Evaluation of research in engineering science in Norway

Energy and Process Technology

Panel 3

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TO THE RESEARCH COUNCIL OF NORWAY

The members of Panel 3: Energy and Process Technology in the Evaluation of Norwegian Research in Engineering Science in Norwegian Universities and Colleges hereby submit the following report. The views presented in this report express a 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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Chairman

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Prof Philip Hutchinson also acted as scientific secretary of the evaluation panel.

Contents

Overall Summary of the Evaluation and General Conclusions

Observations, General Comments, Overall impression

The overall general impression of the research is positive in that, in most of the areas considered, the research is well funded and well organised. The doctoral students are also generally well satisfied with their situation.

The Nature of Engineering Research

The mandate states a requirement for an evaluation of research in Engineering Science. However, a clarifying discussion with the Research Council revealed that what was required was an evaluation of research in Engineering and that the title Engineering Science was a consequence of process of translation from Norwegian to English. Thus the evaluation presented here considers Engineering Research in the round.

Engineering sometimes advances by heuristic methods based on trial and error and data reduction when the underpinning science is unclear or too complicated for the deductive analytic approach of Engineering Science. Engineering Research therefore includes both of these approaches to the acquisition of new knowledge.

The difference is neatly illustrated by the differences between the development of the steam engine and the gas turbine. In the former case it is fair to say that thermodynamics owes more to the steam engine than the steam engine owes to thermodynamics. In counterpoint it would have been impossible to develop machines with the efficiency of current gas turbines without a clear understanding of the laws of thermodynamics. Topics where heuristic approaches are still necessary include turbulent flow and multi-phase flow.

The Role of the University

An important general role of the University is the provision of an independent perspective for its society, which draws on the best of international knowledge and the full range of international opinion. This perspective may often include views and opinions that are at variance with fashionable views or the received wisdom of the society in which it is located. It is this function which underpins the notion of tenure for academic faculty which gives protection from dismissal for promulgating unpopular views.

In the area of engineering research the panel had a powerful impression that the research perspective is introspective with an excessive focus on Norway and the Nordic area. As noted above leading Universities should play an important role in providing an international perspective in their subject areas through education,

consultancy and policy commentary. In engineering this function was seen as relatively weak in terms of international perspective. In particular the University and faculty strategies seemed very closely bound to Government policy with little challenge to the consensus view.

The Balance between Applied and Fundamental Research

The research has a predominantly applied focus and while a strong emphasis on application is appropriate for engineering disciplines, a balanced approach requires strong fundamental research to engender international networking and to underpin the strategic and applied research. There is a need for more emphasis in this area, which should be focussed on areas of excellence and excellent individuals. The difficulty in this area is shown in the lack of faculty time for long term research, the difficulty in funding research assistants and the generally weak performance in refereed publication.

Archival Publication

There is a generally weak performance in archival publication and this is only partly due to the emphasis on applied research. There should be an expectation that successful research should lead on to archival publication and this expectation should be reinforced by an incentive structure.

Recruitment and Retention of Faculty

All of the institutions reported difficulty in recruiting and retaining faculty of the appropriate quality as the salaries offered had become uncompetitive with those outside the university in Norway and with universities in other countries in Europe and in the USA. This will also seriously inhibit international recruitment to the faculty.

If not addressed this will lead on to serious difficulties in the near future as several of the groups have an age structure which is unbalanced, with a lack of younger faculty.

Diversity of Staff

Diversity in the background of the staff and students is important in ensuring that a wide range of perspectives is brought to bear on issues, that the full range of talents in society is available to engineering and that good international connectivity is maintained.

The faculty was lacking in diversity with weak international representation and also few women. Efforts should be made to address this, though it will be difficult to increase international recruitment with the present salary structure.

The Evaluation of Research Proposals

The present system for evaluation of research proposals by the Research Council was using resources inefficiently as the majority of the proposals were unsuccessful. The Research Council should consider a change to a process of review of first an abstract, then a plan and finally a project.

Links with the European Union Framework Research Programmes

There are difficulties in working with the EU in part because of the time and cost of travel to most EU Member States. It would be useful to identify those EU programmes where participation was strategically important and provide support for the costs of interaction and especially travel. This would also reinforce the international perspective in the selected areas.

Utilisation of Laboratories

The National Technical University of Norway (NTNU) and Stavanger University College are well equipped with laboratories and as such maintain strong programmes of experimental work. It was not clear how the financing of the laboratories was done in comparison with, for example, faculty costs. It is possible that the cost of the laboratories is not correctly perceived and that this in turn is leading to poor utilisation of space and under-pricing of applied research for clients. Any changes should be carefully considered so as to avoid damaging the existing strong programmes of laboratory based research.

Links between Institutions

There are related research activities in Petroleum Engineering, a topic of key strategic importance for Norway, in NTNU and Stavanger University College, each with its own strengths. It would strengthen both the research and international visibility of each institution if a policy of more active collaboration was followed.

Narvik University College has a weak research performance in the areas considered here. If it is to develop acceptable levels of research to support PhD education in a reasonable time it will require very close support from an institution, such as NTNU or Luleå University, which is already well established in the relevant fields and the practice of PhD education.

NTNU

At NTNU the relationship with SINTEF is clearly very beneficial in providing the University with support for applied research and access to high quality laboratories. However there is a lack of clarity in the relationship which made it difficult to disentangle the contribution of NTNU from that of SINTEF.

The collaboration between NTNU and SINTEF certainly has a tendency to drive the research of the University towards application and development. We have already noted that the research portfolio of the University should be rebalanced by increasing and strengthening the long term research. We also conclude that the NTNU should review whether a clearer identity and independence is required for the University research in relation to that of SINTEF.

The new faculty structure at NTNU, while unproven, seemed to be working well. The implementation of the change had clearly caused considerable strains. The faculty was not prepared for the management issues involved with any sort of training or personal development in management and leadership skills. Given the likelihood of continuing change in the University and the need for the management of large and complex programmes in many areas of engineering research, it is important to rectify this lack by providing programmes to develop academic leadership and management skills.

Given the importance of Petroleum Technology to the Norwegian economy, it should be a strategic area, and its research more closely linked to other research in the general area of Energy.

Stavanger University College

The strategy of developing as a University now seems likely to be realised and, consequently, a reformulation is now required. The new strategy should emphasise why the selected lines of research have been chosen, why they are considered important and define the philosophy to be used in approaching the chosen topics. It should also reflect the changing nature of the Norwegian oil industry as it moves into its mature phase: less emphasis on exploration topics, more emphasis on improved oil recovery; more emphasis on recovering stranded gas; carbon dioxide storage. Convening a workshop or a retreat to form this strategy is one of the recommendations of this committee.

It would be beneficial to form a link with Rogaland Research to develop the same advantages in applied research as NTNU obtain from the link with SINTEF but maintaining the present clear distinction between the two institutions.

Narvik University College

The institution is isolated geographically and intellectually. If it is to develop satisfactory doctoral level education it will require a closer partnership with an established institution and a significant increase in resources. The group leadership appears to be energetic, which could be a strength upon which to build.

The Processes of the Evaluation

The process of considering separately the three areas of scientific quality and productivity, relevance and impact and strategy, organisation and research cooperation, was helpful in forming a balanced judgement of the research.

The supporting data provide by the Research Council and the self evaluations and other information provided by the institutions were helpful and clearly set out.

The area which requires review is that of the structure of the presentations and the visits to the laboratories. The intention of the laboratory visits was that the panel should see the facilities. However, all groups visited took the opportunity to give further presentations of their work. This extra information was found to be generally useful by the panel. In the case of the Department of Petroleum Technology at Stavanger University College the laboratory visit and additional presentations were essential in reaching an accurate evaluation of the research. Therefore we conclude that laboratory visits including presentations, or some additional presentations by active researchers, should normally be included in the evaluation process in order to reduce the chance of a false impression being created by a single weak presentation.

General Recommendations

- The University should ensure that it is providing an independent view based on an international perspective.

- There is a need to broaden the research perspective to be much more international.

- The research activity should be rebalanced by increasing the amount of long term research in areas of excellence.

- Publication in archival journals should be increased.

- The salary structure for faculty should be reviewed in comparison with international levels and salaries in similar fields in industry so as to ensure that recruitment and retention of faculty of the appropriate stature can be achieved.

- The diversity of the faculty should be increased with a particular emphasis on internationalisation and increased numbers of women.

- The process of review of research proposals should be changed to reduce the effort applied to preparing proposals.

- Participation in the Framework Research Programmes of the European Union should be fostered.

- The pricing of laboratory space should be reviewed to ensure the proper perception of costs by the users.

- Co-operation between NTNU and SUC should be fostered in the area of Petroleum Technology.

- The relationship between NTNU and SINTEF should be clarified.

- Training programmes in management and leadership skills should be developed for faculty to help them respond to change and to assist in succession planning.

- A new strategy is required by SUC which takes account of its probable changed status and the changing requirements of the Norwegian oil industry.

- NUC will require substantial assistance if it is to develop as an institution capable of supporting good PhD research.

- The process of separately considering different aspects to form a balanced evaluation of the research was welcomed and should be continued.

- Future evaluations should provide a mechanism which avoids a single weak presentation giving a false view of a group. This could be achieved by including laboratory visits by the panel which provide for additional presentations by active researchers or by extending the presentation process to include more representation by active researchers.

Evaluation of the Departments and Research Groups

The following sections summarize the evaluations of the departments and research groups within Energy and Process Technology in engineering research at Norwegian universities and colleges. The evaluations are based on information provided during 4 days of interviews in Trondheim and visits (March 1st – March 5th 2004) to laboratories in NTNU and Stavanger University College.

For every department there is an initial commentary and, where research groups are not evaluated separately, there is an evaluation of:

- Scientific quality and productivity
- Relevance and impact
- Strategy organization and research cooperation

For every research group there is an evaluation of:

- Scientific quality and productivity
- Relevance and impact
- Strategy organization and research cooperation

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

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

1 Norwegian University of Science and Technology

Faculty of Engineering Science and Technology

1.1 Department of Energy and Process Engineering

Department Evaluation and Recommendation

The Department of Energy and Process Engineering was established on 1st October 2002. The Department is a merger of the former Department of Thermal Energy and Hydropower, the Department of Refrigeration and Air Conditioning and most of the Department of Applied Mechanics, Thermodynamics and Fluid Dynamics. (The Solid Mechanics Group of the latter was transferred to the present Department of Structural Engineering).

The Department of Energy and Process Engineering is organised into four research groups namely:

- Thermal Energy
- Industrial Process Technology
- Energy and Indoor Environment
- Fluids Engineering

All of these groups are evaluated below.

The overall organisation and management of the Department seemed to be working well even though it was quite new. The Department was well prepared for the evaluation and each group made excellent written and oral presentations of the activities within the department. The new structure also provides good opportunities for synergistic links between the individual groups and potential for development in inter-disciplinary areas.

The Department has 21 professors, 8 associate professors, 8 professor II, and 116 doctoral students.

The data does not indicate gender or ethnicity of the faculty but the names suggest that the entire faculty is drawn from the Nordic area.

The Department has 15 technicians organised as a common staff serving all the different laboratories at the Department.

The Department received 51% of its budget from external sources in 2002. The external income includes contributions of about 5% of the total budget from research and SINTEF Energy and about 10% from the contribution to Dr.ing. students' salaries which are accounted for at other companies. The total spending in 2002 was 86MNOK, which gives an average budget per professor of 2.3MNOK.

24 of the 40 named professors are aged 50 or older and 9 are more than 60 years old. Given that the department will remain at about its present size or grow, the replacement of faculty who retire will provide an interesting opportunity to select new strategic directions for the Department. It is therefore important that the faculty and its leadership carefully consider future research directions and recruit accordingly.

The financial structure of the Department generates a heavy reliance on external funding and about half of that funding (25% of the total department budget) comes from industry. As a result there is very good contact and cooperation with industry and particularly with SINTEF. However, this level of externally financed activity means that there is considerable time spent on writing research proposals and looking for research financing. There is an associated risk that the research programme will move too much into applied research or testing which will not add to the intellectual capital of the department. Happily, there is no indication of a problem in this area at the moment. However, the departmental management must be vigilant in monitoring this lest one develop.

An associated risk with the pattern of financing is that too much time will be spent on writing research proposals, many of which will ultimately fail. There is no data in the material on the success rate of research proposal submissions but a worry was expressed that this is an issue in applications to the Research Council. There are various steps that can be taken to moderate this that are discussed elsewhere.

The integration with SINTEF also provides very good laboratory facilities, which in turn has led to strong experimental programmes in each of the groups.

The key areas of focus selected by the Department, namely energy, environment and food, give a strong and positive signal of future direction.

Overall the Department has the potential to be world leading in several fields and should use the development of faculty vacancies to recruit strongly to reinforce and develop this potential. In so doing it should seek to draw in more faculty from other regions so as to improve both its international perspective and visibility.

The number of PhDs graduated by the Department was 14 in 2003 and 16 in 2002 which is an increase from about 10 in the preceding 2 years. These numbers are quite modest on an international scale for good Universities but are amongst the highest at NTNU.

1.1.1 Thermal Energy Group

Group Evaluation and Recommendation

Scientific Quality and Productivity

This group has contributed strongly internationally in its own fields of endeavour. It is at the top level in the world in carbon dioxide sequestration and has a major role in one very large EU-funded project (ENCAP) related to carbon dioxide sequestration.

The academic profile is strong with 5 professors out of 10 holding doctorates or several years of post doctoral employment with well known universities abroad, e.g. Stanford, Cranfield, Berkeley (2) and Zurich. This international standing has been further recognised by faculty winning three international awards since 2002, a significant number of international invited lecturers and a good output in both quantity and quality of international publications.

The group is also well represented on international committees and conferences and has good mobility both in terms of visiting guest researchers and the faculty spending time in foreign universities.

The output of PhD theses is good and PhD students are often attracted from other disciplines.

The activity in combustion has been recognised by the award of a Marie Curie training site. The group is active in the initiation and operation of the gas technology centre between NTNU and SINTEF which is a substantial international level activity in the field.

There is a potential to be at the world leading level in combustion if the group is able to put more emphasis into kinetic modelling and advanced laser diagnostics. They should also collaborate more intensively with their colleagues in the fluid mechanics group in the department.

The focus in turbo machinery necessarily has been in the operation of the machines as there is no manufacturing base in this area in Norway and this has inhibited developments in turbo machinery design.

Overall there is an impression of positive developments in scientific quality and productivity in the group. If these continue the group should be able to achieve top marks in this field over a period of two to five years.

Relevance and Impact

In this area the group scores very highly. It has generated 10 patents and 2 new applications and founded 5 new companies. The professors all have a very close contact with industry and several have a background in the industrial sector.

The activity tables show many externally financed projects and this level of external funding has been maintained over several years.

The group also plays a key role in offering advice to external bodies. Several of the professors are advisers to the Research Council and Government. The group has had a key role in the outline of the energy research policy for Norway and in contributing to the outline of Framework VI on research relating to carbon dioxide sequestration. There is also a strong engagement in public debate via books, radio, TV and newspapers. Members of the group serve on the steering committee for the state programme for utilisation of natural gas as well as several other committees with relevance to the national and international research in the field.

The relevance and impact of the group is at the highest level.

In addition the group is a key partner to the oil and gas industry in the development of techniques for sub sea multi phased pumping and compression.

Strategy, Organisation and Research Cooperation

The group has a clear strategy with measurable goals. The implementation of the strategy is well advanced. As a result the group has a potential to become stronger in the next few years as the new organisation settles into place.

There are 10 professors, 5 post docs and about 35 PhD students in the group. To give good supervision to all the PhD students the group presently has, it should at least double its number of post docs.

There is a long experience of multi disciplinary research at the national and international level in the faculty. There are good contacts with leading international groups. Several of the faculty have been visiting professors at leading universities and the group hosts guest researchers from other leading universities.

The faculty has also been involved in several international activities such as international evaluations, examination committees and the organisations of conferences in collaboration with the Combustion Institute, ASME and the IEA.

There is a good mix between old and younger professors and the group appears to have at least 5 professors who are well established in their international field.

The group is currently a key partner in 2 EU projects in the field of carbon dioxide sequestration, together with the other relevant European industries and universities.

The group is also a driving partner in a new EU financed laboratory project (which is under negotiation), the ENGAS project, which involves 14 other NTNU laboratories. This will further increase the exchange of international researchers as the project, once realised, will have a status similar to the arrangements for large scale research facilities in the EU framework VI programme.

The group is developing strongly and has the potential to obtain top marks in 2-5 years providing developments continue.

Group Grades

Scientific quality and productivity: 4
Relevance and impact: 5
Strategy, organisation and research cooperation: 4

1.1.2 Industrial Process Technology

Group Evaluation and Recommendation

Scientific Quality and Productivity

This group is at the international level in 3 areas: drying, carbon dioxide heat pumps and liquid natural gas and multi phase transport.

Its position in drying and multi phase transport is recognised in its appointment as a Marie Curie training site. The laboratory facilities are very good which in part recognises the close collaboration of the group with SINTEF.

The group has a long experience in multi disciplinary research and its contribution has been recognised by a significant number of national and international awards. Several members of the group have also been invited speakers at a range of conferences.

There is substantial external support but most of it is at the short and medium level. More long term support is needed.
The quantity of conference publications is very good, as is often the case with groups that have a strong focus on application. The number of journal publications should be higher, though the quality of those produced is generally good.

Only 3 or 4 PhDs are produced per year and it is important that the planned growth to 5 or 6 per year is achieved if the group is to be further developed.

2 of the 10 professors in the group are involved in management positions at the department and faculty level.

The academic profile of the group has potential for development. However, this will require a positive impetus that will require the appointment of a number of young researchers and a significant increase in the number of journal publications if it is to reach top marks.

Relevance and Impact

The group has a strong impact in the area of industrial application. It has produced 11 patents and 2 applications are pending. In addition, 3 new companies have been established based on research from the group. There is very substantial interest from the car industry in Japan, the USA and Europe in the air conditioner developed by the group.

The group has also been innovative in introducing carbon dioxide as the working medium in heat pumps for application in households and cars. The heat pump using tap water with the carbon dioxide working medium introduced as a result of work by the group sold 50,000 units in Japan during 2002.

There is also a large interest from the food industry for the food processing research.

The low temperature research activities in the group have, in collaboration with industry, led to production of new spiral round heat exchanges for liquefied natural gas plants, breaking a world monopoly from a dominant producer. The MFC LNG process will be licensed worldwide.

However, the group has not been active in open debate and influencing public policy. Thus the impact on industry and business is very strong but the impact on society, government and public information is lower than elsewhere. Nonetheless the group deserves top marks for this area.

Strategy, Organization and Research Cooperation

The research group has 9 professors and 2 open professorial positions. They should recruit more young professors and post docs to re-balance the age profile. Some members of the group are well established internationally. The existing faculty has a good international network and cooperation and the group has good connections with other institutions. There are presently 10 guest researchers and 15 under graduate students in the group.

This external connectivity will be fostered by the participation of the group in the new ENGAS EU-funded multi-disciplinary centre for mobility and research in Europe.

The collaboration between this group and others internally is good. It participates in 10 NTNU projects, each of which contains 10 PhD students from different departments.

The connection with SINTEF is also very strong as the group participates in a GEMINI centre within which there is a well organised cooperation between SINTEF and different departments inside NTNU.

The group has been very successful in its links with industry and industrial innovation. However, there is a danger that the academic profile will become too weak if industry funding increases so that it dominates the activities of the department.

Group Grades

Scientific quality and productivity: 4
Relevance and impact: 5
Strategy, organisation and research cooperation: 4

1.1.3 Energy and Indoor Environment

Group Evaluation and Recommendation

Scientific Quality and Productivity

The group has contributed significantly to the field, especially by modelling and by innovation and development of heating, ventilating, and air-conditioning technology, working together with engineering professionals in practice. The group has had a tradition for inter-disciplinary collaboration with medical scientists on the prediction of health effects of the indoor environment. The group is well known internationally.

Because of several internal reorganizations the number of publications has been relatively moderate in recent years, and the tradition has been mainly to publish in international conference proceedings. The group should be encouraged in the future to publish their best research results in the international archival literature.

Relevance and Impact

More than one third of the world's energy is used to establish indoor environments where people typically spend 90% of their lives. The contribution of the group to improve energy efficiency and indoor environmental quality, as well as the efforts to quantify the potential impact of indoor environment and technology on human health and productivity is acknowledged by the professional engineering world that in Norway alone comprises more than two thousand engineers within this field.

The group collaborates closely and has contacts with major Norwegian industries, building owners and consulting engineers within the Gemini project "Energy and Climatization in Buildings". This is organized in fruitful collaboration with SINTEF. Central for the industrial collaboration is that experimental facilities recently have been constructed within the "International Laboratory for Indoor Air Technology".

The Research group plays a key role in disseminating its own and international research results to engineering practice at conferences and through the monthly journal of the Norwegian society for HVAC engineers, NORVAC.

Strategy, Organization and Research Cooperation

A strategy is formulated based on continued close collaboration with SINTEF and industry. Considering the research opportunities and the importance of the field, there

is room for expansion of the activities but the age profile of the staff is rather skewed and lacks sufficient young faculty. To ensure the long-term viability we recommend that a plan for a generational change be established that gradually will give room for younger researchers.

The group has a strong international and interdisciplinary network to researchers through the "International Society of Indoor Air Quality and Climate" and the "International Academy of Indoor Air Sciences", and through the participation in the "European Collaborative Action" (ECA) on indoor air quality and its impact on man. The group is particularly active in international and European standardization within its field and has in practice contributed to establish Norway in a leading role in standardization of the indoor environment.

The facilities are modern and of high international standard.

Group Grades

Scientific quality and productivity: 3
Relevance and impact: 4
Strategy, organisation and research cooperation: 4

1.1.4 Fluids Engineering

Group Evaluation and Recommendation

Scientific Quality and Productivity

The group has a strong research activity in fluid mechanics and hydroelectric power generation. This is shown by the 60-70 publications in refereed journals in the last five years. At least a further 80 papers have been presented at international conferences.

The fluid mechanics research has a relatively fundamental focus, though there is some interesting and novel work on fluid mechanics in sport.

The hydro machinery research is more focussed towards application but, none the less, is at the international level.

The group is well equipped with advanced laboratories including a wind tunnel park and hydraulic test rigs in the Waterpower laboratory. This last has recently been refurbished to support the development of the next generation of hydro machinery, including small scale turbines with minimum environmental impact.

The group also has access good to a range of Computation Fluid Mechanics codes and also uses Molecular Dynamics to study the fundamentals of Heat and Mass transfer.

There is a clear and good potential for the development of strong international level research in Combustion if this group can link its skills in Large Eddy Simulation with those of its colleagues researching Combustion in the Thermal Energy Group.

Overall the group gives the impression of a strong, self sustaining research activity, though there is a warning signal in the failure to support recruitment of Post-Doctoral fellows.

Relevance and Impact

The group has played and continues to play a major role in the development of waterpower systems in Norway. The close collaboration between this group and Norwegian industry has been critical in facilitating the establishment of a world leading position for Norwegian companies in the development and manufacture of water power turbines. The well established collaboration with industry covers research and education.

The impact on the scientific community through publication is strong.

The fluid mechanics work is fundamental and long term but its relevance is more difficult to establish. However the large fraction of PhD students supported by external funds suggests interest from outside bodies and a good level of connection.

Strategy, Organization and Research Cooperation

The group has a clear strategy with specific goals that will contribute to the maintenance of its strong research position. It should consider whether its work on applications of fluid mechanics to sport could have a higher practical impact if there was a more structured approach to the manufacturers of sports equipment.

There is a well established and active tradition of scientific collaboration between the members of the group and the international scientific community.

The group has 7 Professors, 2 Associate Professors, 2 Professor II and 36 PhD students. There is an aim to always have at least 30 PhD students. There are no Post-Doctoral fellows. The group has been unable to find funds to recruit Post-Doctoral fellows. This is a threat to future recruitment of faculty and will reduce the effectiveness of PhD student supervision.

The group should also be encouraged to broaden its target beyond the EU for increased cooperation and student exchange.

Group Grades

Scientific quality and productivity: 5
Relevance and impact: 4
Strategy, organisation and research cooperation: 4

1.2 Department of Petroleum Engineering and Applied Geophysics

Department Evaluation and Recommendation

The Department presented itself as a single unit with only an informal internal structure and is therefore evaluated as a whole. The Department has 13 Professors, 2 Associate Professors, 1 Assistant Professor, 6 Professor II, 4 Post-doctoral research fellows and 45 doctoral students. The principal purpose of the informal groups is the organisation of teaching in their respective areas. Research is organised in ad hoc multi-disciplinary project groups and in groups of doctorate students led by a Professor.
The group is unusual in having geophysics within the department. This subject is normally within geology or in a separate faculty. The emphasis on applied geophysics makes it even more distinct.

Scientific Quality and Productivity

The Department has contributed strongly to research in Reservoir Engineering, Drilling Technology and Production Technology. From the published literature and from the presentations, it is clear that the department generates several original research ideas ("thinking outside the box"). The department complained that they only received funding for short-term research. However, in one of the areas we saw on the tour (rock physics) there was clear emphasis on a long-term research program. Nonetheless the research funding is dominated by industry and it would be appropriate to look to the Government sources for more funding for long term research. Much of the equipment in the NTNU laboratories in this area was paid for through SINTEF. In fact, many of the researchers we interviewed seemed to be more employed by SINTEF than the university. While such ample funding is clearly of benefit to the effort, it raises two points that complicate this evaluation:

a. It is now nearly impossible to compare the NTNU efforts (apart from SINTEF) with other academic efforts, and
b. The research has tendency to be more applications-oriented, almost consulting, rather than fundamental. A good example of this is the visualisation cave, certainly the most impressive such facilities this committee has seen, but the main purpose of which is to speed up technical work rather than to forge new paths.

There is a good ratio of PhD students to staff.

There are not enough publications in refereed journals for this level of effort. There appear to be two reasons for this:

a. The close connection with SINTEF, as mentioned above, and
b. The three year limit on funding provided by government sources for PhD studies. Fundamental work requires more time for quality dissertations.

Also, many of the faculty have ties outside of Scandinavia. As one of only a handful of petroleum engineering departments in the world, this group could do more to become more international.

Relevance and Impact

The area of Petroleum Engineering and Applied Geophysics is a key part of the economy of Norway. As such it is important that this department engages fully with industry and the public sector. The contact with industry is strong. The department has formal research collaborations with many oil companies that support extra staff positions. The link with Government is weaker and should be strengthened.

It is clear that even areas without a strong research activity, such as drilling, have had and are having an impact within Norway. The drilling effort is a good example of how technologies can be conceived in academia and developed through application into commercial use.

Strategy, Organization and Research Cooperation

The Department had a clear and appropriate strategy and presented itself in a coherent way

The internal informal structure for research cooperation seemed to work well. The Department seemed positive in its approach, with relatively few complaints. Morale seemed less affected than elsewhere by the recent reorganisations at NTNU, perhaps because this unit had been relatively unchanged.

As in most of the research groups in NTNU, it was difficult to see the demarcation between the university and SINTEF. However, this collaboration is very positive, and leads to a strong research program. But it also makes it difficult to make comparisons with less well connected institutes.

The committee heard very little about the group's connection with geological sciences. Initiating such collaboration has been a major theme within the petroleum industry for the past 10 years. The committee could not see that this theme was also present within the Department. Perhaps it is present in Applied Geophysics.

The department complained about lack of lab space. Laboratory space seemed crowded, and not kept very tidy. Some of the lab space appeared to have safety issues. A review of the operation of the laboratories would be appropriate.

Group Grades

Scientific quality and productivity: 5
Relevance and impact: 4
Strategy, organisation and research cooperation: 4

1.3 Department of Electrical Power Engineering

Department Evaluation and Recommendation

Electrical power engineering is a mature field; however, research continues to be highly motivated. Electrical power systems constitute very important parts of the current and future energy system, not only because a substantial part of the energy consumption takes place through electric power in the industrialised world, but also because almost all human activities and other infra-structure systems are dependent on a secure supply of electric power. The future has several challenges in relation to new energy production and consumption schemes, new market conditions and maintenance of existing assets. Furthermore, the electric power system is the most important infrastructure system since all activities in today's society depend upon an efficient and reliable supply of electric power. Thus, there continues to be a strong motivation for research in this area.

The areas covered by the Department represent well the international research agenda in the field. By covering the whole area of power systems, power equipment and electrical machines and drives, the Department is more complete than many of its peer departments.

The tradition within the power engineering field is to publish in conferences rather than in refereed journals (which are relatively few). This is also reflected in the department's output. In spite of this tradition the department should strive for more refereed journal publications.

Some detailed comments:

- The faculty, department and the study program "Energy and Environment" is apparently organised along separate lines. Other departments within the energy area are found in two distinct faculties. We find this pioneering approach interesting and we encourage its continuation, but since the programme was implemented a few years ago the existing (new) organisation should be reviewed to see whether this is the most appropriate structure.

- The new study program has apparently been attractive but also the number of dropouts seems to have increased. There should be a review to check whether the intake group will contain a sufficient number of students motivated to study electric power engineering in the final years (in particular subjects which relate to power systems control, electric drives and electromagnetic fields).

Organization, Management and Strategic Plans

- The organisation into research groups is adequate and corresponds to what often is found in other universities.

- The Department has been and is still in a process of replacing retiring professors. It has also been successful in recruiting a few young new professors. Partly the Department faces problems in recruiting students. Marketing of the Department is an important element in the leadership. Also the leadership should work on conveying a strong vision and common goals for the future. Statistics such as those quoted at the beginning of this section should be used to illustrate the importance of the activities of the Department.
- The collaboration with SINTEF is extensive. Presently the strategy in the power systems and power technology field is to cover a broad and diversified field by maintaining close co-operation with SINTEF. As in the case of Petroleum and Geosystems Engineering, the identity of the department in this relationship should be clarified. Such an exercise should review if the basic research needs to cover all application areas and how the basic research should be best organised. It is not obvious that research should be carried out in the identified sub-critical areas, protection in power systems and electrical installations and lighting.
- The extensive laboratories and equipment serve largely the needs of SINTEF. The basic university research may necessarily not depend on all these and a more efficient use of the laboratories could be obtained if the real costs had to be paid.

Recruitment and Mobility

- An example of a presentation to students was given but in general no evidence was given on the role of the Department role in stimulating the interest of young people.
- Recruitment to the doctoral training should be improved including also non-Norwegian students.
- Apparently the Energy and Environment study program has attracted many female students. The challenge for the Department is now to recruit these to its courses.
- The Department gave evidence of its ambition to strengthen international exchange of PhD students and sabbatical leaves of senior researchers. In general the mobility of students after graduation and recruitment to PhD and professor positions seems to be rather narrow and dependant upon local conditions with a particular reliance upon SINTEF.
- A relatively large portion of the power systems and power apparatus PhDs go to SINTEF. This has a positive side in offering job opportunities and maintaining local competence. However, as a result the fruitful effects of national and international exchange are

lost. There should be some effort for a more diverse National and International placement.
- The exposure of industrial research challenges to the PhD students seems excellent.

1.3.1 Electrical Power Systems

Group Evaluation and Recommendation

The group has 4 professors of which 2 soon will reach retirement age. Recruitment of new professors is a priority of the department.

Scientific Quality and Productivity

The scientific quality of the group is very good. The tradition in the field is to publish and participate in conferences and these publications meet high standards. The output of the group is 9 PhDs during the last 5 years which is adequate. The number of refereed articles is relatively few and the group should aim for an increase.

Relevance and Impact

The group has a strong link to the Norwegian power companies through SINTEF. Their contributions to planning methods, power system analysis and reliability have, for example, laid the ground for software products including new companies in Norway and abroad. Their work is highly relevant for power production and distribution.

Strategy, Organization and Research Cooperation

The group has a strong international position and visibility. The group is the lead in two major programs on planning methods and sustainable energy services including research groups in the universities of Helsinki, Porto, MIT, and Chalmers. The group professors are engaged in several international committees, primarily Cigré. Holen was the chair of the Power System Computation Conference held 1999 in Trondheim.

Group Grades

Scientific quality and productivity: 4
Relevance and impact: 4
Strategy, organisation and research cooperation: 4

1.3.2 Electrical Energy Conversion

Group Evaluation and Recommendation

The group has 4 professors. There is no immediate requirement for replacements.

Scientific Quality and Productivity

The research of the group is driven by applications on electrical machines, drives and power electronics. This focus naturally limits the scientific output, which seems to have become saturated during the last years. 5 PhDs were given during the last 5 years that resulted in relatively few publications. However 5 PhDs will be presented in 2004 and the department has the capacity and ambition to increase the number of publications, which is necessary.

Relevance and Impact

The professors in the group have a strong link directly to industry and relatively little co-operation with SINTEF. The research has a goal to introduce new technology in the field of advanced motor drives. This goal has led to several new products. The industrial impact is thus high.

Strategy, Organization and Research Cooperation

The group has a strong international position through one of its members being president of the European Power Electronic and Drives Association and having a great international network. It has also exchanged with leading international universities such as the Universities of Aachen, Minnesota and Wisconsin including sabbatical year exchange of the group's professors.

Group Grades

Scientific quality and productivity: 3
Relevance and impact: 4
Strategy, organisation and research cooperation: 4

1.3.3 Electrical Power Technology

Group Evaluation and Recommendation

The group has recently recruited 2 young professors.

Scientific Quality and Productivity

As a result of administrative tasks and the replacement phase for new professors, the volume of output has recently been relatively small. Only 4 PhDs have been presented during the last 5 years. However several excellent refereed publications have recently been published showing high scientific quality.

Relevance and Impact

The group has a strong link to the Norwegian power companies through SINTEF and to industries providing diagnostic measurement techniques. Their research has contributed to the development of software for transient analysis and instruments for condition diagnostics of cables and switchgear based upon insulation measurements, vibration and acoustic techniques. Their work is highly relevant for power production and distribution.

Strategy, Organization and Research Cooperation

The strategy of the group is to cover a broad diversified area. This should not be necessary and this strategy should be reviewed. A review of the focus and an analysis of the group's approach in selling their topics may lead to a more attractive offer for students. The group has a long tradition and high competence in cable insulation ageing and diagnostics; however the international work in this field has saturated. For simulations of transients they co-operate with BPA in USA and in transformer diagnosis based upon transient analysis, the group co-operates with the leading international research organisations in the field (EdF, Hydro Quebec, University of Stuttgart and ABB).

Group Grades

Scientific quality and productivity: 4
Relevance and impact: 4
Strategy, organisation and research cooperation: 3

2 Narvik University College

2.1 Department for Computer Science, Power and Space Technology

Department Evaluation and Recommendation

Research is a relatively new activity at NUC having commenced only two years ago and, as such, its development is immature and this might explain the grades given.

The Department is organized into three research groups, Electro Mechanical systems, Homogenization theory and Simulations; the first is evaluated here. Before doing this however, we note that the organisation is unusual. Homogenisation theory seems to be a mathematical technique, not the basis for an organisation.

Organization, management and strategic plans

- The Department covers many subjects. From the name of the Department (Institute) it is difficult to identify the content of the undergraduate and graduate/research education.
- There was no discernable vision as to selection of areas of research focus. There also seemed to be no links identified between undergraduate education and the areas selected for research.
- The Department has limited laboratory resources for research, though the committee made this judgement in the absence of a visit.

Because the research is highly diversified and lacks focus it should be done in close collaboration with an institution with high research capacity, e.g. NTNU or Luleå University. The group leadership appears to be energetic, which could be a strength upon which to build.

2.1.1 Electromechanical Systems

Group Evaluation and Recommendation

The group has 1 Professor and 2 Associate Professors, mainly in the field of control engineering, signal processing and cybernetics, and one Associate Professor, mainly in power electronics and electrical drives. In addition, an Adjunct Professor (20%) in the field of applied control is working in the group.

Scientific Quality and Productivity

The scientific basis of the group is limited. The group is working in many different fields. It is not clear how the joint efforts are used for a concentration in electromechanical systems. The first PhD students from the group will graduate in 2004. At present 3 students seem to be engaged in the group. With one exception, the peer reviewed publications are in the field of mathematics.

Relevance and Impact

There is no evidence of impact from the research of the group. The most near impact in the future seems to be a contribution to the pelletization process in cooperation with LKAB. There is also collaboration with the Company NATECH in the field of electromechanical systems.

Strategy, Organization and Research Cooperation

The group has a diversified strategy, perhaps too diversified. They aim to have an expertise in too many areas given their size. The research cooperation should include a joint strategy with an established research group, e.g. the ElectricalEenergy Conversion Group of the Department of Electric Power Engineering at NTNU. A concentration on the interests of local or nearby industries should be strengthened (e.g. LKAB).

Group Grades

Scientific quality and productivity: 1
Relevance and impact: 1
Strategy, organisation and research cooperation: 1

3 Stavanger University College

3.1 Department of Petroleum Technology

Department Evaluation and Recommendation

Stavanger University College will most likely become a university in 2004. The lack of full university status has played a role in the historical development of the Department, resulting in a rather loose organisation for research. Since the reorganisation of the College at the start of 2004, the Department consists of 3 research groups, Production Technology, Reservoir Technology, and Drilling Engineering. Prior to this date it also included groups on Petroleum Safety and Industrial (Petroleum) Economy

The Department has a total of 9 Professors, 8 Associate Professors, 4 Adjunct Professors, 1 post-doctoral research fellow and 16 doctoral students. There are also 6 technical positions.

The Departmental budget was not given by research group. In 2002, prior to the reorganisation, the total budget was 27 MNOK, of which just less than 40% came from external funding. The external funding has more than tripled since 2000, when it contributed 13% of a smaller budget.

Only 8 doctoral students graduated during 2000-2002, of these 4 were from the groups evaluated here. In the same period a total of 116 MSc students graduated of which 66 were from the groups evaluated here. The difference in PhD and MSc numbers is likely a consequence of SUC not yet having university status.

All of the groups achieved almost identical scores and they are therefore evaluated collectively below. This approach is also consistent with that taken for the equivalent subject area at NTNU.

The presentations made to the Panel at Trondheim were weak and did not represent the Department's activities in the best light. They gave a picture of the disadvantages arising from the current unclear status of the university college, but did not sufficiently emphasise the positive aspects of the research programme that the Panel observed during the site visit. In this sense, the visit to Stavanger was very important in forming an accurate impression of the Department.

Like NTNU the Stavanger group is affiliated with an industrial research organisation, Rogaland Research. Unlike NTNU, Rogaland is kept fairly separate from the academic function. The committee was able to clearly separate the functions of the two components. The evaluation here is entirely for the academic faculty.

Scientific Quality and Productivity

Experimental facilities are good for a university, well maintained and clean, and clearly very much in use. The experimental research is a mix of short-term and long

term topics. The Department has been working on some topics for a number of years (chalk rock properties, wettability, and multi-phase flow) and seems to be able to maintain relevant research programs in these areas. The work on wettability in particular seemed to be novel and innovative, based on the testing of clearly formulated scientific hypotheses; this group has enjoyed a well-deserved worldwide reputation in this area.

The experimental research program in drilling appears weak, judging from the presentation in Trondheim, and we did not see anything to contradict that impression in Stavanger. This is surprising, given the excellent drilling research facilities in Rogaland Research (7 test wells), with whom there appears to have been cooperation in the past. It should be noted that one of the key drilling researchers was absent from both the Trondheim and Stavanger visits.

The production, petrophysical and reservoir research programs seemed much stronger than drilling. The researchers are well aware of what is currently happening worldwide in their own field and are contributing to its progress. It is perhaps true that the petrophysical work (dealing largely with capillary pressure) and the wettability work could be more integrated. The work on oil recovery seemed a little less fundamental than the petrophysical and wettability work.

There is clearly a strong demand within Norway (as well as worldwide) for better fundamental understanding of chalk behaviour. The chalk rock mechanics work seemed to have lost some momentum, no doubt because of the health of its senior researcher, but this is likely to pick up again with their participation with Rogaland Research in the COREC project (10 MNOK/year from Conoco-Phillips). The chalk mechanics research also seemed fundamental.

Nevertheless, perhaps because of the university status issue, there are relatively few PhD students. Masters students do a lot of the research.

It seemed that there was more hypothesis-based research at Stavanger than at NTNU.The Department has published a good number of refereed papers over recent years, but there were insufficient refereed publications for the level of effort. A lot of the research is documented only in conference proceedings.

Relevance and impact

The work is well focussed on topics of great importance and relevance to the Norwegian economy. This is reflected in the significant amount of external funding.

The groups operate in a relatively autonomous way and, as they are relatively small, this limits their impact in industry, the scientific community and on Government and society. The proposed consolidation of research interests in the Department should address this issue. Each of the groups has an outlet through local industry for their work and for raising funds and links with other research groups outside Norway. However, more impact would be achieved by a more structured approach to collaboration organised at Departmental level.

Strategy, Organization and Research Cooperation

The strategy to date has been very successful, aimed, in part, at achieving University status. They acknowledge that they need a new strategy now that they are close to achieving University status but so far this has been limited to defining the areas of research on which to concentrate. They still need to develop common plans for further development of the Department. The new strategy should emphasise why they are following certain lines of research, why they are considered important and define the philosophy to be used in approaching the chosen topics. It should also reflect the changing nature of the Norwegian oil industry as it moves into its mature phase: less emphasis on exploration topics; more emphasis on improved oil recovery; more emphasis on recovering stranded gas; carbon dioxide storage. Convening a workshop or a retreat to form this strategy is one of the recommendations of this committee.

Part of the new research strategy will be based on their proximity to the North Sea oil industry. They plan to build on their already existing links with Rogaland Research (RF). The new COREC research project is a good example of such cooperation. Plans to create an international drilling centre together with RF were mentioned in the self-evaluation, but no details were given.

Cooperation with RF can provide enormous experimental capacity and lead to a similar set of risks and benefits as in Trondheim between NTNU and SINTEF. The existence in Stavanger of its own research laboratories will help the university to retain its freedom to determine its own long-term research programme, independently of RF.

With the new status, the Department should also expect to develop a much stronger Masters program, which will have a positive influence on their research activity, provided they have a coherent plan for exploiting it.

Group Grades

Scientific quality and productivity: 4
Relevance and impact: 3
Strategy, organisation and research cooperation: 2

4 Group Discussion with Doctoral Students

Summary

NTNU students showed useful initiative by self-imposing a graduate student survey. The results of the survey showed a general satisfaction with their education. The comments of the students from Stavanger University College were generally consistent with the results of the NTNU survey.

The great majority of the students were satisfied (or better) with the overall quality of their supervision and have a high or very high motivation to complete their Doctoral studies successfully.

Aspects of supervision associated with the discussion of hypothesis and methods were weaker than the discussion of results and analysis.

Almost half of the NTNU students felt that they were poorly integrated into the general research environment.

NTNU students said that attendance at the research methods course did not receive credit and, consequently, few students took it.

Funding support for the PhD degree is limited to 3 years. However, most students have departmental duties and, therefore, usually take 4 years to complete.

There is broad encouragement to study overseas, but this seems to be taken seriously only occasionally. There is too much concentration of Scandinavia (or Northern Europe) as being overseas and it would be appropriate to broaden the range of visits. Students at Stavanger University College seemed to be more open to overseas visits. One said that his program of study required this.

Panel Evaluation

Generally the students were well satisfied with their opportunities and supervision. However, the NTNU student survey highlights several areas which could be improved, namely:

- Discussing hypotheses and methods,
- Contacting relevant scientific communities,
- Organisation and completion of the dissertation.

General integration of the students into the research community should also be improved.

Appendix 1: Mandate

Evaluation of Norwegian Research in Engineering Science

I 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.

II 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 –

- Does 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 PhD 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 PhD theses 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 –

- Does 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?
- Does 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 an active part in international professional committees, work on standardization and other professional activities?

Appendix 2: CVs of each panel member

Professor Göran Andersson
ETH Zurich
Switzerland

Dr. Andersson was born in Malmö, Sweden. He obtained his M.S. and Ph.D. degree from the University of Lund in 1975 and 1980, respectively. In 1980 he joined ASEA:s, now ABB, HVDC division in Ludvika, Sweden, and in 1986 he was appointed full professor in electric power systems at the Royal Institute of Technology (KTH), Stockholm, Sweden. Since 2000 he is full professor in electric power systems at the Swiss Federal Institute of Technology (ETH), Zürich, where he heads the powers systems laboratory. His research interests are in power system analysis and control; in particular power systems dynamics and control involving HVDC and other power electronics based equipment.

Göran Andersson is Fellow of the Institute of Electrical and Electronic Engineers (IEEE), member of the Royal Swedish Academy of Sciences, and member of the Royal Swedish Academy of Engineering Sciences.

Professor Peter K. Currie
Delft University
Holland

Professor Peter Currie has a BSc in Mathematics from the University of Manchester, and a PhD in Theoretical Mechanics from the University of East Anglia. For ten years he lectured in universities in North America and Ireland. He then joined Shell and worked for 25 years in the areas of production engineering and formation damage, including a period in Stavanger as Chief Petroleum Engineer in Norske Shell. Since 1997 he has been a professor in the Petroleum Engineering Section of Delft University, teaching production engineering and carrying out research on near-well bore flow and formation damage. He is active in the international Society of Petroleum Engineers, and has served on its Board as Director for Europe.

Professor Roland Eriksson
Royal Institute of Technology
Sweden

Roland Eriksson is professor in the Electrical Engineering Department at KTH (Royal Institute of Technology). Roland Eriksson was born in1944 in Stensele, Sweden. He obtained his M.Sc and Ph.D from KTH in 1969 and 1975, respectively. In 1969 Eriksson joined Swedish State Power Board (presently Vattenfall) as a research engineer in the electrical engineering development department. During the period 1982 – 1987 Eriksson was employed by Asea (Presently ABB) in the transmission substation division. From 1988 he is full professor at KTH.

The research interests of Roland Eriksson lay in electric power engineering with a specialisation in high-voltage engineering and insulation diagnostics. He is head of the Electrical Engineering Department at KTH and director of the Competence Centre in Electric Power Engineering. He is senior member of IEEE and distinguished member of Cigré.

Professor P. Ole Fanger
Technical University
Denmark

Dr Fanger is Professor at the International Centre for Indoor Environment and Energy at the Technical University of Denmark. His interdisciplinary research work over three decades has contributed to identifying the prime importance of the indoor environment for the quality of human life. His models used worldwide allow for the prediction of the impact of the indoor environment on human comfort, health and productivity.

His research has been recognized by 62 scientific awards in 25 countries, including seven honorary doctorates, 15 medals, 14 honorary memberships of professional engineering societies, and seven memberships of scientific academies, including the US National Academy of Engineering and the Royal Academy of Engineering (UK). He is President of SCANVAC, a Federation comprising 20 000 HVAC engineers in Scandinavia.

Professor Philip Hutchinson
Cranfield University
England

Philip Hutchinson was born in 1938 in County Durham and educated in the local primary schools and King James First Grammar School in Bishop Auckland. He gained a state scholarship and went on to study Physics in the University of Newcastle upon Tyne where he gained an Honours Degree and went to study Theoretical Physics for his PhD.

In 1962 he joined the Harwell Laboratory of the United Kingdom Atomic Energy Authority as a member of Theoretical Physics Division and, save for a sabbatical in the USA in 1969/70, remained there until 1987 by which time he had risen to be the Head of Engineering Sciences Division and Director of the Combustion Centre. His sabbatical was spent at the University of Houston, Texas, developing his interest in two-phase flow. He joined Cranfield University as Head of the School of Mechanical Engineering in 1987. In 1996 he was appointed Deputy Vice-Chancellor of the University with responsibility for the academic programme at RMCS, as Principal, and the School of Mechanical Engineering. In December 2000 his responsibilities were expanded again when he led the merger of the College of Aeronautics with the School of Mechanical Engineering to create the School of Engineering, as it's first Head. He is now Principal at the Royal Military College of Science, a component of the Defence Academy of the United Kingdom.

He also participates in a number of international activities. He was Chairman of the European Research Community in Flow, Turbulence and Combustion (ERCOFTAC), 1994 - 2000, Chairman of the International Energy Agency Executive Committee on Emissions Reduction and Improved Efficiency in Combustion, and is an occasional advisor to agencies of the Norwegian and Swedish Governments on Research Policy and Academic Appointments. He was elected a Fellow of the Royal Academy of Engineering of the UK in 1997. In May 1999 Professor Hutchinson was awarded an Honorary Doctorate in Technology from the University of Lund, in Sweden. His continuing academic interest is in the application of the mathematics of probability and stochastic processes to a variety of natural phenomena which include the theory of dense liquids, turbulent single-phase fluid flow, combustion, laser diagnostics and two-phase flow.

He has published in archival Journals on Statistical Mechanics, Fluid Mechanics, Combustion and Laser Diagnostics.

Professor Larry Wayne Lake
The University of Texas at Austin
USA

Larry W. Lake is a professor of the Department of Petroleum and Geosystems Engineering at The University of Texas at Austin. He holds B.S.E and Ph.D. degrees in Chemical Engineering from Arizona State University and Rice University. Dr. Lake is the author or co-author of more than 100 technical papers, the editor of 3 bound volumes and author or co-author of three textbooks. He frequently conducts industrial and professional society short courses in enhanced oil recovery and reservoir characterization. He has been teaching at UT for 25 years prior to which he worked for Shell Development Company in Houston, Texas.

Dr. Lake was chairman of the department from 1989 to 1997 and formerly held the Shell Distinguished Chair and the W.A. (Tex) Moncrief, Jr. Centennial Endowed Chair in Petroleum Engineering. He currently holds the W.A. (Monty) Moncrief Centennial Chair in Petroleum Engineering. Lake has served on the Board of Directors for the Society of Petroleum Engineers (SPE) as well as on several of its committees; he has been an SPE distinguished lecturer twice. Dr. Lake is a member of the National Academy of Engineers and won the 1996 Anthony F. Lucas Gold Medal of the SPE. He won the 1999 Dad's Award for excellence in teaching undergraduates at The University of Texas and the 1999 Hocott Award in the College of Engineering for excellence in research. He also is a member of the 2001 Engineering Dream Team awarded by the Texas Society of Professional Engineers. Dr. Lake was named an Improved Oil Recovery Pioneer by the Society of Petroleum Engineers in 2000. He currently serves as general editor for the Petroleum Engineering Handbook of the SPE.

Professor Tord Torisson

Lund University
Sweden

Torisson (born 1941) is professor and head of the division of Thermal Power Engineering at the LU, Sweden. Torisson was in the end of the sixties in charge of the design and construction of the new laboratory for the Department of Heat and Power Engineering at LU. The laboratory included boilers, steam and gas turbines, compressors, etc. Following this, Torisson spent four years at Brown Boveri in Baden , Switzerland, working with commissioning thermal power stations. In 1975 he was appointed associated professor in Heat and Power Engineering and also Head of Department at the LU.

In 1980 Torisson left the university for the engineering company SWECO. As consulting engineer he worked with energy conservation projects, mainly for the process- and thermal power industry outside Sweden. In 1987 Torisson was appointed full professor in Thermal Power Engineering at the LU. Torisson has, besides of his professorship, been Dean for the international relations and member of the managing group for the Lund Institute of Technology at LU.

In the interdisciplinary research concerning gas turbines Torisson has been studying fluid mechanics, combustion and heat transfer, as well as new thermodynamic cycles, like the evaporative gas turbine cycles, hybrid system based on solid oxide fuel cells, etc. Torisson is in his research addressing problems relevant for design of thermal power station as well as for effective operation of the stations.

Torisson is a member of the Scientific Advisory Committee for VGB, Technical Association of Large Power Plant Operators. He is also a member of the Scientific Editorial board of the journal VGB Power Tech. Torisson is a member of the Board of the Royal Physiografic Society, Sweden as well as the board of the Swedish gas turbine centre, etc. Professor Torisson has been member of the evaluation committee for more than 10 professor ship installations all over Scandinavian (Sweden, Finland, Norway and Denmark).

Appendix 3: Letters to the Institutions

Institutt for elkraftteknikk
NTNU
O.S. Bragstadsplass 2
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 elkraftteknikk
NTNU
O.S. Bragstadsplass 2
7491 TRONDHEIM

Att.: Instituttleder Erling Ildstad

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 3. Det enkelte institutt må selv gå inn i timeplanen og sjekke aktuelt tidspunkt for oppmøte. Høringene finner som kjent sted i uke 10, dvs. fra mandag 1. mars til og med torsdag 4. 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 6-7 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 3 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**.**

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 for Panel 3

05/02/2004

Evaluation of Research in Engineering Science in Norway
Time schedule for meetings of Panel 3

Date	Time	Institution/department	Research group
Monday March 1 **2004**	0900-0915	Panel's 15 minutes	
		NTNU	
		Faculty of Engineering Science and Technology	
	0915– 1030	*Presentation of the NTNU, SINTEF and the faculty*	
	1030 - 1045	Break	
	1045 - 1200	**Department of Energy and Process Engineering**	• Thermal Energy • Industrial Process Technology • Energy and Indoor Environment • Fluids Engineering
	1200 -1300	Lunch	
	1300– 1430	**Department of Energy and Process Engineering cont.**	
	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 3

Date	Time	Institution/department	Research group
Tuesday March 2 **2004**	0900 - 0915	Panel's 15 minutes	
	0915- 1030	**Department of Energy and Process Engineering cont.**	
	1030 - 1045	Break	
	1045 - 1115	Panel's 30 minutes	
		Faculty of Information Technology, Mathematics and Electrical Engineering	
	1115 - 1130	*Presentation of the faculty*	
	1130 - 1215	**Department of Electrical Power Engineering**	• Electrical power Systems • Electrical Energy Conversion • Electrical Power Technology
	1215 -1315	Lunch	
	1315– 1415	**Department of Electrical Power Engineering cont.**	
	1415 - 1500	Panel's 45 minutes	
	1500 - 1530	*Departure for site visit at NTNU*	
	1530 - 1730	*Site visit Electric Power and Hydro Power lab*	

Evaluation of Research in Engineering Science in Norway
Time schedule for meetings of Panel 3

Date	Time	Institution/department	Research group
Wed March 3 **2004**	0900-0915	Panel's 15 minutes	
		NTNU	
		Faculty of Engineering Science and Technology	
	0915– 1015	**Department of Petroleum Engineering and Applied Geophysics**	• Petroleum Engineering
	1015-1030	Break	
	1030-1115	**Department of Petroleum Engineering and Applied Geophysics cont.**	
	1115– 1145	Panel's 30 minutes	
	1145-1245	Lunch	
		Stavanger University College	
	1245 -1300	*Presentation of the College/Department*	
	1300– 1400	**Department of Petroleum Technology**	• Production technology • Reservoir technology • Drilling Engineering
	1400 - 1415	Break	
	1415 - 1500	**Department of Petroleum Technology cont.**	
	1500 - 1530	Panel's 30 minutes	
	1530 - 1600	*Departure for site visit at NTNU*	
	1600 - 1730	*Site visit*	

Evaluation of Research in Engineering Science in Norway
Time schedule for meetings of Panel 3

Date	Time	Institution/department	Research group
Thur March 4 **2004**	0900 - 0930	Panel's 30 minutes	
	0930 - 1100	**Meeting with Ph. d students**	
	1100 - 1130	Panel's 30 minutes	
	1130– 1230	Lunch	
		Narvik University College	
	1230 - 1245	*Presentation of the College/Department*	
	1245- 1330	**Department for Computer Science, Power and Space Technology**	• Electromechanical Systems
	1330 - 1400	Break	
	1400 - 1800	*Final meeting of panel*	