pedersen

Deputy Head of Education
Jesper Lützen

Deputy Head of Research
Michael Sørensen

Head of Administration
Katja Thorseth
VALUES AND CHALLENGES

VALUES
At MATH the intention is that all decisions should be based on a set of core values which are described as follows:

The Department values research at a high level and within a wide range of mathematical disciplines e.g. geometry, algebra, calculus, statistics, probability, actuarial mathematics, finance, operations research, and more.

The Department values that the employees working in this diverse range of research areas experience MATH as a united institution where mathematics is the foundation and common denominator.

Regarding teaching at MATH, there is emphasis on education that gives theoretical insight, provide high quality mathematics and statistics teaching all over SCIENCE, and contribute significantly to the general level of mathematical skills in society.

Last but not least, the Department never ceases to give high priority to financial sustainability both on the short and on the long run when making decisions.

CHALLENGES AHEAD
We believe that values show their true worth when they are challenged. Of course this is also the case at MATH, where the values are especially challenged within the following areas:

The gravitational pull of excellent people
Recruitment of outstanding researchers is clearly easier in research areas where MATH already employs prime researchers. Focusing on the broad range of the disciplines the Department provides there will be challenges ahead, in relation to recruitment in areas where the department has few or no employees.

More education - in Danish!
MATH has a large portfolio of teaching responsibilities at the undergraduate level, not limited to the many courses for our own
We value that the employees experience MATH as a united institution

undergraduate students but also with the high-quality courses for a range of other programs at the Faculty of Science.

These courses are often taught in Danish, and with an increasing degree of internationalization at the Department the load of teaching for the Danish-speaking employees has been significantly increased at the undergraduate level.

Lack of high school teachers in mathematics
There is a great shortage of high school teachers in mathematics. This is partly due to a natural retirement among mathematics teachers, and partly due to the fact that our graduates in mathematics are much sought after and better paid in the private sector.

This means that students down to the undergraduate level are offered teaching jobs at high schools. This trend is expected to have a negative impact on both the students’ time of completion and the general teaching of mathematics in high schools.

Service courses with professional insight
MATH provides many mathematics and statistics courses for students in other fields of study, for example: physics, chemistry, computer science, biology, and many more.

The mathematical expertise we possess at MATH makes us the obvious providers of these courses. We are continuously aware that this requires not only mathematical expertise, but also an understanding of the specific field of study. After the faculty merger and a targeted recruitment there is currently an adequate number of staff who possess these interdisciplinary skills.

It is, however, a continuous challenge to ensure that we also prospectively recruit academic staff who have the right multidisciplinary profiles so that we can continue to provide courses which in addition to being mathematically and statistically sub

stantiated also motivates and inspire students from other fields of study.

Rampant Growth
The Department of Mathematical Sciences has gone from being a small organization with a low change in staff composition, to a dynamic organization with a large flux of postdocs, PhDs, and guests. As a result of this process the challenge arose that a feeling of unity and organizational belonging can no longer be based on a personal knowledge of all the people associated with the department.

In addition, the increasing employment and student admission enhances pressure on facilities, such as offices, classrooms and meeting rooms, as well as on the administration in the form of inquiries, workload and further need and demand for standardization of procedures.

Low elasticity in costs
A significant strengthening of the Department’s research, will usually be grounded in the recruitment of international top-researchers, who on one hand are more easily recruited for permanent positions but then at the same time constitute a permanent expense. Popularly speaking, good mathematical investments are expensive in the long run. With our clear value of financial accountability, this implies a limitation to the growth of the Department, despite a positive economic situation.
With the tremendous growth in the number of staff and students at MATH there is a greater need for the formalization of the involvement of organs at the Department e.g. committees, student political councils, boards, and associations.

There are great resources and knowledge in student-run organizations, which are currently not sufficiently exploited. It is the clear objective of the department to use the knowledge and resources to create greater awareness and ownership among students, in relation to the Department’s research, teaching and organization.

There is a need for further clarification of the division of labor between committees, councils and boards, with the purpose to ensure effective decision-making and participation. In addition, an effort is needed in order to make the Department Council a constructive and useful body.
At the administrative level, work is in progress towards establishing a stable and future-proof administration, focusing on even better problem solving and a good working environment.

At MATH we want to give all students, staff, and guests a good, personal service. This means, among other things, a clear division of labor in the administration as well as a dedicated one point of entry to the administration for guests and new employees, who cannot be expected to possess a full understanding of the Department.

With the creation of four new sections, the organizational division has become less focused on research groups. Despite this, it is still desired to maintain the identity of the different research groups at MATH.

We want to give all students, staff, and guests a good personal service.
Another way to increase the number of graduated is a greater focus on retention of student rather than increased enrollment.

Graduates from all four of our programs are in high demand and unemployment has remained low, despite the financial crisis that has otherwise affected job opportunities in many fields. At MATH we will continue to be an educational institution that can deliver coveted candidates, for both the private and public sectors. There is a greater demand for theoretical statisticians and competent high school teachers in mathematics than the Department is able to produce.

By highlighting the high school teacher profession as a career path and by offering teaching focused on high school didactics the Department will further support more students to receive a targeted set of skills that makes them capable of providing prime teaching within the fields of mathematics.

In addition, the department will make targeted recruitment among the students of the humanities in order to increase the number of graduates with a mathematical background. This is done with special focus on presenting mathematics as an additional attractive option while giving a realistic picture of the skills required for completion of a minor degree in mathematics.

Another way to increase the number of graduated mathematicians and theoretical statisticians is an increased focus on retention of students rather than to raise enrollment.

There are also considerations on how it might be possible, through further education, to enhance the skills of high school teachers and engineers. This is an area that can and will be explored further.
\[ \psi \in L^2(\mathbb{R}^n) \]

\[ \phi, \psi \in L^2(\mathbb{R}^n) \]

\[ f \mapsto \|f\|_{L^p(\mathbb{R}^n)} \]

\[ \|f\|_{L^p(\mathbb{R}^n)} = \left( \int_{\mathbb{R}^n} |f(x)|^p \, dx \right)^{1/p} \]

\[ S_{\mathcal{F}} = \cdots \]

\[ \cdots \leq C \]
MATH will continue to maintain the large number of outstanding visiting researchers which is considered one of the prime pillars for mathematical research at a high international level.

The handling of the guests will remain a priority in the administration and a continued effort will be made towards improving the experience for both hosts and guests visiting the Department.

Multidisciplinary collaborations with researchers from other disciplines is also an area in which the department can grow. A challenge here is to maintain a theoretical mathematical focus which is the prime trademark of the Department.

The fledgling Laboratory of Applied Statistics provides consulting for researchers and students from all over the Faculty of SCIENCE concerning statistical problems and experimental designs. The Laboratory is also involved in research collaborations regarding projects with substantial statistical content. This is expected to improve both the quality of research at the Faculty in general, and the research in theoretical statistics at the Department. The quality of the Laboratory is maintained and developed by the Department’s focus on hiring statisticians at a first class research level.

In the near future there will be multiple upgrades in many areas, for example algebra, mathematical biology, mathematical physics, statistics and probability theory.

The Department must also continue to explore hitherto unused sources of funding. This has previously been done with success, for example the Willum Foundation and the Danish National Advanced Technology Foundation.
STRENGTHENED EXTERNAL COLLABORATION

The University and thus MATH, is more than ever aware of the need for interaction between academia and the rest of society. This will be enhanced through further concrete steps:

- The development of high school visits, including engagement in collaborations with selected high schools with the aim to participate in the development of teaching at high schools.
- Participation in the Culture Night in Copenhagen.
- Continuation of the highly successful use of the Industrial PhD Programme in collaboration with our business partners.
- An increased focus on making research applications in collaboration with business partners.
- Target specific sections of the Department’s website towards business collaborations. This includes publicly announcing cooperation contracts with the purpose of partly inspiring new collaboration and partly showing that academic freedom prevails in such projects.

A role model for an increased interaction between MATH and the private sector is at present the ACTULUS project. The ACTULUS project is a shining example of a mathematical project in collaboration with the private sector which accomplishes a combination of scientific excellence with the latest IT technologies, and results in both an academic and a commercial success.

MATH is aware of the need for interaction between academia and the rest of society.
INFRASTRUCTURE AT MATH

In the future, we have several logistic challenges. One of the most significant is that as a result of our success the number of staff, students and courses is steadily increasing, while the same is currently not the case with the number of rooms and square meters which is in some cases in an outright decline.

During the coming period, there will be a continuous update of the IT infrastructure at MATH. This goes for the IT used for research as well as that used for supporting the administration.

At MATH many current individual solutions are composed of various platforms. Efforts should be made to use, to the maximum extent possible, the standard IT infrastructure which is supported by SCIENCE or KU, while at the same time preserving the essential functionality of the solutions.

Furthermore, extra attention must be given to the handling of the growing data volumes, especially in experimental mathematics and statistics. This challenge is shared with other Departments and should hence be solved in collaboration.

In mathematical sciences the – maybe – most important tool for conducting outstanding research is knowledge sharing. This is traditionally done by the use of black boards and chalk, but is nowadays also conducted via white boards and projectors. We aim to keep a Department that is sufficiently equipped with these means of research as well as exploring new means and remedies e.g. pen casting, cleaners for chalkboard erasers, and more.
DIALOGUE AND COMMUNICATION
– INTERNAL AND EXTERNAL

Dialogue and communication at MATH, should contribute considerably to the individual employee’s knowledge of the research, staff and administration at MATH. It requires quite an effort since the department until recently has been an institution where everyone knew everyone and where the flux of employees has been low.

The main sections of priority are as follows:

DANISH COURSES
To ensure better dialogue and a greater affinity for foreign employees, all new international employees are offered Danish courses according to their level. It is believed that an increased understanding of Danish culture and language promotes the integration into social environments at the Department. Furthermore it ensures a certain attachment to Denmark, which may be strategic for a potential recruitment purpose and for creating a network of ambassadors for the Department around the world.

Permanent employees are expected to acquire the skills to teach in Danish at some point.

INTERNAL COMMUNICATION
In order to ensure that all employees at MATH are up to date on the
EXTERNAL COMMUNICATION
Despite a strong urge to disseminate the successes of MATH, it is not very often done. This is mainly due to the exclusionary nature of mathematical research, which makes it understandable to only a small audience. Therefore external communication from MATH should focus on promoting a positive attitude towards mathematics as a field, with emphasis on mathematics as a fascinating and creative human activity.

IN VolV EMENT
Involvement at MATH is open to anyone who is interested. This applies for the official channels, e.g. Department Council, as well as for the informal channels, e.g. knocking on the door of the management.

An annual two-day meeting for permanent employees ensures that there is a proper framework for discussing the principles for teaching, research, and development at MATH. Furthermore the meeting serves as a platform for the informal exchange of ideas.
Thank you for reading the MATH 2016 Strategy!

Published by
Institut for Matematiske Fag
Universitetsparken 5, 2100 København Ø
Tlf. +45 35 32 06 75
imf@math.ku.dk
www.math.ku.dk

Grafisk design og produktion
Katja Thorseth & Jim Høyer