Evaluation of research in engineering science in Norway

Construction Engineering, Production and Operation

Panel 1

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TO THE RESEARCH COUNCIL OF NORWAY

The members of Panel 1: Construction engineering, Production and Operation in the evaluation of Norwegian research in engineering science in Norwegian Universities and Colleges herewith submit the following report. The views presented in this report are expressed in consensus among the members in the Panel. The members are further in collective agreement with the assessment, recommendations and conclusions presented.

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Executive Summary

The Research Council of Norway (RCN) appointed three expert panels to evaluate research in engineering science in Norway. This report presents the conclusions of Panel 1: Construction engineering, Production and Operation. (Panel 2 dealt with Structures, Materials, Product development and Design, and Panel 3 with Energy and Process Technology.)

The subdivision of the engineering science in three groups, for evaluation purposes, looked somewhat arbitrary so that, during the evaluation, panel 1 frequently felt that its view on a particular research group or department was incomplete. It is laudable that RCN decided to make a Joint Committee Report to synthesize the views of the three panels. On the other hand, the separation of ICT and Electrical engineering in a new faculty, as if they did not belong to engineering science, may not promote the synergy with the more traditional engineering sciences that represent the bulk of the disciplines in the Faculty of Engineering Science and Technology.

The panel carried out its evaluation less than two years after a major reorganization of NTNU and its faculties had taken place. The waves have not dampened yet and according to the Chinese saying: 'one cannot mirror oneself in streaming water'. The water is not quiet enough to allow the panel to make a sharp up-to-date picture of the state-of-research of the visited departments.

At the Norwegian University of Science and Technology (NTNU) and at Faculty levels, strategic plans have been set up, which were explained to the panel. It was a general feeling among the panel members; however, that those plans have in general not reached the department and research group levels yet. Moreover, the re-clustering of faculties and departments into larger units does not seem to have stimulated the desired collaboration spirit between member groups and individuals. The panel learned that too many one-professor enterprises still exist next to each other.

These somewhat critical remarks in regard to higher organisational levels do not prevent the panel to state that in many –traditional- areas where Norway has excelled in the past, it continues to do so in several departments. Several imminent dangers might jeopardise this position and must be considered carefully:

- The 'age quake' among the academic staff is a curse, as it threatens to leave strategic academic positions, requiring difficult-to-find expertise, unoccupied in the future, but also a potential blessing, as it allows to embark on new disciplines,
- The disappearance of the category of teaching assistants loads the academic staff with an exaggerated teaching burden, to the detriment of research output,
- The removal of the ICT, electrical engineering and management disciplines from the Faculty of Engineering Science and Technology may hamper the synergy required in contemporary multi-disciplinary research.
- The publication culture in most research groups is not adapted to the requirements of the modern research establishment. A shift should take place from local (national) and conference publications towards papers in international, peer-reviewed journals, considered relevant by the university peers.

- The PhD culture is not well established yet at NTNU. A Graduate School and Research Schools (at NTNU, national or even Nordic level) might be considered.
- Valorisation of research into spin-off companies is limited at NTNU. More aggressive stimulation policies, through courses and/or an industrial liaison office, are required.
- A special effort should be devoted to allow the rapid development of the small institutions (Narvik University College and Stavanger University College) to swiftly achieve a competitive level, to allow them to fully assume the role they are supposed to play in their regions.

With this report, we hope to have fulfilled our mission and to have done justice to the mandate under which we carried out this evaluation. We sincerely hope also that the report, its conclusions and its recommendation be a valuable guide to RCN in defining their future policies.

Introduction

The Research Council of Norway has decided to evaluate research in engineering science in Norway. Three expert panels have been set up to cover the entire field of engineering science. This report pertains to the assessment activities of Panel 1: Construction Engineering, Production and Operation. (Panel 2 dealt with Structures, Materials, Product Development and Design, and Panel 3 with Energy and Process Technology.)

This report contains the evaluation of 14 departments/research groups at Norwegian University of Science and Technology (NTNU), 7 research groups at the Agricultural University of Norway (AUN), 3 research groups at Narvik University College (NUC) and 2 groups at Stavanger University College (SUC).

According to the mandate (see Appendix 1), the report of this panel will form the basis for the future strategy of the Research Council, both in the short and the long run.

It is fair to state that the scientific and technologic areas covered by this report belong to the so-called 'traditional' sectors, in contrast to the 'newer' sectors like ICT, microelectronics and biotechnology. It must be realised however that these traditional sectors still represent the technologies contributing the major share of the economies of the industrialised world in general and of Norway in particular, and will continue to do so for quite some time. Therefore, Norway should safeguard the prominent position it has in some of those sectors, by offering high-level education and by trying to be at the vanguard of the scientific developments in those areas. It is important to realise that ICT and microelectronics have fundamental impacts also on those traditional sectors and therefore have to be integrated into the curricula and research programmes. The panel has paid particular attention to the manner in which the different research programmes have made use of the opportunities offered by the ICT and microelectronics revolutions. It has found that this integration was often absent or underdeveloped in the departments evaluated.

The manufacturing and agricultural sectors, being major generators of wealth, should be developed in order to compete with low-wage countries. Creative product development and flexible production of complex products should be the answer and here again, top-class research should provide answers to these difficult challenges. Many other challenges lie ahead, such as global warming and its consequences, energy production, the food chain, the human habitat, etc., which can and should be tackled by the research groups assessed in this report. The importance of these issues, for Norway and the world, warrants a high-level research effort in those areas.

This report outlines Panel 1's perception of the level and relevance of the research in the areas it investigated and how the departments and research groups are coping with the problems raised nationally as well as internationally.

According to the mandate, outlined in Appendix 1, there are two main tasks:

- Assess critically strengths and weaknesses, international level, areas to be strengthened, … of Norwegian research in engineering science
- Function as a platform for future development of engineering science

The evaluation is designed to reinforce the role of the Research Council as an advisor to the Norwegian Government.

General Observations

Some observations with respect to the organisation of the evaluation

The self evaluation reports prepared by the departments have been a valuable guideline before and during the evaluation. Adherence to a stricter format of the reports would have saved much time of the Panel. For example, the research output (publications of different categories) of the groups could have been presented in a more systematic and synthetic way.

The site visits proved to be a necessary phase in the evaluation. In several cases it gave the evaluation panel a much better view on the performance of the visited group and thus influenced the rating positively.

The recent restructuring of faculties and departments at NTNU had a somewhat confusing effect on the self evaluation reports. As a consequence it was sometimes difficult to correctly assess the research performance of a group.

Rating of small research groups

Panel 1 found it difficult to assess the research of the small groups at the smaller institutes (Narvik University College and Stavanger University College) – who were obviously suffering from their limited resources – with the same criteria as used for the established groups at NTNU and the Agricultural University of Norway (AUN). The panel therefore chose to give only one general rating for each of these research groups instead of three as in the case of the groups at NTNU and AUN.

SINTEF and NTNU

The panel realises that the special situation of a major research institute living together, on the same campuses, with a major university of technology, influences the way in which the research groups at NTNU perform. Hence, this necessarily has influenced the assessments of this panel.

Publication culture

Most of the disciplines assessed by this panel belong to the so-called 'traditional' engineering disciplines, with close historical links to the 'market' (industry, public services, …). Publication on an international scale was and still is not customary in those disciplines and this is reflected in the publication scores of most of the evaluated groups. This has been acknowledged by the panel, but it has not prevented the same panel to recommend changes and adaptation of the requirements that characterise a modern research establishment.

PhD culture

A similar remark as in the previous paragraph can be made regarding the doctoral studies. The relatively low interest from the 'market' (industry, public sector) in doctoral graduates has meant that a more developed PhD tradition is only now emerging at NTNU. See section 5 for more details.

Academic workloads

Almost all research groups have pointed out that the high teaching workload of the academic staff made it difficult to do more and better research. The fact that teaching assistants seem to become an extinct species and that doctoral students are not supposed to assist in teaching assignments means that the academic staff has to do much of the lab and exercise work themselves.

The 'age quake' among the academic staff

The majority of the evaluated research groups are confronted with the issue of an aging academic staff. This is in many 'traditional' departments a source of unique expertise that will be difficult, if not impossible, to replace. On the other hand, the need for replacement of a large proportion of the staff in the near future, together with the recent reorganisations, provide unique opportunities to embark on new strategic disciplines and closer collaboration in multidisciplinary teams.

Reorganisation and efficiency

Integration and consolidation seem still to be incomplete in most of the new departments. Even after the reorganisation there remain many small groups working independently.

Most reorganisations in the departments assessed by Panel 1 took place some two years ago. If one of the aims of that reorganisation was to increase collaboration, then it must be concluded that it has not in all cases succeeded so far. It is perhaps an illusion to hope that reorganising a structure automatically fosters collaboration. Moreover, the logic behind some reorganisations was not clear to this panel.

Separation of ICT

The separation of ICT and electrical engineering from the Faculty of Engineering Science and Technology may turn counter-productive in the future. In the world, there is indeed an increasing tendency toward multi-disciplinary approaches in design and manufacture of complex engineering systems. Concurrent and simultaneous engineering are the only ways to go when one desires to achieve optimal systems. Care will have to be taken to ensure and ascertain that faculty limits are no barriers that hamper collaboration. Moreover, the separation of Technology Management from the Faculty of Engineering Science and Technology is questionable.

NTNU's strategic plan

The strategic plan as formulated by NTNU and by the faculty looks somewhat vague and is not always reflected in the research programmes (see further). It is unclear how a uniform and systematic implementation of the plan will be achieved. There was no substantial evidence from the dean that the departments have understood, or shared, the vision concocted at faculty level. A strategic plan must be translated into lower-level goals in order to become effective and control points must be built-in into the process.

Spin-off policy

While it is explicitly stated as one of the strategic goals of NTNU to create new industrial activity, (very) few new spin-off companies seem to emerge out of the research activity of the Faculty. If this impression is right, it is worrying. Different actions should be taken at NTNU level to stimulate entrepreneurship among the students and the researchers, by for instance organising discussions or even courses on this crucial topic and by rewarding success.

Recruitment

Effective recruitment processes on all levels – involving student, researchers, teachers, technical and administrative staff – are crucial in securing long-term development of academic environments as well as strategic planning and policies stimulating mobility and international collaboration and exchange.

General recommendations

The recommendations presented in the following sections build upon, and have been distilled from the general observations that the panel made. They enjoy, therefore, a certain universality that is applicable to Faculty and University levels. Specific department and group recommendations are given at the appropriate sections in the main body of the report.

(Re)Organisation of research groups

It is recommended that the reorganisation into fewer departments and restructuring into new combinations be critically assessed in the near future. It is the conviction of this panel that some new combinations are counterproductive. The existing strategic plans, at all levels (NTNU, Faculty, …), if they are to be taken seriously, have to serve as touchstones for the assessment.

Some groups are too small to be viable in the long run and should be combined/integrated into larger units, possibly across institutes' boundaries. Such (re)considerations would have to take into account the age structure of the present staff and the opportunities created by the replacement needs.

Publication strategy

The publication output of most research groups should be improved. The emphasis is still too much on internal reports, national publications and on conference proceedings. Publication in well-selected international journals with high impact factor will have a beneficial influence on the fundamental part of the research activity of the groups. In order to be effective, such a requirement must however be accompanied by a clear policy and incentive structure at NTNU and the Research Council of Norway (RCN) levels.

Care should be taken to assure that the adopted publication policy is relevant for the discipline. A mechanism could be to agree on a set of high-level journals per discipline that are considered internationally by the peers as important for the discipline. Blindly following the Science Citation Index could be counter-productive and may undermine the attempts to build up a relevant publication culture.

PhD education

It is recommended to establish a new tradition of PhD education at NTNU. This can be achieved by organising a uniform framework at NTNU level. Research schools, where high-level graduate courses are offered, have proven successful in other European countries (e.g. the Netherlands and Denmark). Nordic research schools have been effective in other disciplines and may prove to be one effective way to proceed. See section 5 for detailed recommendations.

Relation NTNU/SINTEF

The presence of SINTEF is a potential blessing and curse simultaneously. The infrastructure (buildings and equipment) they bring with them on campus significantly extends and enhances the capabilities of the departments. On the other hand the panel consistently heard the complaints from the departments about SINTEF establishing or even imposing their research programmes.

There is a fundamental contradiction between the assumed long-term research vision of the faculty and the direct application-oriented strategy of SINTEF. The role of SITEF should be the shorter-term developer role while the scientific faculties should be responsible for the longer-term basic as well as applied research.

Ways should be found to safeguard the independence of the NTNU research groups in defining their research programmes and in defining publication priorities. This independence must allow the NTNU groups to more strongly emphasise their fundamental research component.

Reducing the academic work load

The problem of overworked academic staff should be given serious attention. If budgets do not allow hiring more academic staff, other (creative) measures could be considered, such as, re-installation of the teaching-assistant category; reducing the number of (elective) courses offered; reducing the number of "contact hours"; etc.

Internal evaluation measures

It is recommended that a comprehensive internal research evaluation system be developed at department/research group level. Such a system could serve as an allocation mechanism for (the research) part of the NTNU funding (e.g. 30%). (The other part, 70%, would be allocated to teaching.) Such a system should encompass a sufficiently broad spectrum of evaluation criteria: not only publications (of different categories), but also (number of) PhDs, projects, scientific service to society, etc.

Research at NUC and SUC

It is recommended that RCN provide special incentives to develop research in niche areas to NUC and SUC to allow them to quickly reach a critical size so that they can prove their value on a competitive basis.

It is further recommended that funds be allocated for appointing high-level visiting professors for short periods (2-3 years) with the aim to speed up introduction of new research areas.

Spin-off policy

It is recommended that more explicit actions be taken at NTNU-level to stimulate entrepreneurship among the researchers and the students.

Evaluation of departments and research groups

The following sections sum up the evaluations of the departments and research groups, based on the self-evaluation reports and the hearings and site visits carried out in the period 8—12 March, 2004. For every department, general considerations on organisation, management, strategic plans, recruitment and mobility are given, and where appropriate a department recommendation.

For each research group, an evaluation is made based on three criteria:

- Scientific quality and productivity
- Relevance and impact
- Strategy, organisation and research cooperation

A five-point scale is used to evaluate each of these three categories for the research groups. The grades given are:

- 5 - Excellent
- 4 - Very good
- 3 - Good
- 2 - Fair
- 1 - Weak

This is followed by a *group recommendation*.

The grade *excellent* indicates work that is comparable to the best international research in the field. A few groups reach that level. The average rating over all the groups is close to *very good*, which indicates an overall healthy situation.

1. Norwegian University of Science and Technology

The Norwegian University of Science and Technology (NTNU) has 7 faculties and 53 departments. The evaluation carried out by Panel 1 covered 4 departments of the Faculty of Engineering Science and Technology (13 research groups) and 1 research group in the Faculty for Architecture and Fine Arts.

Of NTNU's 20,000 students, 7,500 are in engineering programmes. Annually, 2,250 bachelor and master degrees are awarded and, in 2002-2003, 208 doctorates were awarded.

With a staff of 3,300, a budget of NOK 2.8 billion and some 500,000 square metres of premises, NTNU is one of the major technical universities in Europe.

In this section, important data and considerations relevant to this evaluation report are discussed.

NTNU's main objectives are:

- To be internationally recognised among the leaders in research and education in technology and natural sciences;
- To achieve high quality in all activities of a wide range of disciplines;
- To foster innovation by stimulating cross-disciplinary interaction and cooperation;
- To play a critical and constructive social role;
- To take active steps towards a more balanced integration of female expertise in scientific and academic developments.

In the period 1997-2001 the study programme in engineering was extended from 4.5 to 5 years. In 2001 the number of faculties was reduced from 13 to 7, and in 2002 the number of departments was reduced from 78 to 54. The consequence of this reorganisation hampered, in some cases, the coherence and transparency of the self evaluation reports.

The engineering sciences, subject of this evaluation round by three Panels, are largely located in the Faculty of Engineering Science and Technology, with the exception of:

- Architectural Design, History and Technology and Building Technology within the Faculty of Architecture and Fine Arts,
- Electrical Power Engineering within the Faculty of Information Technology, Mathematics and Electrical Engineering, and
- Materials Technology, Physical metallurgy, Extractive metallurgy within the Faculty of Natural Sciences and Technology.

In 1999, NTNU formulated 5 strategic research areas reflecting national needs and industrial strengths:

- Energy and the environment
- Medical technology
- Materials science
- Marine and maritime research
- Information and communication technology (ICT)

Of the three National Centres of Excellence hosted by NTNU, one (Centre for Ships and Ocean) is hosted by the Faculty of Engineering Science and Technology, Department of Marine Technology, and another (Norwegian Geotechnical Institute) has three partner departments (Civil and Transport Engineering, Structural Mechanics, Geology and Mineral Resources Engineering) in the Faculty of Engineering Science and Technology.

An important asset for NTNU is the presence on its campuses of SINTEF. SINTEF is one of Europe's largest independent research organisations, with a staff of 1,700 and a turnover of NOK 1.6 billion (EUR 200 million). Its main focus is on contract research in technology, natural and social sciences. Its presence enhances and complements the infrastructure of NTNU considerably. On the other hand, by its size, the impact on the research programmes of the departments is highly significant and the independence of the associated departments often appears compromised.

A general problem that NTNU is coping with presently is its aging academic staff and the difficulties of replacing them with comparable successors. Special attention should be paid to this problem, particularly in the more traditional areas of engineering where Norway still plays a leading role but where it is increasingly difficult to find young specialists in those areas.

Faculty of Engineering Science and Technology

The Faculty emerged in 2001 from four previous faculties (Mechanical Engineering, Civil and Environmental Engineering, Marine Technology, Geology and Petroleum Technology) totalling 20 departments. It is now the dominant faculty of NTNU. Those 20 previous departments are now consolidated into 10 new departments. Consolidation and strategic developments were a considerable focus of effort during the last two years. It would seem that after two years, this consolidation has been only partially implemented.

The faculty has developed a research strategy entitled: 'Technology for Sustainability and Innovation'. Their visions to accomplish this general strategy are:

- Creating added value through knowledge
- Contributing to a sustainable society.

An important goal the faculty has set for itself is to create new industrial activity. It was the impression of this panel that the creation of spin-off companies is under par compared to other major technical universities in Europe.

Of the five strategic research areas at institutional level (see above), three are of particular relevance for the faculty: Energy and the environment, Materials science, Marine and maritime research. Additionally, the faculty has defined four other areas of priority:

- The energy sector
    - How to make sustainable energy technology a national area of strength?
    - How to contribute to better utilisation of Norway's petroleum resources?

- The civil engineering sector
    - How to maintain and develop Norway's infrastructure to satisfy the needs of society?
- The fishery and aquaculture sector
    - How to create added value from fishery and aquaculture?
- Industrial innovation
    - What goods and services can be produced profitably in Norway in the future?
    - How to improve productivity of the industry in Norway?
    - To develop applications of advanced new materials (composites, nanotechnology).

This report covers research activities in (parts of) the following departments:

- Department of Civil and Transport Engineering (6 research groups)
- Department of Hydraulic and Environmental Engineering (3 research groups)
- Department of Marine Technology (1 research group)
- Department of Production and Quality Engineering (3 research groups)

1.1 Department of Production and Quality Engineering

The Department of Production and Quality Engineering consists of three research groups, covering three main areas: Manufacturing Systems, Operations Management, and Reliability, Availability, Maintainability and Safety. The total staff amounts to 58 persons, of which the group Manufacturing Systems has 4 permanent academic staff, 2 post docs, 1 teaching assistant and 10 PhD students. For group Operations Management these figures are: 5.2/1/1/12 and for Reliability, Availability, Maintainability and Safety, they are: 2.4/1.2/0/4.

All staff members report directly to the Head of the Department, who co-ordinates operation. A management group meets 2 to 4 times a year to deal with strategic matters. Regular co-ordination and operational meetings are held. There are no formal research groups; the three mentioned groups are working rather informally together.

The head of department is very much concerned about the declining interest in the field of manufacturing, as recently demonstrated both by SINTEF and the university. He feels that the department is in search of a new mission and he feels uncertain about its future.

Many research problems are closely related to management or industrial engineering. The fact that these subjects are dealt with in different departments does not simplify things. The enrolment of master students in manufacturing is declining. Although there are many contacts and projects with industry, the 'profile' of the department in the Norwegian society is low. This is perhaps due to the ad-hoc 'more-of-the-same' character of some of the projects. A more aggressive (proactive) and creative policy for finding new, future-oriented topics is desirable.

The academic staff seems to be engaged in teaching to such an extent that they have little time over for considering new research opportunities. The age distribution of the academic staff looks favourable and most are in the 35-60 years bracket. There is only one female staff member, at post doc level.

Only one PhD student out of a total of 27 is directly financed by NTNU. This low level of internal financing is attributed to the low popularity of this research field among the students. On the other hand it is a remarkable achievement of the department to secure 26 PhD positions from external sources.

The research facilities are excellent, both buildings and equipment, mainly thanks to the presence of SINTEF.

Recommendation

Image building in manufacturing should be a top priority for the department, by emphasising the high-tech image of manufacturing and stressing the ICT-aspects. The rapid prototyping project is a good example. Management of strategic matters should be improved.

1.1.1 Research group: Manufacturing Systems

The Manufacturing Systems group consists of 4 professors, 2 post docs, 1 teaching assistant and 10 PhD students.

Their current research concentrates on three areas:

- Chip removal machining processes,
- Computer aided manufacturing and rapid prototyping,
- Development of efficient automated manufacturing and assembly processes.

The first programme concentrates on machining of hard light alloys, an important and timely topic in modern manufacturing, particularly in the aerospace sector. Thanks to the presence of SINTEF and VerkstedtPartner(*), the manufacturing lab is excellently equipped with the most modern machine tools. Only the metrology lab is outdated and deserves urgent updating. Dimensional quality control is indeed closely intertwined with the manufacturing processes and deserves the same attention as the processes themselves.

The second area emphasises research in rapid prototyping technology, a series of ICT-based new manufacturing processes. The group rightfully concentrates on the development of one of these processes: metal printing. The project is carried out in an international context by an enthusiastic team.

The research in the area of automated manufacturing and assembly is much less structured and seems to consist of a series of rather unrelated small projects without an overall research vision. The aims of the research programme do not appear to have

(*) VerkstedPartner is a privately owned company, which has emerged from NTNU and SINTEF. It serves several NTNU and SINTEF departments with prototype building.

been clearly explained; neither in the self evaluation report, nor during the hearing and the visit.

Scientific quality and productivity

The publication level of the group is average but almost exclusively confined to proceedings of international conferences (with one exception). The research results are mainly extended case studies resulting from projects. There are few results on scientific breakthroughs or solutions to generic problems. The rapid prototyping project offers potential for the future in this respect.

The number of PhD students is adequate (10). The collaboration with control engineering and ICT departments should be improved.

Relevance and impact

Some of the work is highly relevant but apparently with low impact on Norwegian industry. The research on machining of aerospace alloys seems to largely benefit one company. Other research areas in manufacturing processes that could benefit a larger part of industry could be explored. The work on rapid prototyping could lead to the creation of a new industrial activity in Norway.

Strategy, organisation and research cooperation

The changing attitude of SINTEF and NTNU regarding manufacturing has created uncertainty in the department, resulting in a general lack of clear strategy. This is particularly visible in the area of automation.

The international network of the group is good. Several international research projects are under way and student exchange in both directions is at a high level. The high number of PhD students seems to contradict the statements made on the unpopularity of manufacturing in Norway.

Group grades

Scientific quality and productivity: 3 (Good)

Relevance and impact: 3 (Good)

Strategy, organisation and research cooperation: 3 (Good)

Group recommendation

Define a coherent research programme with short- and long-term goals clearly formulated. Closer collaboration with ICT and Control departments is required.

Extend process research to more innovative processes (EDM, ECM, laser machining). The rapid prototyping activity offers excellent opportunities. Make automation and assembly research more energetic. Update metrology labs.

1.1.2 Research group: Operations Management

The Operations Management group consists of 5.2 professors, 1 post doc, 1 teaching assistant and 12 PhD students. It spans four main areas of research

- Production planning and control
- Logistics and supply chain management
- Quality and performance management
- Project management

A large part of the contract research of the group is channelled through SINTEF Industrial Management and through the privately funded Norwegian Centre of Project Management.

The Operations Management group is a well-organised research group, which seems to cooperate well with the other groups in the department. They run a large number of national and international projects in the four areas listed above. The group enjoys international reputation thanks to project collaboration, publications, and the organising of international conferences. Some 15 international guest researchers have stayed for longer periods at the department.

Scientific quality and productivity

The group has an impressive publication record in peer reviewed journals, conference proceedings, and book chapters in the best project management forums. They have awarded 4 PhD degrees over the last three years and there are presently 12 PhD students.

Relevance and impact

This leading group undertakes relevant research, timely and significant from an economic point of view. Their impact on industry and government organisations in Norway is considerable. Yet, the identity of the group would be enhanced by a more focused research agenda.

The emphasis of the group's research is on problem solving rather than on the creation of 'new knowledge'.

Strategy, organisation and research cooperation

The Operations Management group has a clear vision and strategy for the next 5 years. Their desire to belong to the best in Europe is realistic and justified.

They cooperate nationally, on Nordic, European and global basis with all the relevant organisations. Their strategy is to continue work with industry that provides funds and relevant research issues. No problems are encountered in recruiting students. The group organises executive programmes for working professionals as well as an international Master programme.

Group grades

Scientific quality and productivity: 5 (Excellent)

Relevance and impact: 4 (Very good)

Strategy, organisation and research cooperation: 5 (Excellent)

Group recommendation

The group is on the right track. If any recommendation is to be made, some more emphasis on the creation of "new", generic knowledge would make the group even stronger internationally. Collaboration with the ICT department should be strengthened.

1.1.3 Research group: Reliability, Availability, Maintainability and Safety

The Reliability, Availability, Maintainability and Safety group is the smallest group in size and consists of 2.4 professors, 1.2 post docs, no teaching assistants and 4 PhD students. The research activities of the group cover the following areas:

- System reliability theory (reliability assessment of safety systems, oil/gas well equipment, sub-sea production systems)
- Risk analysis (methodology and modelling)
- Maintenance (management and optimisation)

The Reliability, Availability, Maintainability and Safety group is small but very effective and productive. Both basic research and applied research projects are undertaken, the latter mainly in cooperation with SINTEF. They work across disciplines together with other departments.

The group has a clear vision for the next five years and a strategy for growth.

They have no problems to recruit Master and PhD students. The PhD students are encouraged to spend some time at top universities abroad. The professors have a broad international network and they teach courses all over the world.

Scientific quality and productivity

The publication productivity of the group is high. They publish in the best international journals. They produced leading international textbooks, one of them already used at recognised institutions such as MIT.

The group awarded only one PhD over the last three years but presently has 4 PhD students.

Relevance and impact

The Reliability, Availability, Maintainability and Safety group has collaborated with many national organisations and companies (Norwegian Railway Administration, Norwegian Petroleum Directorate, Norsk Hydro, Norwegian National Security Authority, and others) to solve problems related to maintenance management, risk assessment and control, etc. They further participate in establishing national and international guidelines and standards on dependability of products and on maintenance. Two spin-off companies have emerged from RAMS' activities and the group further offers a wide range of courses for industry.

Strategy, organisation and research cooperation

The strategy of the Reliability, Availability, Maintainability and Safety group is clearly to continue to be a leading international research group and the necessary actions are being taken to realise this goal, e.g. by being the Marie Curie Training Site for PhD training in the group. Also synergy is strived for through the ROSS network, coordinating all the group's activities of NTNU, for which the head of the Reliability, Availability, Maintainability and Safety group is the leader. Complementary competence is looked for through carefully selected research relationships in the EU.

Group grades

Scientific quality and productivity: 5 (Excellent)

Relevance and impact: 5 (Excellent)

Strategy, organisation and research cooperation: 5 (Excellent)

Group recommendation

This group should be supported to grow since it has the potential to be an internationally leading group in Risk Analysis. This latter area is of significant importance to many of the Norwegian industries. One idea would be to form an interdisciplinary research programme with an associated "research school", a PhD programme with students from many disciplines and from all the Nordic countries and maybe also from other countries. Such an effort would provide a solid scientific grounding for many of the applied fields in engineering. The programme could also extend its influence to other faculties, such as management and social sciences.

1.2 Department of Marine Technology

This department now covers what has been a major national focus both historically, through shipping and shipbuilding, and for the last thirty years through the offshore sector resulting from the joint exploitation with the UK of the North Sea hydrocarbon deposits. The new department has a very large MSc intake of 90 to 100 per year, comparable with Civil Engineering (a department with six research groups and over twice the faculty staff size) as the largest teaching intake in the faculty. The Marine

Technology Department also has the advantage of having direct access to a complex of world-class marine technology facilities (e.g. large scale towing tank and ocean basin), which are operated and maintained by MARINTEK.

The academic staff level in the Department is substantial at 43 of which 24 are professors and assistant professors. There are 11 adjunct professors, 8 post doctoral researchers. There are 38 PhD students with preponderance in the Marine Structures research area rather than Marine Systems that Panel 1 considered. It is clear that with such a large teaching load there is a consequential impact on the level of research.

The link of the Department to MARINTEK as a strategic centre in SINTEF is fundamental and contributes significantly to the Department‘s international reputation. The MARINTEK team of 180, of which 110 are MSc/PhD level, could be seen as both an asset to the Department, in the facilities and practical work it provides for the students, but also inhibiting a long range and strategic approach to department led research. Again the bulk of the facilities are more relevant to the Marine Structures half of the Department’s research focus than that of Marine Systems, reinforcing the asymmetry in the new Department’s structure

The Department was formed 18 months ago from four small departments and the integration process is still under way. Now that Marine Technology is no longer its own (small) faculty the physical separation of Marine Technology from the rest of the Faculty of Engineering Science and Technology is seen as disadvantageous both administratively and for research, given the pressures for multidisciplinary research.

The role of the Marine Structures research group is clearly dominant in the Department, owing in part to encompassing more than just traditional ship structural research and that traditional hydrodynamic loading mechanisms and design of offshore structures are also within its expertise, but more importantly the group contains two world authorities, Professors Faltinsen and Moan, giving it a world wide standing. This has been recognised by Professor Moan heading up the Centre for Ship and Offshore Structures, one of 13 Norwegian National Centres of Excellence.

Judging the Department’s research capability and health by its production of PhDs over the last four years, it is significant that 27 of the 37 PhDs were from what is now the Marine Structures research group and that 17 of those were supervised by the two world eminent researchers named in the previous paragraph.

Recommendation

Given the weak links and the unbalance between the Marine Structures group and the Marine Systems group the Department should reconsider its research strategy.

1.2.1 Research group: Marine Systems

The previous Faculty of Marine Technology consisted of four departments: Marine Design, Marine Engineering, Marine Hydrodynamics and Marine Structures. The Marine Design and Marine Engineering departments were merged and formed the Marine Systems group, and the Hydrodynamics and Structures departments formed the Marine Structures group. The Marine Systems group has 9 professorial staff, 2

post doctoral members and 11 PhD's distributed over four research teams. The age distribution is unfavourable with many professors retiring within a few years. Recruiting replacement faculty may prove to be a problem and so it may become difficult to maintain the research thrusts.

The four research areas on which the group is focused are the Design of Marine Systems, a long established area which has pioneered the systems approach to marine design under its Emeritus Professor Erichsen; Technical Operations of Marine Systems, a more operations focused approach, particularly with regard to the successful offshore sector; Marine Engineering and Internal Combustion Engines, a traditional field alongside naval architecture (now essentially in the Marine Structures group) focused on ship propulsion plant, but increasingly concerned with the environmental issue of engine emissions; and the Fishery and Aquaculture, another major part of the Norwegian economy with the team focused on fishing craft and more recently the growth in aquaculture.

Currently there are five thrusts to the research of the group: Energy Efficient All Electric Ship, drawing on the marine engineering facilities with 1 post doctoral researcher and 4 PhDs plus an EU project, FCSHIP; Technical Operations of Marine Systems in the oil and offshore sector jointly with MARINTEK; Maritime Logistics, with an international project, INSUMAR, involving Singapore and Georgia Institute; Sustainable Fishing Vessels and Fishing Fleet, with 1 PhD; and Underwater Technology for use by marine research, with 1 PhD.

Scientific quality and productivity

The majority of the research work is carried out through participation in MARINTEK, SINTEF and other organisations like the Directorates of Fisheries and the Department of Archaeology. As a consequence, the publication output is limited to 'local' papers and conference proceedings. PhDs should result in more journal papers. The large number of finalised PhDs at the department comes mainly from the other (Marine Structures) group.

Relevance and impact

While covering a major part of the nationally vital maritime sector, the group seems to be overshadowed by the Marine Structures group and its associated Centre of Excellence in Ship and Offshore Structures, so for example only 3 of the 11 academic advisors to MARINTEK are from the Marine Systems group. Nevertheless this group is not just a significant contributor, with its MARINTEK associates, to Norwegian research but retains a strong international reputation as part of Trondheim Marine Technology capability.

Emphasis has been too much on directly applicable projects through SINTEF or MARINTEK, and not on visionary long-term projects. The all-electric ship is a good example of such a visionary project.

Strategy, organisation and research cooperation

The grade assessment could be improved if the group would focus on clear priority areas (i.e. Aquaculture, sustainable emissions) and if it would establish stronger

working relations with other research groups (such as Marine Civil Engineering, Aquaculture, Project Management and Logistics).

The "separation of concerns" between Marine Structures and Marine Systems seems to be counterproductive. More systems-thinking is required.

Group grades

Scientific quality and productivity: 3 (Good)

Relevance and impact: 4 (Very good)

Strategy, organisation and research cooperation: 3 (Good)

Group recommendation

There is a need to tackle the professorial demographics and increase the top publications per academic. The research focus is generally sound but needs to be more integrated, as there is still a sense of unfinished reorganisation. The work on IC Engine emissions indicated new staff could be attracted into sustainability-focused research. There seemed to be a lack of joint focus in the group or a common research profile.

The number of permanent academic staff should be increased especially in the Fishery and Aquaculture group, given the importance of the field. Generally the number of researchers in each of the groups is too small to attract PhD students.

1.3 Department of Civil and Transport Engineering

The Department of Civil and Transport Engineering was established in September 2002 as a union of five different departments: Building and Construction Engineering, Geomatics, Geotechnical Engineering, Road and Railway Engineering and Transport Engineering. The department now comprises six research groups being formed from the previous departments (where Department of Building and Construction Engineering is divided into two research groups, and the departments of Road and Railway Engineering and Transport Engineering are gathered in one research group) and a research group being moved from the Department of Structural Engineering: Building and Materials Technology, Geomatics, Geotechnical Engineering, Marine Civil Engineering, Project Management and Construction Engineering and Road and Transport Engineering. While previously housed in 4 separate buildings on the campus, they are since January 2003 relocated in the same building.

The department has a total staff of 112 persons: 42 professors (17 full; 16 associated/assistant; 9 adjunct (20%)), 2 post docs and 7 research fellows, 44 (of which 33 external) PhD students and 18 technical/administrative employees.

The department in its present structure seems to consist of fairly traditional groups lumped together for no obvious reason to an outside observer. The result of this is that there seems to be a lack of leadership with vision. Where is the big idea for the department? The expected synergy that should follow the reorganisation has not yet

been realised. Small research groups work independently. Being under the same roof is apparently not sufficient to promote collaboration.

The relationship with SINTEF is sometimes problematic, e.g. with respect to publication policy and intellectual property rights. The department is perhaps too involved in the SINTEF activities to be able to determine their goals independently. These goals should be different from those of SINTEF. The Panel was pleased to learn that it is the intention of the department and SINTEF to work more closely together in the newly established Gemini centre on "Road and Transport Engineering".

The department finds it difficult to recruit PhD students. The present number of 44 is adequate, but these students are unevenly distributed over the 6 research groups. More than half of the PhD students are funded from external sources, 35% are non-Norwegian and 25% are women. The PhD students are not sufficiently encouraged to spend part of their study abroad, the main reason for that being the limited financial resources. Some business sectors in civil engineering show very little interest in PhDs, making it particularly difficult for the department to raise the interest of bright MSc graduates in pursuing PhD studies.

Special recruitment efforts have led to a steady increase of enrolment for the MSc programme over the last 5 years. Over 50% of the scientific staff is above 55. The replacement issue should be taken as an opportunity to rejuvenate the research programme of the department and make it more adaptable to the contemporary societal challenges. A clear research strategy for the next 10 years is therefore urgently needed. It is laudable that the faculty has decided to fund a strategic project of the department to develop a new education and research profile for the department.

Recommendation

Reconsider the department management and the formation of groups from a strategic research point of view. Improve the publication policy with respect to Journal papers.

1.3.1 Research group: Building and Materials Technology

The Building and Materials Technology group is 15 persons strong: 3 professors, 2 associate professors, 1 assistant professor (with the same duties as an associate professor), 1 adjunct professor (20 % of full time), 0 post docs, 6 doctoral students (5 externally funded), 2 technical/administrative staff members.

Research is being carried out in three main areas: (i) Wood as a building material, (ii) Heat transfer in window frames with internal cavities, and (iii) Impact of climate change on the built environment.

The research of the group is concentrated on wood as a building material. Aspects such as fire resistance, durability, wooden claddings are studied. Concrete is dealt with in another department and is completely left out in the Building and Materials Technology group although it is a very important building material. Masonry is included in the work of the group but is not in focus.

Important areas such as structure elements, acoustics, composites and functional elements (e.g. windows) are dealt with only at Master level. Ongoing effort is to establish a broader base of collaboration with researchers within the fields of architecture, ICT, design support systems, and health aspects including indoor climate.

Scientific quality and productivity

The group is member of the Wood Centre established at NTNU; its director belongs to the Building and Materials Technology group. The collaboration of the group with industry and public sector in Norway is mainly channelled through SINTEF and the Norwegian Building Research Institute (NBI).

The Building and Materials Technology group produced a handbook on 'Moisture in Buildings' that is very popular in Norway's building community.

The international network of the group is mainly related to regulation and normalisation activities rather than to international research projects. Building and Materials Technology group's other international activity is directed towards strengthening the education systems in third-world countries. The international journal publication rate is low (<0.5 papers/professor/yr). Some 25 international conference papers, published in proceedings over the last four years is a good average. There are many local publications that serve the Norwegian market well.

Relevance and impact

The impact of the present research for Norway is considerable, wood being a strategic material for Norway. The international impact and relevance is much less felt.

Strategy, organisation and research cooperation

The strategy of narrow focusing on application of wood and fire-resistance in buildings is a result of the limited number of staff.

To help development of a visionary research strategy and to attract more funding it is recommended to set up large multidisciplinary integrated projects that can have a large impact nationally and internationally.

Group grades

Scientific quality and productivity: 3 (Good)

Relevance and impact: 3 (Good)

Strategy, organisation and research cooperation: 3 (Good)

Group recommendation

There is an urgent need in this group for innovative ideas, high-risk initiatives and a clear vision. Closer cooperation with other groups inside and outside the department is a must. The international research network should be strengthened.

The research should be bootstrapped to a higher level if its future impact is to be safeguarded. Modern technologies like ICT, intelligent materials, nanotechnology should be studied and tested on their use in future building products and the necessary links to researchers in such disciplines including the more conventional fields of structure engineering, indoor-climate, acoustics and agriculture buildings.

1.3.2 Research group: Geomatics

The Geomatics group has a staff of 11: 5 professors (presently; it rose from 2 in 2000), 0 post docs, 4 PhD students (2 extern), 3 technical/administrative staff.

Its research areas are:

- Photogrammetry (digital industrial photogrammetry),
- Geodesy (physical geodesy, geodynamics, advanced positioning), and
- Geographic Information systems (storage and analysis of spatial information, interactive maps, cartography on electronic maps, temporal GIS).

Collaboration exists with SINTEF Highway engineering and the Norwegian Mapping Authority.

The group is too small to tackle the many subjects it has to deal with now. A better focus is needed. Several questions have to be answered, such as: Is remote sensing more relevant than photogrammetry? Is GIS more relevant than cartography? Is geoid computation a task for NTNU rather than for the Norwegian Mapping Authority?

There is great research potential in the group, e.g. remote sensing in combination with GIS. Presently, the group acts as a collection of individual scientists. It certainly could accomplish more if it gets a common vector of direction.

The group wants to maintain a broad profile dictated by the job opportunities, which pop up. This might be a weakness in the long run. They find it difficult to recruit enough qualified PhD students and no clear plan exists for new recruiting efforts. It seems further difficult to recruit Norwegian students. Effort should be made to recruit a few post docs: a group active in publishing while at the same time serving as “role models” for potential PhD students.

There is no dual research group at SINTEF.

A strategic plan will be worked out this year—not a moment too soon.

Scientific quality and productivity

The publication level and rate (average of 3 international papers for 5 professors) are low and most publications are due to one professor. No PhDs were awarded in 2000, 2001 or 2002. The present number of 4 ongoing PhDs, in a group of 5 professors is too low, in an area of such strategic interest.

The group should be participating in EU or Galileo projects.

The group does good work within the areas covered but some important areas are missing.

Relevance and impact

The different academic members of staff work, mostly on an individual basis, on several projects, mainly applied but also more fundamental, in collaboration with other departments at NTNU, SINTEF. There is some national impact but the scientific activity seems to be spread too thinly to really make a difference.

Geomatics is a subject of the future that deserves further to be supported and developed.

Strategy, organisation and research cooperation

Presently there is no visible strategy in place.

Cooperation within the group and with other disciplines at NTNU and AUN is recommended.

There is a network of collaboration on national and international level. A clear strategy to participate in major international projects, such as Galileo, is absent.

Group grades

Scientific quality and productivity: 2 (Fair)

Relevance and impact: 3 (Good)

Strategy, organisation and research cooperation: 2 (Fair)

Group recommendation

Formulate a focused and coherent research programme and strategy with short- and long-term objectives that is also realistic considering the size of the academic staff. The division between university research and research made through public means, at other institutions, should be made clear. Strong links should be established with ICT. "Market" the group by a visible project involving "hi-tech" engineering and science. All initiatives to raise the scientific level deserve to be supported.

1.3.3 Research group: Geotechnics

The research group Geotechnics has 2 professors, 1 associated professor, 1 assistant professor, 1 adjunct professor, 0 post docs, 5 PhD students, 6 technical and administrative staff.

Research is carried out on investigating basic soil behaviour including constitutive modelling and FEM analysis, improving testing procedures in field and laboratory, and solving practical design problems. The group is the NTNU node in the Centre of Excellence: 'International Centre of Geohazards (ICG)'.

The GeoSuite programme, funded by the Norwegian Research Council (RCN), to develop a complete geotechnical design tool, at Nordic level, is an excellent example of national/regional collaboration.

The research group Geotechnics has been one of 5 members in "Soft Clay Modelling for Engineering Practices (SCMEP)". This research group is now the only research group at NTNU which is participating in the negotiations for the next round inside EU's Research Training Network (RTN) through the proposal "Advanced Modelling of Ground Improvement on Soft Soil (AMGISS)".

Recruitment of PhD students (presently 5 for 4 professors) seems to be problematic. The majority are non-Norwegian, but this may have to do with the international nature of some projects. However, to safeguard the scientific level of the research, more Norwegian PhD students would be beneficial.

Scientific quality and productivity

The research group Geotechnics is a well-recognised group, nationally as well as internationally, with big achievements in marine geotechnical engineering. The quality of their work is high but their scientific productivity, measured in terms of publications and new PhD's, is low. (Very) few journal papers are produced (by one or two professors). It seems as if the group does not find publishing important. There are 5 ongoing PhD students at present, only 2 completed doctorates in the last three years.

Relevance and impact

This is a future oriented discipline that should be preserved and developed in Norway, where a variety of geotechnical problems have to be effectively handled.

High practical relevance and impact, when viewed as a group of consultants, but academic relevance is unclear. The group needs some ambitious research projects. GeoSuite is a good example with high potential impact.

Strategy, organisation and research cooperation

The group's strategy is to keep up operative skills in geotechnical engineering in Norway over a broad range, in teaching as well as in research. This is a commendable attitude for a field of high importance for Norway in which a long tradition exists at NTNU. The position of the group in the Centre of Excellence: International Centre of Geohazards (ICG) is therefore very important.

The group's long-term research strategy is not as clear as its strategy with respect to short-term technical projects. Their position vis-à-vis SINTEF seems to be more independent and healthier than for many other groups at NTNU. The group coherence also looks healthy.

Group grades

Scientific quality and productivity: 4 (Very good)

Relevance and impact: 3 (Good)

Strategy, organisation and research cooperation: 3 (Good)

Group recommendation

Revitalise the area by formulating a research programme, strategy, and vision, that is focused and visible. This will attract new research students. Link to, alternatively, build new research school on a Nordic basis.

1.3.4 Research group: Marine Civil Engineering

The Marine Civil Engineering group has 3 professors, 1 associated professor, 2 adjunct professors, 0 post docs, 11 (2+9) PhD students and 2 technical/administrative staff.

This is an important topic nationally given the maritime focus and the preponderance of ports. The group has been belatedly added to the new and large Department of Civil and Transport Engineering, with the conviction that it has significantly more potential in this new configuration. It has been heavily involved in North Sea petroleum industry which is considered to have peaked and in moving into deeper waters less dependent on civil engineering. This may be reflected in the small number of MSc students, despite indications that global warming may make the subject a critical field of endeavour.

The research includes the following fields: (i) Analysis of wind, water waves and currents, (ii) Erosion, sediment transport, scour and scour protection, (iii) Wind, wave and current forces, (iv) Breakwaters, coastal and offshore structures, despite little Research Council interest, (v) Computational fluid dynamics (CFD), applied to sea behaviour in the littoral zone, with the indication that the related SINTEF team provides most of the expertise, (vi) Arctic marine engineering, which is considered to be a growth area but has currently a small team involved, (vii) Stochastic techniques. This is an impressive range of topics for a relatively small group like MB. Shifts in research scope will have to be considered in view of the shifting interests from industry. Arctic marine engineering seems to be gaining in importance with the upcoming oil exploration activities in arctic waters.

With the declining interest from (undergraduate and graduate) students, a new recruitment plan for academic staff is needed. The age problem is particularly acute in this group and the replacement problem challenging. For an area as strategic for Norway as marine civil engineering, special actions will have to be taken at NTNU level. The group is convinced that with the newly introduced two-year international MSc degree programme it will attract 8-10 international students.

The research group appears to be below a critical mass and, in our opinion, not yet fully integrated into the rest of the Department of Civil and Transport Engineering, with in many respects more in common with Marine Technology both in environment, such as offshore, and industry, such as ports and fisheries. Despite recognising it has knowledge, facilities and good image in the third world, it does not seem to be exploiting the environmentally crucial role that sea defence/coastal protection is likely to play, owing to the predicted effects of global warming on coastal environments.

Scientific quality and productivity

The group has a very good international publication record, with 19 joint publications with international partners over the last five 5 years. There are 11 PhD students, many of them from overseas. During the last three years 7 PhD degrees have been awarded. The journal publication record could be improved.

The sabbatical system is used extensively within the group and many visiting scholars stay for more or less extended periods with the group.

Relevance and impact

The Marine Civil Engineering group has to be kept, nursed and further developed, because of its strategic importance for Norway and the prominent position it presently occupies in Norway and internationally. The replacement of the aging staff has to be taken as an opportunity to strengthen the group in its strong disciplines (arctic and coastal engineering) and to reorient towards new promising disciplines (renewable energy).

Strategy, organisation and research cooperation

The strategy of the group is not clear. They are aware that several areas need to be stressed in the future but no explicit programme is formulated. Important areas to consider are: coastal engineering, new renewable energy (wind). Merging with the Marine Systems research group in Marine Technology or joining that Department as a third research group might be an option. The group's reliance on SINTEF for CFD is unfortunate.

Group grades

Scientific quality and productivity: 4 (Very good)

Relevance and impact: 4 (Very good)

Strategy, organisation and research cooperation: 3 (Good)

Group recommendation

There is a need to increase the number of MSc students, which has not shown the same recent upswing as in the rest of Civil Engineering. An increased teaching load must, however, not prevent an increase in the publication level. The opportunity presented to Norwegian Marine Civil Engineering by the apparent need to greatly increase training and research given the potential effect of global warming on the coastal environment worldwide should be grasped as the way to raise the group's profile, recruitment and research portfolio.

The need for updating the hydraulic laboratory should be critically analysed in the light of a clearer long-term research programme, considering the needed resources to run the laboratory.

1.3.5 Research group: Project management & Construction

The Project management & Construction group consists of 2 professors, 2 associated professors, 2 assistant professors, 4 adjunct professors, 0 post docs, 7 PhD students, 6 research fellows and 1 technical/administrative staff member.

The research programme embraces the following areas: (i) Project management, (ii) Construction engineering, and (iii) Facilities management. This is a very traditional profile of institutions that are active in the area of construction and (front-end) project management. It covers all the phases in the life cycle of constructed facilities. This is a very large scope and as in most places the group has had to focus on selected topics within the defined domain. Thus the focus is on project management in general, and on hard rock tunnelling, especially blasting. In the facilities management area issues that relate to life cycle analysis are the only ones dealt with.

The research programmes are embedded in several collaboration frameworks, like the Norwegian Centre for Project Management (NSP), 'LCC for Buildings and Structures' supported by the Nordic Industrial Fund, the Norwegian Ministry of Finance, the Public Roads Administration.

The group attracts large numbers of undergraduate students, confirming a trend where students are more and more attracted to 'management' disciplines. Consequently, and in view of the fact that the group is small, the teaching load of the staff is high. This has a negative influence on the research output. Research is mainly applied, which is characteristic of these kinds of research groups. Basic research is very limited.

The group is in high demand and well financed by industry, much less from NTNU.

The long-term strategy is not obvious and it has not been made evident that by focusing on the areas mentioned above, the group makes the best use of its limited resources. It would be beneficial if synergy between the areas could be achieved. The group collaborates with several other departments at NTNU and SINTEF and Norwegian Geotechnical Institute (NGI).

The age distribution in the group is favourable. Recruitment at MSc level is no problem. Mobility of researchers is very low, considering the nature of the problems dealt with.

Scientific quality and productivity

The publication output of the group consists mainly of local publications (which are also published in English and distributed by sale to the international tunnelling industry), technical reports, in addition to software products to engineers and craftsmen. There are very few, if any, scientific publications in international journals. Only 3 PhD degrees were awarded over the last three years (one technically oriented on tunnel boring, two more in Norwegian, hence with only local influence). Presently 7 PhD candidates are working towards their degrees.

Relevance and impact

Seen from an industry perspective, the group's impact is quite considerable through their many local publications, technical reports and software products. The impact as seen from the research point of view is low to negligible. There is a great need of

project management skills in industry and Norway, with its many giant projects in the offshore engineering sector, has been a leader in using advanced tools for planning, scheduling and controlling projects.

Strategy, organisation and research cooperation

There is a need to develop research that brings the different sub-groups together. Further, there is a need to enhance links to similar research in other departments or groups. Linking up with e.g. Facilities Management in the Department of Building Technology, with Technology Management and Behavioural Sciences, and with ICT groups dealing with software engineering could provide a basis for interesting interdisciplinary research projects. Tunnelling is an important area of competence in Norway and a major tunnel project could serve as a joint laboratory for the group.

There is a lack of strategy. A possible strategy could be, via their work with industry in the area of project management, to transfer the ideas to construction. The intended focus on tunnelling and rock blasting has not been presented clearly (and might be only inspired by the presence of specialists in the group).

Group grades

Scientific quality and productivity: 2 (Fair)

Relevance and impact: 3 (Good)

Strategy, organisation and research cooperation: 3 (Good)

Group recommendation

The group should formulate and give priority to a coherent long-term research strategy, which involves (or makes use of) relevant partners inside and outside the university.

A focused interdisciplinary research programme should be developed in which all sub-groups participate and that provides the framework for PhD work. The number of PhD students should be increased, as should the collaboration with international research groups. A culture of publishing in peer-reviewed journals should be developed.

1.3.6 Research group: Road and Transport Engineering

The Road and Transport Engineering group has 5 professors, 1 associated professor, 2 assistant professors, 1 adjunct professor, 2 post docs, 1 research fellows, 11 PhD-students (all external) and 4 technical/administrative staff. The main fields of research are planning, construction, operation and maintenance related to (i) Highway and Railway Engineering, (ii) Traffic Engineering, and (iii) Transport Planning.

The group uses extensive research facilities, like the Road Technology Laboratory, and the Road User Behaviour Laboratory, jointly owned and operated by NTNU and

SINTEF. It further maintains good relations with the Public Road Administration and the Norwegian Rail Authority.

The Road and Transport Engineering group has a solid reputation, good labs, and carries out practice-oriented research for a broad, predominantly Norwegian client base.

The cooperation with SINTEF perceived by the group as an advantage may also be disadvantageous when it comes to independently establishing research priorities and so the drive of the group in this regard must not be impeded.

Several opportunities exist and could be further explored to adapt the group's activities to the contemporary requirements in transport systems engineering. Examples are: integrated transport systems adapted to the different landscapes of Norway, rehabilitation and maintenance of infrastructure, and environmental issues like noise abatement. Other interesting research opportunities are located in the broad area of integrating the design engineering aspects with planning of transport and maintenance of the whole system.

The different parts of the organisation are not integrated yet and do not take advantage of the possibility to focus on one of tomorrow's biggest issues: managing a crumbling infrastructure with a holistic perspective. A more aggressive attitude may be necessary.

The staff age problem is also likely to hit this group.

Scientific quality and productivity

The group has produced many PhDs in the recent past and there are presently 11 PhD students enrolled. The subjects of their thesis work seem mainly inspired by the operational needs of the Norwegian Public Roads Administration and Norwegian National Rail Administration and SINTEF, rather than solving more basic generic problems.

The publication output is low and mainly confined to conference proceedings and local papers and reports. Only two professors have a sizeable journal publication output.

Relevance and impact

The research is mainly carried out in collaboration with and ordered by the Public Road Administration and the Norwegian Rail Authority, and vis-à-vis industry in direct collaboration with SINTEF. The direct impact on Norwegian society is considerable. The relevance and impact of the research is however very low. International impact exists through collaboration with Ethiopia, through publication of two books and through guest lectures at several high-level universities by one or two professors of the group.

Strategy, organisation and research cooperation

The strategy formulated by the group consists mainly in consolidating the existing partners inside and outside the university. No strategy is formulated to improve the level of generic research and the levels of publications or to gain strength by

focussing on major "systems" problems that could involve all subgroups, e.g. pavement or bridge management, multimodal transport, and freight.

Why not link with Marine Technology for transport on multi-modal basis?

Group grades

Scientific quality and productivity: 3 (Good)

Relevance and impact: 3 (Good)

Strategy, organisation and research cooperation: 3 (Good)

Group recommendation

The group should develop a coherent strategy with identifiable short and long term goals, which involves relevant partners inside and outside the university. Such strategy can, furthermore, serve as a framework for identifying basic research needs and yet also allow for "problem solving" research in collaboration with SINTEF. The strategy should also outline a policy for publishing in peer-reviewed journals.

1.4 Department of Hydraulic and environmental Engineering

The department has 15 faculty members, 3.5 post docs and 18 PhD students. They are dynamic and well balanced, with a high-level research activity, working with societal and engineering aspects of water resources and environmental management, on a good scientific and practical level.

The department evidently functions very well, although there seems to be somewhat unclear roles, between the department and SINTEF, as shown by their joint presentation. The well-elaborated strategies presented were less visible in the self-evaluation report. The department has a determined and active approach to assure recruitment and mobility in a wide industrial setting. Engineering science and practice are well integrated. They graduate 6 PhD's per year and the publication rate is excellent.

Water—Energy—Environment are three strong components that effectively linked together provide a good base for both research and educational efforts. The department has good cooperation with SINTEF. Good strategy and plans for the future are in evidence. They seem to be well established and are quite outspoken also on the vulnerability in a too close alliance NTNU-SINTEF in the water area.

Recommendation

Solid waste management sector at the department should be expanded: it is an important area for the future.

1.4.1 Research group: Hydraulic engineering

The group consists of 6 faculty members, one post doc and 6 doctoral students. Scientifically, it is a well-balanced group that has a strong technological history, but keeps up to date, including CFD and even aquaculture in its scope of activity. They have clear objectives and realistic plans: goals are selected following national and international needs. They cover the basic research-innovation chain. Both clients and funding are available; however, they seem to lack the funds for maintenance and updating of lab and field instrumentation. They are not dependent on SINTEF for cooperation after restructuring of SINTEF.

The research group has an interesting and well-developed profile and the possibility to further strengthen such important areas as dam safety and flood risk management by identifying the interaction more clearly between floods and dams, in a risk perspective. They have world-class research in some areas, with good simulation tools, being developed at the department.

They have a strong leadership, well performing national and international cooperation and a better-defined plan (though it is not always clear) than other departments, and the internal organisation works well. They are also aware of weaknesses and take actions. They recognise clearly the pros and cons of SINTEF. They have strong and well-organised links and collaboration with geotechnology, and possibly also with marine technology. They appear to be working on future possibilities with Norwegian industry.

The group has a reasonable age distribution and they seem to be able to attract the good PhD students, being the most successful of the three departmental groups in recruiting students. There is a large production throughput of Masters as well as good number of PhD students per full professor.

Scientific quality and productivity

This is an excellent group with world-class quality that is well recognised internationally. Good publication culture, high publication rate, including many journal papers while also being responsive to industry. They develop models to understand the basics such as: CFD, physical simulations in laboratory and in the field, eco-hydrology, river engineering/erosion and sediment transport, cold climate issues, climate change, distributed hydrological modelling – a variety of high quality products. Productivity of PhDs is generally high.

Relevance and impact

The research area has a high relevance and is of strategic importance for Norway. The group has a large international exposure and a strong impact. It is strong both academically and scientifically, dealing with problems of high relevance for industry as well as society.

Strategy, organisation and research cooperation

The group enjoys good funding and has strong international research cooperation. It is unfortunate that they have no link with Marine Civil Engineering (though it is not

evident how such links should have been achieved). Strategic thinking is well in evidence, (there are plans for the next 5 years), however, their strategy could have been more clearly defined.

Group grades

Scientific quality and productivity: 5 (Excellent)

Relevance and impact: 5 (Excellent)

Strategy, organisation and research cooperation: 5 (Excellent)

Group recommendation

The Hydraulic engineering research group has developed a strong platform also for significant contributions to educational programmes within a traditional civil and environmental engineering framework. Integrated water resources management is a perspective that implicitly emphasises the multidisciplinary character of hydraulic engineering research. We recommend the group to continue in these directions to strengthen, even more, efforts to contribute to achieving sustainable water related physical infrastructure systems. Of particular importance for Norway is to maintain high competence in hydropower technology with focus on cost-effective rehabilitation and renewal measures as well as a safe and environmental sound management of this energy resource.

1.4.2 Research group: Water and Wastewater engineering

The Water and Wastewater engineering group has 6 professors, 3 post docs, 8 PhD students and two technical/administrative staff.

Impressive research group that is among the top three in Europe, with its high quality research in wastewater processes, water chemistry, microbiology, infrastructure strategies, etc. It combines basic research with unique technologies and spin-off companies, and enjoys high international reputation and an excellent publications record. Although the funding policy is good, the group is dependent on SINTEF, (but the cooperation is fragile). The “Treatment” group is very active, has contacts outside Norway and organises conferences. The “Systems” group coordinates a European project cluster, showing good result.

In all aspects, this is a very well organised group. The group management is very active and competent showing good leadership at department level; the group itself is well structured and has balanced research profile and good internal organisation as well as international networks. With its strong teams, it has become the leading EU water programme group. Moreover, the group has clear objectives and focuses on selected important areas of research. Despite making plans for the future, the strategic plan is less clear. On the other hand, a strategy to cover all aspects from basic information collection to commercialisation is probably too ambitious for a university. The group is to start a spin-off company based on the project results. Lab maintenance could be a problem, given that funds for maintenance and updating of lab facilities are lacking.

As in the case of other groups, age could be a problem for the group (45 is youngest). It seems to be difficult to recruit students, despite special efforts put into recruitment. They have an adequate number of PhD students per professor, but a low throughput of MSc candidates.

Scientific quality and productivity

Internationally acknowledged, top class group with high publication rate including many peer-reviewed papers and 50 joint publications; many international conference publications. They have many industrial contacts, 7 guest researchers, and 5 post docs over the past five years. They have awarded 6 PhDs in 3 years and presently have 8 ongoing PhDs.

Relevance and impact

High relevance and high impact, nationally and internationally. Work has resulted in a spin-off company.

Strategy, organisation and research cooperation

Strategy in both areas is excellent and geared towards typical Norwegian situation. However, there is some concern for SINTEF-dependence, which reflects the fragility of NTNU/SINTEF relationship. Strong international research cooperation is in evidence, but strategy is not so clearly defined, in particular, how to proceed without SINTEF.

Group grades

Scientific quality and productivity: 5 (Excellent)

Relevance and impact: 5 (Excellent)

Strategy, organisation and research cooperation: 4 (Very good)

Group recommendation

Similar recommendations as proposed for the Hydraulic engineering group are valid here. Additionally, it is of interest to highlight the role of (strategic) environmental impact assessment that is an important instrument not only for environmental control but also a key method for developing the technology towards overall more efficient systems solutions.

1.4.3 Research group: Solid Waste Engineering & Recycling

This is the “Cinderella” group of the department; lacking a fulltime professor, which adversely influences their activities. It is too small a group to achieve a critical mass. The focus is on “software”/modelling and interdisciplinary research, which is probably realistic under the present budget conditions. The PhD students are

organised within the Industrial Ecology Programme at NTNU; there is no parallel group at SINTEF with a lab to support activities. The present precarious situation results from SINTEF deciding to stop activity in solid waste engineering. The group is sub-critical in its present form and needs a more aggressive strategy. As it is, there are hardly any organisation or labs, nor a strategic plan for research (the group works largely on the implementation of EU-directives in Norway.)

The recruitment is at an extremely low level, owing to –so far– part time professorships. They have no MSc students and only 4 recently recruited PhD students, who are doing most of the research. The group badly needs more faculty staff.

Scientific quality and productivity

The publication output is low and there are only few industrial contacts, few PhD's, (4 PhD students now over last 3 years).

Relevance and impact

The topic is very important and well in line with strategic objectives of the university to focus on the need for sustainable environmental systems in society, but the impact of research is low. There is hardly any research except for 4 PhD students and it is not clear who is supervising them.

Strategy, organisation and research cooperation

There is no clear strategy or vision. Design activity does not match the overall research strategy. There is a link to thematic industrial ecology, but no SINTEF link. The absence of SINTEF activity is detrimental for the group. All seems presently to dependent on the return of the currently absent full-time professor.

Group grades

Scientific quality and productivity: 2 (Fair)

Relevance and impact: 3 (Good)

Strategy, organisation and research cooperation: 2 (Fair)

Group recommendation

There is a strategic link between solid waste handling and different recycling technologies and other efforts in society to minimise environmental impacts. There is a huge need for knowledge and incentives for applying such strategies also in the developing world. We are convinced that given adequate support the research group in Solid waste engineering and recycling will find ways of developing scientific strength and a well balanced research programme that matches the significance of the research field.

1.5 Department of Architectural Design, History and Technology

1.5.1 Research group: Building technology

The group has 5 professors, 1 post doc and 10 PhD students. For the purpose of this evaluation, this group has been presented as consisting of two divisions: Energy use and sustainable design, and Facilities management.

This is a relatively small organisation with, as a consequence of recent reorganisations, no clear organisational structure. The group carries out R&D projects around energy, management and wood, using "technology as an inspiration in architecture" as the group puts it. The staff consists of architects and engineers. The very small permanent staff is compensated for by wide spread cooperation with other departments and, in particular, with SINTEF.

The Energy division, which has a relatively large number of PhD students, seems to "exist" even if it is doing mostly coordination work. This raises the question whether research could really be evaluated without SINTEF. The Management division, with its enthusiastic professionals, has important links to social science. If the university considers it important, a more serious effort should be made to support it.

The group seems to have a defensive attitude in strategic planning. Energy use and Sustainable Design are the focused research fields, which are of high interest, but the group must build up professional staff and find replacement for those who are retiring. It appears that students are interested in architecture, which provides good conditions for recruitment, as the best could be selected.

Scientific quality and productivity

Although the productivity is internally high, far too low a number of papers are published. There are hardly any international publications, which may be mitigated by the fact that there are only few journals on architecture.

Relevance and impact

The research is of high relevance, but funding has too much of a short term nature; the group needs more permanent faculty members. Impact is difficult to evaluate.

Strategy, organisation and research cooperation

The group lies on the boundary of Civil Engineering and Architecture. It has strong research cooperation with 11 PhD's linked to SINTEF research. Strategy includes 'Building 2020' but needs to build up faculty team size. Research output is high-level integration of almost all aspects in building design, production and maintenance. Strategy of the faculty is to combine scientists and practicing architects. Research cooperation seems in this respect to be good.

Group grades

Scientific quality and productivity: 3 (Good)

Relevance and impact: 3 (Good)

Strategy, organisation and research cooperation: 3 (Good)

Group recommendation

The group has interesting and highly relevant research fields, with important links to social science, which are also appealing and attractive to students. However, they are highly dependent on SINTEF for their research activity. It is recommended that a more serious effort should be made to support the group. In particular, they must be helped to build up professional, permanent staff.

2. Narvik University College

Narvik University College (NUC) is located in Northern Norway, 200 km north of the Arctic Circle. It is a small institution with approximately 1100 students and 140 staff members. Three-year BSc programmes are offered in several fields of engineering and in nursing, and MSc programmes are offered in engineering (building, mechanical, electrical, computer technology, space technology). PhD studies can be pursued at NUC but the degrees are awarded by NTNU or Luleå University of Technology.

2.1 Department: Institute of Building, Production and Engineering Design

The department is one of four departments at NUC. Three research groups are being created in that department: Virtual Manufacturing and Supply Chain Management and Logistics, Energy and HVAC, and Building Technology.

The department needs a breakthrough in terms of financing and strategic alliance. NUC is a university bringing significant benefits to the region. Therefore, the Research Council of Norway should take some responsibility in allocating special funding to allow the research groups a quick start by helping them to reach and pass a critical size.

Another boost of the research level could be obtained by providing funds to finance high quality visiting professors for a limited period (2-3 years).

2.1.1 Research group: Building Technology

Rating: Good (grade: 3)

The research group has chosen to focus on performance of cement-based materials in cold climates, including development of low-energy materials that minimise negative environmental impacts. The last area includes the use of waste materials from the cement industry.

Cold chambers are available for various types of experimental set-ups for testing of material sample performances. Test rigs and instrumentation are designed by the staff. A multipurpose load and deformation controlled testing machine, able to work with specimen at temperatures down to -40^{o} C, will soon be installed in the laboratory as part of a cooperation with a local branch of the research company NORUT Teknologi A/S. Cooperation with Norwegian and Danish cement industries is established.

The present research deals with theoretical and experimental studies of mass transfer in cement based materials in cold climates, durability of concrete structures, and design and performance of smaller wooden houses in extremely cold areas. Formal research collaboration is established with University of Tromsø, NTNU, Luleå University of Technology, Sweden and Arkhangelsk State Technical University, Russia.

Given the difficulties in attracting scientific staff, focus should be on research education through PhD-studies.

Relevance and impact

The chosen areas of research are relevant for all cold regions with building infrastructure. Successful research in the area of new cement based materials will have a positive impact on society.

Scientific quality and productivity

Both the scientific quality and the productivity in terms of publications are good given the size of the staff and the short time the group has been in existence. With the planned expansion of the group with two PhD students the research capacity will be increased significantly and will then reach the critical size of a research group. Still, a group of this size needs close cooperation with other researchers or research groups in order to gain sufficient strength.

The group has been active in applying for research money both on a national and an international level. This should continue as it can be expected that chances for funding will increase with the size of the research group.

Strategy, organisation and research cooperation

With respect to research areas, it is recommended that the group follow the strategy already defined. Given the difficulties in recruiting scientific staff the focus should be on getting more PhD-positions financed.

The research group within Building technology/building materials is the node point of cold climate research and of the generation of basic knowledge within models and experiments for civil engineering education. Therefore, also the research component deserves to be strengthened. The cooperation with NORUT Technology for research and education at NUC should be intensified.

The continuous efforts of the group to apply for funding seems to become successful.

Group recommendation

Expand the research capacity by close scientific cooperation with other research organisations. Keep on applying for research funding.

2.1.2 Research group: Energy and HVAC

Rating: Good (grade: 3)

The Energy and HVAC group deals with energy efficient HVAC installations in buildings in cold climates. Ongoing research projects are: (i) Performance of rotary heat exchangers, (ii) Simplified methods for dimensioning and commissioning VAV systems, (iii) Heating and ventilation balancing rig, (iv) Energy efficiency.

The main facility is a HVAC laboratory test room, completely designed and built by the research group and containing multiple installations for heating, ventilation and air conditioning, all of which can be computer controlled and applied in numerous combinations. A nearly complete set of measurement systems including gas tracer, smoke visualisation, thermo-camera, particle counter, acoustic measurement equipment, is available. A large collection of hand-held instruments for measurement of parameters related to building-physics is also available. They put the group in an excellent position to do advanced research, but also to help the local building industry with their short-term problems. The laboratory facilities provide excellent conditions for research within indoor climate, building automation, heating and ventilation, and energy flow in buildings. This includes calibration and verification of related numerical models.

Although the R&D profile relates mainly to energy efficient HVAC installations in buildings in cold climates, the group is also working with energy efficiency in urban and industrial environments. Within this field four R&D projects have been carried out within the last couple of years in cooperation with private industries and /or public bodies. Related to the HVAC-test room the ongoing research projects deal with performance of rotary heat exchanges, methods for dimensioning and commissioning VAV systems, and energy efficiency in HVAC-technology.

A PhD-study on coordination and integration of heat stations was started recently. A large number of more practical projects has been undertaken in the fields of thermography, noise and indoor climate for industrial clients, contractors and public authorities.

As it is difficult to attract scientific staff, it is necessary to focus on research education through PhD-studies.

Relevance and impact

Focusing on energy efficiency and improved HVAC-technology related to buildings in cold regions is a good choice considering the importance for society and the level of the present knowledge. The number of joint projects with the business and the public sector confirms this.

Scientific quality and productivity

Given the small size of the group and the few years of work as pioneers within the field at Narvik University College, the scientific results and the productivity are good. It is expected that the research and related publication efforts can expand so that less effort will be required to build up the laboratory facilities.

Strategy, organisation and research cooperation

The selected area of research is highly relevant and should not be widened as this already constrained by staff size. The assignment of the group as a node (‘Technology in Cold Climates’) in the National Qualifications Network is a good starting point to develop a solid research activity on HVAC.

It is recommended that numerical modelling be coupled to the experimental research so that generic engineering tools can be generated. One professor and two more PhD-students are needed in the group in order to form a reasonably sized research unit. More international research cooperation should be established. This collaboration can effectively utilise existing networks and strategies established by a group of universities in the northern regions.

Group recommendation

The group should find ways of expanding the number of staff and should establish more international research cooperation. Numerical modelling should be an integrated part of the HVAC research activities.

2.1.3 Research group: Virtual manufacturing, Supply Chain Management and Logistics

Rating: Good (grade: 3)

This group has presently 8 staff members: 1 professor, 3 associate professors, 1 professor II, 2 PhD students and one technical staff member.

The main activity of the group is on virtual manufacturing, i.e. modelling, visualisation, simulation and performance analysis of manufacturing systems. The group has a full array of CAD-packages at their disposal and a 3D visualisation laboratory. They have a varied portfolio of application-oriented projects (cost reduction in fish supply chains, quality optimisation in manufacturing of Si solar cells, North East West freight corridor, underwater unmanned welding, automatic welding robot, factory planning projects, …) where they use the available infrastructure.

An obvious extension of the activity would be to use the 3D visualisation lab for collaborative engineering (e.g. with the design lab in Luleå University), by making the screen interactive e.g. with a laser pen and/or a haptic interface.

The link between the CAD-systems and the rapid prototyping activity, e.g. for creating optimised STL-files, is an obvious research opportunity to be further exploited.

There is a well-integrated, low cost CIM-system set up in the lab, consisting of a machining centre, two robots and a co-ordinate measuring machine. The subsequent extension to include the CAD and the process planning phases of the manufacturing cycle is potentially useful for local manufacturing industry and can be used as a base for further research in computer-integrated manufacturing and for project work.

The mechatronics activity is presently purely oriented towards developing set-ups for teaching purposes. The intended projects on underwater robots and welding robots for spherical tanks open up opportunities for interesting mechatronics based research projects. The offline-programming problem is a particularly interesting one and could be developed in collaboration with the virtual manufacturing lab.

Scientific quality and productivity

The group has tackled a variety of manufacturing and product development problems around the visualisation lab and the available CAD/CAM software packages. This is a good starting base but at the moment the projects lack clear focus and scientific approach. A few well-supervised PhD students could make the difference in the future. The publication record of the key members of the group is good. The current emphasis is understandably on conference proceedings.

Relevance and impact

The relevance of most projects is clear. The visualisation lab could be used more appropriately for some projects. There are several opportunities for collaboration with local industry that could be explored more aggressively.

Strategy, organisation and research cooperation

The group needs a clearer research strategy. Although the department is small, there seem to be very few contacts between the three groups despite much potential for synergy. The manufacturing group contacts with the computer science department could also be very beneficial.

Research on supply chain management should be primarily focused on issues of regional development, like harbours, multimodal transport, fishery, etc.

Group recommendation

Develop a more coherent research programme built on the regional characteristics and resources.

3. Agricultural University of Norway

The need for modernising and increasing the efficiency of Norwegian agriculture and food production led to the establishment of Norwegian Institute of Agricultural Engineering, LTI, at Ås, close to Oslo in 1948. It worked closely with the Agricultural University founded around 1900 and located also in Ås. Recent large structural changes at the Agricultural University have had a major objective to reduce administrative costs, increase efficiency and to provide basis for more competitive research groups and educational programmes. The changes have largely affected the technically oriented research groups and departments like the Department of Agricultural Engineering. They have merged into the new Department of Mathematical Science and Technology which provides education in mathematics, physics, informatics and basic engineering and several applied technical sciences – building technology and architecture, machinery and bio-systems engineering, water and environmental engineering, aquaculture engineering and surveying - linked with a research portfolio.

There are 9 five year MSc-programmes (5 technology-oriented) and 7 PhD-programmes.

The strategic plan of the Agricultural University puts focus on research in five major areas:

- Environmental science
- Food science
- Biotechnology
- Aquaculture
- Business development

The self-evaluation covers the former department of Agricultural Engineering but strategies and plans reflect the new department.

3.1 Department of Agricultural Engineering

(Now merged into Department of Mathematical Science and Technology)

The department has a unique combination of biological, agronomical and engineering competence in one organisation. It gives the engineering science at the university a platform of interdisciplinary capacity for understanding the interactions between technology, biological systems, living organisms and nature that is found nowhere else in Norway. At the same time this also provides a difficulty for a small organisation to be able to allocate both manpower and resources and handle crucial needs for effective recruitment on all levels to assure a qualified and stable research capacity.

Technology is not visible in the research strategy of the university. It is rather seen as a “toolbox” for biological and production oriented disciplines. There has also been a long period with a decreasing funding base. The image of the department is to some extent that of an institute serving a low-technology and subsidised industry.

There is a need for a strategy aimed at a more efficient and quality oriented organisation, with special attention to:

- Environmental engineering with emphasis on nature based and sustainable recycling technologies for organic and municipal waste and waste water including small-scale and distributed bio-energy systems.
- Aquaculture engineering with emphasis on high-quality sustainable systems for breeding, slaughtering and food processing.

Efforts are required to establish better laboratory facilities.

3.1.1 Research group: Building Technology and Architecture

The group has 8 professors, 1 doctoral student and technical/administrative employees. They deal with measures to stop degradation processes in older buildings owing to corrosion and aggressive gases, especially of concrete structures; new ways of using wood materials; interactions between animals and the internal building environment; building aesthetics; the interaction between farm buildings, building traditions and the rural cultural landscape in Norway. The research has three foci: agriculture, engineering and architecture. The ongoing restructuring of farm size in Norway directs the research emphasis towards buildings. Technology is not visible as the university focuses primarily on biotechnology.

The group has probably good potential, but this is difficult to gauge. There seems to be a lack of research vision or attractive strategies for rural development in Norway. They have a low international profile and low publication standards.

The overall position of the group seems in decline. They sounded tired; a more energetic leadership is needed. The present focus on future needs in farm buildings and on the use wood materials in CAD design is good, but beyond that their vision seems limited.

While staff is aging, there is a halt in recruitment of qualified young staff. Many MSc students contribute to the research, but there are very few PhD students.

Scientific quality and productivity

The rate and the level of scientific publications are low —“architects don’t publish”.

Relevance and impact

The research topics are relevant. The impact is however mainly national and limited.

Strategy, organisation and research cooperation

The group vision is limited in scope. There seems to be no long-term strategy in place. The group’s research network is weakly developed; nationally as well as internationally.

Group grades

Scientific quality and productivity: 2 (Fair)

Relevance and impact: 2 (Fair)

Strategy, organisation and research cooperation: 2 (Fair)

Group recommendation

There is a need to identify future research areas stemming mostly from farm size changes and rural development in Norway (and perhaps in Scandinavia). A vision and strategy should be developed under a much stronger leadership than at present. They should be attractive enough such that more PhD students and young staff members join the group. Publication policy and cooperation should be significantly improved to have more visibility and larger impact.

3.1.2 Research group: Machinery and Biosystems Engineering

The group has 12 faculty members and 2 doctoral students. It comprises two sub-groups, the first providing the basic engineering education, and the second responsible for the agro-technology and bio-systems engineering courses. In research the two sub-groups interact very closely and can be considered as one group. The research profile of the group includes:

- development of new machinery and methods for agriculture and bio-production,
- handling and processing of biological materials,
- technology for production of bio-energy,
- environmental measures,
- testing and certification of agricultural machinery,
- assisting in the development of small, innovative companies and technology transfer

The group is young and has a good age distribution, but it is too small to handle effectively all above-mentioned subjects. Their focus on sustainability is positive. The mixed scientific staff (from AUN and NTNU) of enthusiastic professionals has undoubtedly research potential. They have a well-established contact network with industry.

The group is spread too thinly, but they see the need for team building. They could be much stronger if activities were not so widely spread both over topics and locations. Six staff members graduated from the department and there is one professor working outside the university for the government. All of the staff members have more than 10 years of research experience.

Research is very much based on MSc students. As a consequence, it is difficult to do research in fields which are not in the curriculum.

Scientific quality and productivity

Although the group has a reasonable number of international publications, they have sufficient material to do much better. Their productivity in applied research is at a reasonable level. They need more international focus in their research approach.

Relevance and impact

The applied research results produced have both relevance and impact. New companies have emerged based on the research of the group. However, they still need to convince the life science focused institutions of their industrial value.

Strategy, organisation and research cooperation

No firm strategy has been presented, although they have got a plan and the drive to execute it, with prototypes ready for take-up by industry.

Group grades

Scientific quality and productivity: 3 (Good)

Relevance and impact: 3 (Good)

Strategy, organisation and research cooperation: 3 (Good)

Group recommendation

The size of the group should be increased. This should be associated with a careful strategic planning to decide priorities: at present the group focuses on too many topics. A stronger integration of engineering and life sciences is advised. It is suggested to locate the entire group at a single site. More PhD students are needed to increase flexibility in research, which is now limited by the too large contribution of MSc students. More publication activity – national and international alike – is a must.

3.1.3 Research group: Water and Environmental Engineering

The group is small with 7 faculty members (of whom only 2.2 profs on university salary, but will increase this year to 3.2.) and 3 doctoral students. Previous MSc-profile in Hydro-technology (drainage and irrigation) and Environmental engineering (water and municipal engineering) is now shifted to Environmental engineering and management.

Research focuses on: (i) Recycling technologies, (ii) Natural systems for wastewater treatment (bio-filters, constructed wetlands…), (iii) BMP (Best Management Practice) for sustainable urban infrastructure, and (iv) Flood mitigation by optimal functioning of urban drainage systems

The group shows a lot of dynamism, with a clear focus on rural areas and developing countries and the vision to show the road to a sustainable society. They have an impressive frontier programme, with too many topics however in comparison to the

size of the group, good international profile and cooperation (working with many partners in Norway, USA, Canada, … China), with positive pilot plants and demonstration projects.

Their MSc intake is increasing again, after a temporary dip. However, their publication record is rather low and they need more PhD students. They have a potential for modelling natural systems given the integration with mathematicians.

The group has a clear strategy and strong leadership. They are focused on becoming a leading centre for recycling and natural systems for waste water and bio-energy. (This might be too ambitious for such small a group). Their research area might be an inspiration for a future Centre of Excellence.

They are the smallest group in the department and obviously have the potential to grow. They have good opportunities and could attract PhD candidates for which they are reluctant because of their limited supervision capacity). They need to recruit more post docs and PhD students.

Scientific quality and productivity

The scientific quality of the group's research is high. They need to convert their numerous high-level reports into journal papers, for which they would need time and PhD students.

Relevance and impact

The selected research topics are very relevant and have a high impact: Patents have been filed and some results are commercialised.

Strategy, organisation and research cooperation

The group is vulnerable to loss of key personnel. They have extensive international cooperation related to solving problems in developing countries. A stronger cooperation with NTNU would be sensible.

Group grades

Scientific quality and productivity: 3 (Good)

Relevance and impact: 4 (Very good)

Strategy, organisation and research cooperation: 3 (Good)

Group recommendation

The group is characterised by a contradiction which might be a threat: though the group is rather small, it developed an over-ambitious programme on an attractive field and got probably more visibility than justified. This issue should be seriously resolved by taking a number of actions: increase the size of the unit (and attracting more PhD students); decrease the number of projects; go into more scientific detail and focus on new fields such as the modelling of semi-natural treatment systems; more cooperation

with NTNU; increased support to the group leader, and produce more archival journal publications.

3.1.4 Research group: Aquaculture Engineering

With 4 faculty members and 3 PhD students, this is smallest research group; with no MSc-programme. Activities include: methods for farming of mussels, mussel farming for environmental cleaning up procedures; development of an industrial model for large-scale mussel farming in Norway for the EU-market.

Although small, this group is well focused and inventive, with sustainability as the underlying theme. They have good leadership, strong contact with industry (which is a platform for them) and increased focus on reduced production costs. However, facilities are poor and badly located for dealing with salt-water aquaculture, which is by far the most important activity. They do have an alliance with a neighbouring institute, which gives them access to their lab on the west coast. They have only few PhD students, and could be highly vulnerable given the strong national competition; they need more staff in order to be sustainable. Most of the group members work for a company. They are a positive group, see positive solutions and have good publication record. The lab is a must.

Scientific quality and productivity

For such a small group, they have a very good number of publications, including papers in refereed journals, and an internationally acknowledged expertise.

Relevance and impact

The group's research field is obviously very relevant for Norway (and other countries). However, the group needs more/better lab facilities and staff in order to make a stronger impact.

Strategy, organisation and research cooperation

The group has strong international contacts. Cooperation with NTNU-aquaculture is not clearly spelt out in the strategic plan. The group is really too small to remain viable in the long run. Why not integrate aquaculture research on a national level? More cooperation within the department, as well as with NTNU (Marine Systems and Marine Civil Engineering) seems appropriate and possible.

Group grades

Scientific quality and productivity: 4 (Very good)

Relevance and impact: 4 (Very good)

Strategy, organisation and research cooperation: 3 (Good)

Group recommendation

The group requires more staff and PhD students to have a sustainable future. The same statement applies to laboratory: facilities are very poor and the location of the lab is bad. There is a strong national competition. For this reason more cooperation with NTNU and the development of a national strategy on aquaculture research is recommended.

3.2 Department: Mapping sciences (Mathematical Science & Technology)

Before September 2003, the Department of Mapping Sciences was one of several departments of the Agricultural University of Norway. It then became the Geomatics Section of the Department of Mathematical Science & Technology. It consists of three small groups:

1. Geodesy and Surveying (G&S)
2. Photogrammetry and Remote Sensing (PRS)
3. Geographic Information Systems (GIS)

The department has 13 faculty staff, one post doc and 6 PhD students and no technical/secretarial employees. The department has suffered from many uncertainties, in its relation to agriculture, and many changes. They seem not quite clear on which research topics they should focus and suffer from general problems, such as age, overload, etc. In the somewhat defensive presentation to the panel, the department was presented as a whole and not as individual research groups. Consequently, the evaluation is presented here in the same manner.

They express the wish to be visible and be the centre of gravity for Norway within the disciplines of Geodesy and Surveying, Photogrammetry and Remote Sensing, Geographic Information Systems. With the present group, this is an ambitious goal. There are disparate areas even in the separate groups—there seem to be no common research goals; publications, which are at a low level, are very diverse. It seems as if the university group does not have a close relationship with industry, since they only get 5% funding from that source (+5% in kind). Their strategy and role of Geomatics at NHL and in society should be more clearly stated.

The department is a new formation, with no visible plan. They have no technical/secretarial staff, so that even when 40% of professor's load is theoretically allocated to research, only 10% is used in practice because more time is spent on teaching and administration. They need to develop a professional leadership and use the platform of interdisciplinary capability. The area has high potential and it should be "marketable". Lack of a strategy for the research is also in evidence.

Recruitment is generally weak: very few MSc students (10 B.Sc.'s and 10 MSc's are produced each year), but efforts are being made to change the situation. There is a lack of funds that are necessary for growth. A recruiting plan is needed since faculty staff is aging.

Scientific quality and productivity

Relatively few PhD's are produced and no PhD programme in Photogrammetry is available. Scientific publications are very limited (as an average for the group, but there are big differences within the group).

Relevance and impact

The area is important: there is much need of mapping sciences in many areas, including future interest from the telecom industry. However, the group's impact on society seems limited and it will remain unclear if they do not coordinate and focus.

Strategy, organisation and research cooperation

They express the wish to be seen as the Geomatics centre in Norway rather than part of the Agricultural University. They need to develop a strategy for how to collaborate with informatics, natural resources and different industries. The Geomatics section strives to be the national centre of mass for academic education and research within the mapping science. Having identified the resources to reach this goal, the plan to do so is not clear. There is a vision of focusing on Georeferencing Environmental Information. This is realistic as many topics in the university can provide the relevant information. Mapping environmental change over time is part of the selected research topics of the department. They lack external funding.

Group grades

Scientific quality and productivity: 2 (Fair)

Relevance and impact: 2 (Fair)

Strategy, organisation and research cooperation: 2 (Fair)

Group recommendation

A pro-active strategy should be developed for the group to dissolve present uncertainties, which are only partially stemming from changes in agriculture and recent reorganisation within the university. Structural changes and a new recruitment policy are recommended since at present there are too many professors without assistance, too few MSc and PhD students, unfavourable age distribution etc. A more energetic leadership with vision is needed which defines clear (interdisciplinary) objectives on a field having much potential (in the interface of mapping sciences, environment, rural development, IT etc.) and enhances cooperation in-house and nationally alike. Modern disciplines like satellite-based navigation, airborne image and laser scanning, synthetic aperture radar, and Geographical Information Systems are all relevant to Norwegian Society. However, the areas demand expensive equipment and well-educated researchers. More contacts with industry and fund raising activities are recommended. Publication policy should be significantly improved and the international profile of the group should be raised.

4. Stavanger University College

4.1 Department of Industrial economics, Risk management and Planning

4.1.1 Research group: Planning and urban design

Rating: Fair (grade: 2)

The group has 5 faculty staff and one PhD student. Their main activity is in urban design planning combined with industrial economics and risk management, where they want to emphasise urban development and design. With a Transport/Shipping interface, this topic should have a research market; the point of departure being the Petroleum industry. The group, which is in a period of transition and reorganisation from college to university in the near future, is too small and with high teaching load. But they have a number of interesting opportunities for alliances in both education and research.

They have an exchange programme and summer courses; that increases the cross-disciplinary activities. However, as a new group, they have no real, strategic plan yet. The area of 'Technical Planning' could take on responsibility for PhD's together with the "Safety management, Risk analysis" group, in the Department of Petroleum Technology. Existing very qualified experience in risk analysis and risk management from a long period of Norwegian offshore activities provides an excellent base for these efforts.

They have very few MSc students and need to recruit more PhD students and younger staff. Teaching seems to take a lot of effort (though they have only about 10 students/faculty member).

Scientific quality and productivity

The group has only one PhD student. It has an interesting mix of disciplines, but very few publications in total. There is no research programme as such in the group yet.

Relevance and impact

The group is still searching for a role in urban planning and design. It could become a very interesting research group with a focus on system integration that is unique (Urban planning, Industrial Economics and Risk Management). Research could lead to an acceptable level of relevance and impact if the multidisciplinary cooperation with other groups (including Risk evaluation) can be established. Each of the professors is a specialist with long experience, but the research content of their work has been low. Publications, if produced, are mainly for local consumption.

Strategy, organisation and research cooperation

The group could play a useful role given its multidisciplinary nature (architect/ civil eng/ transport). They have already established cooperation with Aalborg university (student exchange) and contacts with a couple of other major universities. Research work is, however, not yet well coordinated within the group and is carried out on an individual basis. There is strength within urban planning (ground and transport) with the hope that the cooperation with the Risk Management group and others will develop into research programmes. Port planning is, so far, not included, although ports can have significant impact on urban areas. There is no visible research strategy, nor programme.

Group recommendation

The recommendation will focus on the importance of strategic planning of both research and educational programmes. The group should identify possible partners in society that can benefit from a strategic partnership with the university. The industrial sector is strong in the Stavanger area and there are also most likely clear community based interests in urban planning for development of transport and communication systems and environmental management within a regional development framework. There are probably strong incentives for creating local competitive educational programmes on university level, linked to research activities, to offer to students in the region. This provides a good base for long-term planning of the development of the university.

5. The PhD programme

The PhD programme is the backbone of the research activity at any university. In engineering in general and the Faculty of Engineering Science and Technology of NTNU in particular, the tradition of PhD-embedded research is rather young and no formal system is in place yet. The panel felt it is highly relevant to pay special attention to this aspect of fostering research. A meeting with a representative delegation of PhD students was organised, a summary report of which is given below. Some recommendations conclude this section.

5.1 Meeting with PhD Students

Eight PhD-students attended the meeting, six from NTNU (among which 2 were female students and one student from Germany) and two from the Agricultural University in Ås. The engagement in their studies ranged from one to 3.5 years.

The purpose of the meeting was to better understand the way in which doctoral students are involved in the ongoing research programmes at NTNU and how they perceived their status as doctoral student.

A PhD-candidate can apply for a position through the central university system where vacancies are posted or directly through a professor who has vacancies in the framework of a new project. In most cases the student has to make and defend a proposal. The establishment of a university-wide IT-based platform for PhD-students could make the communication on various PhD-related topics more effective.

The PhD-students have to follow a 30-credits programme of courses, in the beginning of their study. They can select from a reasonable variety of courses, ranging from specialised subject-oriented courses to courses on research methodology and scientific writing.

Interaction with the supervisor is not uniformly satisfactory. There does not seem to be a PhD-'culture' or a common idea of a 'good research environment' (e.g. regular 'research seminars' for PhD students). There are no generally accepted 'qualities of a good supervisor'. Some students see their supervisor almost on a daily basis, others much less frequently, some never at all. There are no milestones where the progress is assessed and reported to a higher authority (e.g. a faculty supervisory PhD-committee). Some of the PhD-students suggested a research co-ordinator (post doc?) would be very helpful, particularly in the starting period of the PhD research.

The initiative to write a paper or attend an international conference mainly comes from the PhD student. Financing of costs for attending conferences is not always guaranteed. This problem is particularly acute for foreign students with a scholarship that barely covers their living expenses. Also the logistic support (e.g. for developing and building test set-ups) is problematic for these foreign PhD students owing to lack of appropriate funding. The PhD students urgently requested a solution to this problem. The PhD students who receive a salary (280 000-300 000 NOK – 29% tax) receive a 'bench fee' of 22 000 NOK to cover the working and travelling costs.

The teaching load of the PhD students seems not to noticeably affect the research work. Students hired on a 3-year basis do not have many teaching duties, students on a 4-year basis have to spend up to 25% of their time teaching. This situation, however, where PhD students are not much involved in teaching tasks creates another problem: that of overloading the academic staff with teaching tasks. This complaint was almost universally expressed by the academic staff throughout the evaluation week.

For students having research topics involving significant experimental work delays in the research often occur owing to insufficient effective support from technical laboratory staff.

Owing to the relatively low number of PhD students in many research groups, there are few or no organised meetings where the PhD-students can discuss problems, technical or other, of common interest.

The university should consider it of utmost importance to communicate down to the PhD-level its overall research strategy: stimulating creativity, and a critical and constructive attitude. The PhD-level is the key creative level.

5.2 Recommendations

- The establishment at NTNU-level of a more formalised PhD programme is desirable.
- The establishment of Research Schools, eventually in a Nordic framework would enable high-level graduate courses to be offered.
- The availability of vacant positions for PhD should be centrally announced
- The guidance of the PhD student must be taken seriously. A published ‘guide for PhD supervisors’ seems essential for all parties.
- Besides a thesis supervisor, a ‘mentor’ at post-doc level or higher should be assigned to each PhD student at the start of the programme.
- The publication policy for research work achieved by the PhD student must be clarified with the supervisor.
- Appropriate operational costs during the PhD study (test set-ups, travelling costs) must be provided by the supervisor.

Appendix 1: The Mandate

Evaluation of Norwegian research in engineering science

Introduction

The Research Council of Norway has decided to evaluate research activities in engineering science in Norwegian universities and colleges. The reports of the individual evaluation panels together with the report of a principal evaluation committee will form the basis for the future strategy of the Research Council.

The objective of the evaluation

The objective of this evaluation is to assess the quality and relevance of research in Engineering science in Norwegian universities and colleges.

The evaluation process is expected to:

- Offer a critical assessment of the strengths and weaknesses of Norwegian research in Engineering science, both nationally and at the level of individual research groups and academic departments. This includes both the scientific quality of research in an international context and its impact on society.
- Identify research groups which have achieved a high international level in their research, or which 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 possess necessary competence in areas of importance for the nation. One important aspect of this, to assess recruitment to Engineering science.

The long term purpose of the evaluation

- Function as a platform for future development of Engineering science
- Give feedback regarding the research performance of individual groups and departments, as well as suggestions for improvements and priorities
- provide the institutions concerned with the knowledge they require to raise their own research standards
- Improve the knowledge base for strategic decision-making by the Research Council
- Represent a basis for determining future priorities, including funding priorities, within and between individual areas of research.

The evaluation is designed to reinforce the role of the Research Council as an advisor to the Norwegian Government and relevant ministries.

Organisation

Evaluation panels will be established for major subfields within engineering science. A principal evaluation committee with chairman and co-chairman from each of the panels as members will write a summary report based on the general conclusions and recommendations of the panels for the subfields.

Terms of reference

The panels are requested to make use of the departments' self-evaluations in its *assessment of the overall state of Engineering science* and to draw up a report with a set of specific *recommendations for the future development* of this field.

The panels are further requested to *evaluate the departments* with respect to organization, management and strategic plans, *evaluate research groups* with emphasis on three major aspects bearing in mind the resources available: i) Scientific quality and productivity, ii) Relevance and impact on society, and iii) Strategy, how research is organized, and research cooperation both nationally and internationally.

The conclusions of the panels and principal evaluation committee should lead to a set of recommendations concerning the future development of research in Engineering science in Norway.

General aspects

- Which fields of research have a strong scientific position in Norway and which have a weak position? Is Norwegian research being carried out in fields that are regarded as relevant by the international research community? Is Norwegian research in Engineering science in the frontier of scientific developments internationally within specific areas?
- Is the present research in Engineering science relevant to the future needs of Norwegian business sector and public sector? Are new developments on the international scene represented on the research agenda ?
- What impact does the research have in society? Do research groups maintain a good network to the business sector and the public sector?
- Is there a reasonable balance between the various fields of Norwegian research in Engineering science in view of the needs for competence in the Norwegian society at large?
- Is there a reasonable degree of co-operation and division of research activities at national level ?
- Are there any other important aspects of Norwegian research in Engineering science that ought to be given consideration?

Academic departments

Organization, management and strategic plans

- Are the academic departments adequately organized?
- Is scientific leadership being exercised in an appropriate way?
- Is research within individual departments carried out according to an overall research strategy?
- How is the status w. r. t. laboratories and research infrastructure and do they demonstrate ability to make use of the infrastructure ? Is there sufficient co-operation related to the use of expensive equipment?

Recruitment and mobility

- Do the scientific staff play an active role in stimulating the interest among young people, in particular women, for engineering science?
- Is recruitment to doctoral training programs satisfactory, or should greater emphasis be put on recruitment in the future?
- Do they pay attention to the challenge of motivating more female students to go into research?
- Is there an adequate degree of national and international mobility?
- Are there sufficient educational and training opportunities for Ph. D. students related to future oriented industrial research challenges?
- Do graduates go to research jobs in the business sector?

Research groups

Scientific quality and productivity

- Do the research groups maintain a high scientific quality judged by the significance of contribution to their field, prominence of the leader and team members, scientific impact of their research?
- Is the productivity, e.g. number of scientific and professional publications and Ph. D. thesis awarded, reasonable in terms of the resources available?
- Do they show ability to work effectively with professionals from other disciplines, and to apply their knowledge to solve multifaceted problems?

Relevance and impact

- Do the research have a high relevance judged by impact on society, value added to professional practice, and recognition by industry and public sector?

- Do the research groups have contracts and joint projects with business and public sector, are they awarded patents, or do they in other ways contribute to innovation?
    - Do the research group contribute to the building of intellectual capital in industry and public sector?
    - Do they play an active role in dissemination of their own research and new international developments in their field to industry and public sector?
    - Do they play an active role in creating and establishing new industrial activity?

Strategy, organization and research cooperation

- Have research groups drawn up strategies with plans for their research, and are such plans implemented?
- Is the size and organization of the research groups reasonable?
- Is there sufficient contact and co-operation among research groups nationally, in particular, how do they cooperate with colleagues in the research institute sector?
- Do the research groups take active part in interdisciplinary/multidisciplinary research activities?
- How is the long term viability of the staff and facilities evaluated in view of future plans and ideas, staff age, research profile, new impulses through recruitment of researchers?
- Is the international network e. g. contact with leading international research groups, number of international guest researchers, and number of joint publications with international colleagues, satisfactory?
- Which roles do Norwegian research groups play in international co-operation in their individual subfields within Engineering science?
- Do they take active part in international professional committees, work on standardization and other professional activities?

Appendix 2: CV's of Each Panel Member

Hendrik Van Brussel (°1944), is full professor in mechatronics and automation at the Faculty of Engineering, Katholieke Universiteit Leuven (K.U.Leuven), Belgium, and chairman of the Division of Production engineering, Machine design and Automation (PMA), Department of Mechanical Engineering.

He received his B.Sc ME (Technisch Ingenieur) degree from Hoger Technisch Instituut, Oostende, Belgium, in 1965, and his M. Sc. EE (Burgerlijk Ingenieur) and PhD degrees from K.U.Leuven, Belgium, in 1968 and 1971 respectively. From 1971 until 1973 he was active in Bandung, Indonesia, establishing a Metal Industries Development Centre and as an associate professor at Institut Teknologi Bandung.

He was a pioneer in robotics research in Europe and an active promoter of the mechatronics idea as a new paradigm for machine design. He has published extensively on different aspects of robotics, mechatronics and flexible automation. His present research interest is also shifting towards holonic manufacturing systems, behaviour based robots, and micro and precision engineering, including microrobotics.

He is Fellow of SME and IEEE. He received honorary doctor degrees from the Rheinisch-Westfälische Technische Hochschule (RWTH), Aachen, Germany, from 'Politehnica' University in Bucarest, Romania, and from 'Transilvania' University in Braşov, Romania. In 2001-2002 he served as President of CIRP (International Institution for Production Engineering Research). He is a Member of the Royal Flemish Academy of Belgium for Sciences and Arts, and Foreign Member of the Royal Swedish Academy of Engineering sciences (IVA).

He was chairman of the panel on research for the Quality Assessment of Education and Research in Mechanical Engineering in the Netherlands in 2000.

Bengt Lindberg is professor in Production Systems since March 2000 and head of the department of Production Engineering at the Royal Institute of Technology, KTH.

He has an M.Sc (M.E.) 1980, Lic.Sc (M.E.) 1984, PhD (M.E.) 1986, from KTH, Sweden; Management and Business Education, 1997, Swedish Institute of Management, IFL.

His research area covers manufacturing system configuration design, digital projecting, principles and methods in the development process as well as manufacturing processes and equipments for manufacturing systems. One of the main issues is to develop an efficient, flexible, and industrially relevant methodology for modelling and simulation of manufacturing systems. The chair comprehends also principals and methods for flexible manufacturing and equipment. With emphasis on material handling and technique for automation, as means for integrated systems. The research area compasses a holistic view on the interaction with the production realisation process.

Bengt Lindberg has also 15 years of experience from Scania. His industrial career covers responsibilities from production engineering, engine production to development tools for the product realisation processes.

He is a member of, The Royal Swedish Academy of Engineering sciences, (IVA); Chairman for the Royal Swedish Academy of Engineering sciences, IVA / IFG,

Industrial Research Committee. Board member of the Competence Centre Woxén, KTH; Board member of the Alfvén Laboratory, KTH; Board member of the Vehicle Technology Centre, KTH; Chairman for Engineering Institute, KTH; Board member of the Nano- and Microtechnology Centre; Board member of the Swedish Machine Tool and Cutting Tool Manufactures Association, FVM; and Board member of KTH.

László Somlyódy is Professor and head of Department of Sanitary and Environmental Engineering, Budapest University of Technology and Economics, Hungary. His professional experience spans: water quality management and modelling, systems analysis, eutrophication, regional and global water/environment issues, flood control, river basin management and wastewater engineering. He gained experiences in Europe, North/South America and China. He is author of nine books, about 120 articles and more than 100 research reports, and has given lectures in about 40 countries. Professor Somlyódy is member of: Hungarian Academy of Sciences (chairman of its Engineering Department), European Environmental Science Foundation, European Academy of Sciences and Arts, International Water Academy, a number of Hungarian and international high level advisory boards (including EU bodies), and journal editorial boards. He is president elect of the International Water Association, president of the Hungarian Wastewater Association and Chairman of the Science and Technology Council in Hungary.

Kai Borre is professor in Surveying at Aalborg University since 1976. He is head of Danish GPS Center and head of the international master of science study in GPS Technology at Aalborg University.

Dr. Borre is a chartered surveyor 1966, M.Sc. in geodesy (Copenhagen University), in 1969, and Dr. Techn. in 1986 (Graz Technical University). Dr. Ing. h.c. 1993 (Vilnius Technical University).

He is author of five books in surveying, network design, error propagation, and GPS. Since 1996 regular visits to MIT.

In 2001 Borre initiated a network for small and medium sized enterprises which focuses on Galileo based activities.

David Andrews was given a new Chair in Engineering Design at University College London in September 2000, following his early retirement from the UK Ministry of Defence where in his last two senior posts, he was first Director of Frigates and Mine Countermeasures and, latterly, the Team Leader for the Future Surface Combatant Integrated Project Team. From 1986 to1990 he was the Warship Project Manager for the procurement of the Royal Navy's Replacement Amphibious Shipping Programme. He was subsequently Head of Preliminary Design in the Future Projects (Naval) Directorate, where he was responsible for the initial studies on the Royal Navy's new Aircraft Carrier, Future Attack Submarine and Future Surface Combatant and was the authority on unconventional hull forms. He was MoD sponsored Professor of Naval Architecture at UCL from 1993 to 1998.

At UCL as Professor of Engineering Design he has set up a new Design Research Centre in the Department of Mechanical Engineering, which is focusing on computer aided preliminary design, trimaran design research, ship combat system integration

and design methodology for complex systems. He has an acknowledged international reputation in design synthesis and the methodology and acquisition of such complex systems. On Trimaran ship design, he is the author of the most comprehensive set of published learned papers and was interviewed by the national media on the occasion of the launch of the first Trimaran warship prototype in May 2000. As Chairman of International Marine Design Conference's Design Methodology Panel he produced the first State of the Art report on Marine Vehicle Design Methodology.

He is a Chartered Engineer, a Fellow of the Royal Society of Arts, a Fellow of Institution of Mechanical Engineers and Fellow of the Royal Institution of Naval Architects, for whom he chaired the Future Directions Committee, is a Member of Council, past Chairman and now Vice Chairman of the Membership Committee and recipient of several awards. In 2000 he was elected a Fellow of the Royal Academy of Engineering.

Hans Falk Burcharth (Dr. Techn.) is since 1974 professor in Marine Civil Engineering at the Department of Civil Engineering, Aalborg University, Denmark. He was head of the department for 25 years since its start in 1974. He established the Hydraulics and Coastal Engineering Laboratory in Aalborg.

His research is theoretical and experimental mainly related to turbulence, coastal protection and coastal structures including material aspects. Pioneered new methods for reliability based performance design of breakwaters. He is

- Broad engineering experience from own consulting engineering company and world-wide activities as consultant to public authorities and private enterprises.
- Coordinator and partner in large EU-research projects. Judge of expert in the Danish Civil Engineering Arbitration Court, expert witness in international arbitrations. Author/co-author of a number of books and app. 120 papers.
- Editor-in-Chief: Elsevier Science Journal: Coastal Engineering, since 1993.
- Member of the Danish Academy of Technical Sciences. Member of the Danish Technical Research Council and Chairman of the Civil Engineering Committee, 1985-1995.
- Member of various Danish governmental committees for offshore oil and gas research, and a wave power committee.
- Chairman and participants in a number of PIANC working groups related to port engineering.
- Doctor Honoris Causa, University of Ghent, 1996.
- Advisory professor East China Technical Univ. of Water Resources, Nanjing.

Hans C. Björnsson is a professor of Civil Engineering at Stanford University (USA) and in Systems Management at Chalmers University in Gothenburg, Sweden. He is PhD (Construction Management), Chalmers University of Technology, Sweden, 1974; Master of Urban & Regional Planning, University of Illinois at Urbana-Champaign, U.S.A.1974; MSc in Civil Engineering, Chalmers Univerity of Technology, Sweden, 1967.

He is in charge of the ”e-commerce and supply chain management” thrust area of the Center for Integrated Facility Engineering at Stanford where his research involves a wide range of technical, social, economical and managerial issues. He is a former dean of the School of Technology Management & Economics at Chalmers and a professor of Construction Systems Management there. He has been the director of IMIT and on the faculty of University of Illinois at Urbana-Champaign, M.I.T., and the University of Southern California. He is a member of the Royal Swedish Academy of Engineering sciences. His research areas include: Modeling and simulation of construction processes; Computer-Supported Collaboration; Evaluation of IT Investments; and Management of Technology.

Klas Cederwall is professor emeritus in Hydraulic Engineering at the Royal Institute of Technology, KTH.

His research area covers civil and environmental engineering with focus on hydraulic engineering. Special topics are hydropower and dam construction, river and coastal engineering, risk analysis and safe dam management.

Klas Cederwall has previously had different research positions at Chalmers Institute of Technology, California Institute of Technology, Technion in Israel and University of Novosibirsk in Russia. He has supervised 65 graduate students for their Licentiate and PhD several of them in multidisciplinary research projects.
He has had the following academic assignments: Dean School of Architecture, Surveying and Civil Engineering, KTH, member of University Board, KTH, Chairman Department of Civil and Environmental Engineering, KTH, member of Scientific Committee, Swedish Building Research Council, Scientific coordinator Geotechnical research group, Chalmers Institute of Technology, Scientific coordinator Archipelago Research Center, KTH, member Royal Academy of Engineering sciences, IVA.

Appendix 3: Letters to the Institutions

Institutt for produksjons- og kvalitetsteknikk
NTNU
S.P. Andersens v. 5, Valgrinda
7491 TRONDHEIM

Vår saksbehandler/telefon	**Vår ref.**	**Oslo,**
Dag Kavli / 22 03 73 61	2003/01284	29.08.2003
	Deres ref.	

Evaluering av forskning innen ingeniørvitenskapelige fag – Informasjonsmøte, faktaark og egenvurderinger

I Informasjonsmøte

Vi viser til brev av 20. juni om Forskningsrådets forestående evaluering av forskning innen ingeniørvitenskapelige fag ved universitetene og utvalgte høgskoler.

Forskningsrådet inviterer med dette til felles orienteringsmøte for involverte instituttledere og andre aktuelle aktører

torsdag 18. september 2003 kl. 1200 -1600 på hotell Royal Garden, Trondheim med registrering fra kl.1140.

Hensikten med møtet er å informere om evalueringen med fokus på opplegget, mandatet for evalueringspanelene, instituttets/forskergruppens egenvurdering, fremdriftsplan med mer, se vedlagte program. Vi legger stor vekt på å ha en åpen dialog om evalueringen, og har satt av tid til drøfting av spørsmål.

Vi gjør oppmerksom på at instituttet kan stille med 3 deltakere. For Norges landbrukshøgskole, Høgskolen i Stavanger og Høgskolen i Narvik, dekker Forskningsrådet reiseutgifter for inntil 2 deltakere per institusjon (dagsreise). Vær vennlig å melde fra til Bente Johansen, baj@forskningsradet.no, om antall deltakere og navn på disse **innen 10. september.**

II Faktaark og egenvurderinger fra instituttene

Hvert institutt skal fylle ut et faktaark. Hensikten med faktaarket er å lette panelenes arbeid med egenvurderingene, se veldagte faktaark med veiledning.

Frist for innsending av faktaarket til Forskningsrådet er **15.11.03** Arket sendes elektronisk til Bente Johansen: baj@forskningsradet.no merket *Faktaark.* Instituttet skal sammen med faktaarket legge ved en liste med navn og adresser (e-post og vanlig adresse) for alle fast vitenskapelig ansatte og postdoktorer (alle de personer som sender inn CV), slik at Forskningsrådet kan oppfylle krav fra Datatilsynet om å informere direkte de personer som omfattes av evalueringen.

Egenvurdering

Egenvurderinger fra instituttene/forskergruppene vil utgjøre et sentralt grunnlag for de internasjonale evalueringspanelene. Kvaliteten på egenvurderingen vil være av stor betydning for panelenes vurdering av forskningen og dens rammebetingelser og for evalueringsrapportens samlede kvalitet.

Vi ber om at hvert institutt utarbeider en egenvurdering i henhold til vedlagte utkast til disposisjon med beskrivelse. Beskrivelsen kan bli justert etter møtet 18. september, og endelig beskrivelse (på engelsk) vil bli lagt ut på Forskningsrådets nettsider kort tid etter.

Egenvurderingen inkludert alle vedleggene bes innsendt på papir.

Frist for innsendelse av egenvurderingen er 1.12.03.

Egenvurderingene vil bli gjennomgått av Forskningsrådet før materialet blir oversendt evalueringspanelene. Som tidligere nevnt, vil møter med panelene og fagmiljøene bli avholdt vinteren 2004.

Når utkast til panelrapporter foreligger, vil instituttet få tilsendt egen omtale for faktakontroll før endelige rapporter offentliggjøres. Evalueringen begrenses til vurderinger og anbefalinger på institutt-/forskergruppenivå, og enkeltforskere vil ikke bli omtalt ved angivelse av personnavn.

Forskningsrådet legger vekt på at hver enkelt forsker som omfattes av evalueringen skal få god informasjon, blant annet vil hver vitenskapelig ansatt få tilsendt brev om evalueringen. Vi viser ellers til Forskningsrådets nettsider hvor det jevnlig vil bli lagt ut informasjon om evalueringen.

Kontaktpersoner

Spørsmål i tilknytning til evalueringen kan rettes til:

- Prosjektleder Malena Bakkevold, tlf. 64972872/95759533, e-post: post@malena.no
- Spesialrådgiver Dag Kavlie, Området for naturvitenskap og teknologi, tlf. 22037361,

  e-post: dk@forskningsradet.no
- Prosjektsekretær Bente Johansen, tlf. 22037348, e-post: baj@forskningsradet.no

I det videre arbeidet vil hvert institutt bli bedt om å utpeke en kontaktperson for evalueringen.

Med vennlig hilsen

Norges forskningsråd

Ole Henrik Ellestad

Direktør

Naturvitenskap og teknologi

Tone Vislie

Avdelingssjef

Vedlegg:

- Program for informasjonsmøtet
- Utkast til disposisjon for egenvurderingen
- Faktaark med veiledning
- Oversikt over fagmiljøene i evalueringen
- Fremdriftsplan
- Mandat

Institutt for produksjons- og kvalitetsteknikk

NTNU

S.P. Andersens v. 5, Valgrinda

7491 TRONDHEIM

Vår saksbehandler/tlf.	**Vår ref.**	**Oslo,**
Malena Bakkevold/95 75 05 33	2003/01284	12.02.2004
	Deres ref.	

Evaluering av ingeniørvitenskapelige fag – Timeplan og retningslinjer for høringsmøtene

Vi viser til kontakt per brev og e-post om evalueringen og tidspunkt for høringsmøtene.

Vedlagt følger timeplan for instituttenes/forskergruppenes møter med panel 1. Det enkelte institutt må selv gå inn i timeplanen og sjekke aktuelt tidspunkt for oppmøte. Høringene finner som kjent sted i uke 11, dvs. fra mandag 8. mars til og med torsdag 11. mars.

For å oppnå likebehandling forutsettes det at timeplanen holdes av alle parter.

Forberedelser

Hvert høringsmøte vil ha en todelt oppbygging med innledning/presentasjon fra det aktuelle instituttet/forskergruppene og påfølgende spørsmål fra panelet.

Panelet er godt kjent med det innsendte materialet. Punkt 3 under A Department level i egenvurderingen omtaler instituttets sterke og svake sider. Leder av panelet ønsker at presentasjonen især konsentreres om dette punktet, samt at sterke/svake sider i tillegg ses i et framtidsperspektiv. En slik analyse går under betegnelsen SWOT-analyse hvor akronymet står for ”Strenghts” (styrke), ”Weaknesses” (svakhet) - i dag - og ”Opportunities” (muligheter) og ”Threats” (trusler) - i framtiden. I tillegg til ”Weaknesses” ønsker panelleder også at ”Obstacles” (hindringer) per i dag blir belyst, slik at

vi i realiteten får en "SWOOT-analyse" mer tilpasset forskningsverdenen. Instituttet velger selv i hvilken grad de aktuelle forskergruppene vil presentere seg selv. Forskergruppene bør i tilfellet forme sin presentasjon rundt en tilsvarende, kort SWOOT-analyse.

Vi er generelt oppmerksomme på at framtidsperspektivet har en naturlig kobling til både nåtid og fortid. Hvilke forskningsincitamenter er viktige? Gjør framstillingen så konkret og oversiktlig som mulig – **og husk at den skal være på engelsk**.

Forholdet mellom innledning og høring skal være i størrelsesorden 20 – 80. Konkret betyr dette at dersom et institutt står oppført med 2 timer i timeplanen så skal innledningen (SWOOT-analysen) utgjøre maksimalt 24 minutter av møtet (inkludert presentasjon av forskergruppene). For å sikre tilstrekkelig tid til spørsmålsstilling forbeholder panelet seg retten til å avbryte innlederne dersom de går ut over den skisserte tidsrammen.

Vi anbefaler at innlederne benytter lysark slik at informasjonen kommer tydelig fram. Ta med 10 kopier av presentasjonen (**på engelsk**) slik at denne er tilgjengelig for panelet i det videre arbeidet.

Informasjon og inntrykk fra høringsmøtene må betraktes som tilleggsinformasjon til det materialet som allerede er innsendt fra instituttene/forskergruppene og som utgjør hovedmaterialet for evalueringen.

Deltakelse

Det er nødvendig å begrense antallet deltakere under høringsmøtene. Maksimalt antall deltakere fra deres institutt er satt til 5 personer. Høringsmøtene for de største instituttene vil gå over flere timer. Instituttet bestemmer selv om deres representanter skal delta under hele høringsmøtet eller om de skal komme til ulike tidspunkt.

Vi ber om at liste over instituttets representanter med navn og tittel sendes Bente A Johansen per e-post innen **25. februar**, se adresse nedenfor.

Praktiske forhold

Alle intervjuer finner sted på Royal Garden Hotel i Trondheim. Flybussen stopper like utenfor hotellet.

Generelle spørsmål i tilknytning til høringsmøtene rettes til:

- Spesialrådgiver Dag Kavlie, tlf 22 03 73 61, e-post: dk@forskningsradet.no

- Prosjektleder Malena Bakkevold, tlf 64 97 28 72/95750533, e-post: post@malena.no

Praktiske spørsmål rettes til:

- Prosjektsekretær Bente A Johansen , tlf 22 03 73 48 , e-mail: baj@forskningsradet.no

Panel 1 ser sammen med Forskningsrådet fram til en viktig og hektisk uke og takker for arbeidet som blir lagt ned i denne forbindelse fra instituttenes/forskergruppenes side.

Med vennlig hilsen

Ole Henrik Ellestad

Avdelingssjef

Divisjon for vitenskap

Malena Bakkevold

Prosjektleder

Fakultetet for ingeniørvitenskap og
teknologi, NTNU

Vår saksbehandler/tlf.
Dag Kavlie, 22 03 7361

Vår ref.

Deres ref.

Oslo,
02.02.2004

Evaluering av ingeniørvitenskap – Møte med doktorstudenter

Under Forskningsrådets møte med panellederne i desember kom det frem at lederne ønsker et eget møte med representanter for doktorgradsstudenter i løpet av høringsukene i Trondheim. Vi har derfor lagt inn et møte med doktorgradsstudenter i timeplanen for hvert panel. I tillegg til studenter fra NTNU vil det også komme doktorstudenter fra Høgskolen i Stavanger (panel 3) og Norges landbrukshøgskole (panel 1) til møtene.

For NTNU blir det tre møter. Møtetidspunktene er som følger:

Panel 1: Onsdag 10.mars 1230 - 1400

Panel 2: Onsdag 3.mars 1230 - 1400

Panel 3: Torsdag 4. mars 0930 - 1100

Møtene blir holdt på Royal Garden hotell.

Møteopplegg

Møtet vil bli lagt opp uformelt med spørsmål fra panelet og diskusjon. Hensikten med møtet er å få synspunkter fra studentene på tema som har betydning i forhold til mandatet for evalueringen.

Vedlagt følger en liste med spørsmål vi i samråd med panellederne mener det kan være interessant å komme inn på i møtene. Møtene skal ha en åpen form. Panelet kan velge å ta opp også andre spørsmål med studentene, og på samme måte har studentene muligheter for å ta opp tema de er opptatt av.

Vi ber om at NTNU, gjerne gjennom organisasjonen for doktorstudentene, finner frem til **4-5 studenter per panel** som er villige til å delta på møtet. Det er ønskelig at det kommer doktorstudenter fra de instituttene som er dekket av det aktuelle panelet. Vi oppfordrer deltakerne til å ta kontakt med andre doktorstudenter innen de berørte fag i forkant av møtet. Diskusjonen i møtene vil foregå på engelsk.

Spørsmål angående møtene kan rettes til:

- Spesialrådgiver Dag Kavlie, tlf 22 03 73 61, e-post: dk@forskningsradet.no
- Prosjektleder Malena Bakkevold, tlf 64 97 28 72/95750533, e-post: post@malena.no

Med vennlig hilsen

Norges forskningsråd

Ole Henrik Ellestad
Avdlingssjef

Malena Bakkevold
Prosjektleder

Vedlegg : Meeting session between the Panels and the Ph.d. students - Tentative list of questions to be discussed**.**

Evaluation of Engineering Science in Norway

Meeting session between the Panels and the Ph.d. students

Tentative list of questions to be discussed:

- How is the interaction with the professor in charge, with the rest of the research group and with other Ph.d.students? Do you have contact - e, g. common seminars - with Ph. D students in other, related fields?

- How much of your time goes to general studies (courses, reading literature) compared to time to research?

- How are the opportunities to get international experience by going to international conferences or to work for some time at institutions in other countries? Have you presented your work at any conference, do you plan to?

- How will you publish your work?

- Do you have contact with industry in your research?

- Do you get proper training in scientific methods related to your field, and are you trained in communication skills?

- How do you consider the organization of the Ph.d. study in your department?

- To what degree are the students in your department stimulated by the scientific staff to go into research?

- Do you feel motivated to pursue a further research career within research institutions or in industry after completing the degree? Why not/why yes?

- What are you the most/the least satisfied with in your doctoral studies?

The Ph.d. students should also have the opportunity to raise other issues.

Appendix 4: Time Schedule

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Evaluation of Research in Engineering Science in Norway
Time schedule for meetings of Panel 1

Date	Time	Institution/department	Research group
Monday March 8 2004	0900-0915	Panel's 15 minutes	
		NTNU	
		Faculty of Engineering Science and Technology	
	0915– 1015	*Presentation of the NTNU, SINTEF and the Faculty*	
	1015 - 1030	Break	
	1030 - 1200	**Department of Production and Quality Engineering**	• Production Systems • Operation Management • Reliability, Availability, Maintainability and Safety
	1200 - 1300	Lunch	
	1300– 1330	Panel's 30 minutes	
	1330 - 1500	**Department of Marine Technology**	• Marine systems
	1500 - 1530	Panel's 30 minutes	
	1530 - 1600	*Departure for site visit at NTNU*	
	1600 - 1800	*Site visit*	

Evaluation of Research in Engineering Science in Norway
Time schedule for meetings of Panel 1

Date	Time	Institution/department	Research group
Tuesday March 9 2004	0900-0915	Panel's 15 minutes	
		Faculty of Engineering Science and Technology	
	0915– 1030	**Department of Civil and Transport Engineering**	• Building and Materials Technology • Geomatics • Geotechnical Engineering • Marine Civil Engineering • Project Management and Construction Engineering • Road and Transport Engineering
	1030 - 1045	Break	
	1045 - 1200	**Department of Civil and Transport Engineering cont.**	
	1200 - 1300	Lunch	
	1300– 1345	**Department of Civil and Transport Engineering cont**	
		Faculty of Architecture and Fine Arts	
	1345 - 1430	**Department of Architectural design, history and technology**	• Building technology
	1430 - 1530	Panel's hour	
	1530 - 1600	*Departure for site visit at NTNU*	
	1600 - 1800	*Site visit*	

Evaluation of Research in Engineering Science in Norway
Time schedule for meetings of Panel 1

Date	Time	Institution/department	Research group
Wed March 10th 2004	0900 - 0915	Panel's 15 minutes	
		Faculty of Engineering Science and Technology	
	0915– 1100	**Department of Hydraulic and Environmental Engineering**	• Hydraulic Engineering • Water and wastewater engineering • Solid waste engineering and recycling
	1100 - 1130	Panel's 30 minutes	
	1130– 1230	Lunch	
	1230 - 1400	**Meeting with Ph. d. students**	
	1400 - 1430	Panel's 30 minutes	
		Narvik University College	
	1430 - 1445	*Presentation of the College/Department*	
	1445 - 1600	**Department for Building, Production and Engineering Design**	• Integrated Building Technology • Industrial Engineering
	1600 - 1615	Panel's 15 minutes	
	1615 - 1645	*Departure for site visit at NTNU*	
	1645 - 1800	*Site visit*	

Evaluation of Research in Engineering Science in Norway
Time schedule for meetings of Panel 1

Date	Time	Institution/department	Research group
Thur March 11th 2004	0900-0915	Panel's 15 minutes	
		Agricultural University of Norway	
	0915– 0930	*Presentation of the Institution*	
	0930 - 1030	**Department of Agricultural Engineering**	• Building technology and Architecture • Machinery and Biosystems Engineering • Water and Environmental Engineering • Aquaculture Engineering
	1030 - 1045	Break	
	1045-1200	**Department of Agricultural Engineering, cont**	
	1200 - 1300	Lunch	
	1300-1430	**Department of Mapping Science**	• Geodesy and Surveying • Photogrammetry and Remote Sensing • Geographic Information Systems
	1430 - 1445	Break	
		Stavanger University College	
	1445 -1500	*Presentation of the College/Department*	
	1500 –1530	**Department of Civil Engineering**	• Technical Planning
	1530 - 1600	Break	
	1600 - 1800	*Final meeting/closing of the week*	