Evaluation of research in engineering science in Norway

Structures, Materials, Product Development and Design

Panel 2

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TO THE RESEARCH COUNCIL OF NORWAY

The members of Panel 2: Structures, Materials, Product Development and Design in the Evaluation of Norwegian Research in Engineering Science in Norwegian Universities and University Colleges hereby submit the following report. The views presented in this report are expressed in consensus among the members in the Panel. The members are further in collective agreement with the assessment, recommendations and conclusions presented.

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Executive Summary

In general the Panel finds that NTNU and the University colleges in Narvik and Stavanger perform their functions well. The Panel was assigned the task of evaluating the research and the more applied development work for industry, but has also examined the graduate school education at doctoral level.

The Panel has found that the university system in Norway works with little bureaucracy. In general it has very good funding for research, which in some fields is of a high international standard. The research is well adapted to the present needs of Norwegian industry and the universities have excellent contacts with industry often via SINTEF, which is the prime vehicle for this co-operation. This is especially true for NTNU. A relevant conclusion is that NTNU is of great value to Norwegian industry. The university colleges in Narvik and Stavanger are in the same way of vital importance for the regional industry. However, in the future the pattern of industry in Norway will be much more global and also involve more small entrepreneurial units. Universities will need to adapt to these conditions through a more flexible approach built on research teams and co-operation rather than on individuals.

The Panel also found that the reward system for academic faculty in Norway tends to reward applied research over basic research, perhaps an unintended outcome. One example is the provision of travel funds for presentation of a paper at an international conference, but no comparable reward for publication in peer-reviewed international journals. A second example is the considerable augmentation of personal income possible through SINTEF interactions, but nothing of comparable magnitude for basic research achievements and advances. The Panel recommends a more balanced reward system in this respect.

NTNU has recently been reorganised. The Panel finds that the new organisation is generally well adapted to its purpose – departments are larger than earlier and of critical mass. They are divided into research groups that should have great interest in and benefit from co-operation with each other. They are also big enough to be forceful partners in co-operation with Norwegian and European industry. However, it is the opinion of the Panel that the organisation does not yet work as intended. Thus, with some exceptions, the groups within departments do not co-operate. Even within groups, co-operation between researchers is often limited. This means that the full strength of the new organisation is not exploited.

The strategy for graduate studies is appropriate, but evidently not yet fully implemented. The graduate students are, however, satisfied with existing conditions. They get an education well adapted to the needs of industry and often do their research work in co-operation with, or even in, industrial companies.

During the interviews, the Panel received a number of repeated complaints from faculty members, namely:

- high and uneven working loads for faculty related to teaching,
- an aging staff and difficulties in employing new staff members,
- lack of communication within and among departments
- difficulty in recruiting women in faculty positions and as doctoral students.

The Panel had great difficulties in understanding and evaluating budgets and accounting because of the unclear relationship between NTNU and SINTEF. A clearer understanding would have been helpful in any attempt to evaluate research productivity.

The conclusions above provide a general introduction to the views of the Panel. More detailed comments and recommendations are set out below under specific headings.

General observations and recommendations

National policies
The Panel inquired whether there is a national policy for the Norwegian university system. If there is, it evidently does not exist in print. Norway has one university with engineering faculty, NTNU, and the Panel assumed that it should then cover all the needs of the nation as regards academic higher education, research, and development in engineering for society and industry. In the fields this Panel reviewed this is largely the case. NTNU works very well for industry and is well adapted to the needs of Norwegian industry. What seems to be missing in some fields is basic research, which is essential for renewing advances that feed applied research and which increases the standard of living sustainably. Sjekk korrektur på siste ord i setningen.

The national policy for the university colleges is less clear to the Panel. Are these intended to grow to universities with broad scientific programs of international standard? Or, are the ambitions limited? Should they serve as supporters of the respective regions regarding higher education and research and development work for the local industry and society? In the latter case the fields of specialisation should be chosen accordingly, which seems to be largely the case. The research should also be of an applied nature, which is also mostly true. The viewpoint of the Panel is that great priority should be given to regional aspects. Thus the formulation of educational programs, funding of research and also recruiting of faculty should be made with focus on the local, regional needs.

Balance between industrial and basic research
The role of Norwegian universities is to support the national Norwegian industry and the society at large, not only today but also in the future. This cannot be achieved by exclusively carrying out research projects for industry. The academic development of the university must be cultivated. This is done through basic research performed in contact and co-operation with the international academic community, publishing in internationally recognised journals and contributing to international conferences. This promotes the long-term development and renewal of faculty and research, which in turn is necessary for the renewal of the educational programs for the benefit of industry and society. It is also beneficial for the development of industrial companies in new areas. At the broadest level, it is often basic research, which opens up new avenues of wealth creation and sustainable standards of living.

The somewhat traditional direction of Norwegian research is also affecting the future recruitment situation at the universities. To attract younger researchers new and active research areas should be available. Researchers who have the ambition to pursue a long research career want interesting, innovative research topics where new breakthroughs are possible. Moreover, a continuous renewal of research is also advantageous to attract more students both to the undergraduate and graduate programs.

One major conclusion of the evaluation Panel is that Norwegian universities should give higher priority to academically motivated research leading to publication in refereed journals at the expense of projects for the industry and non-peer-reviewed publications. To be effective, the priority must be bolstered by rewards systems favouring such activities for individual faculty members.

Management and accounting
From the documentation provided and the interviews conducted, it was difficult for the Panel to understand the management structures of the various institutions being evaluated, and the extent to which strategic planning for research was being carried out at different levels, for example at institutional, faculty, department and research group level. A change to a system in which the strategic planning is made more explicit and transparent is likely to bring considerable benefits, especially with the changing nature of industry and increasing international competition for research funds and trained researchers. In particular, research strategy needs to be communicated to individual researchers, and rewards systems consistent with these goals established.

From both a financial point of view and in terms of strategic planning, it was apparent that the senior management of the institutions did not have sufficient information and data regarding research costs and research outputs. Thus there is no real ability to evaluate the relationships between research costs and research outputs in a way required for successful planning in a globally more competitive research market. At the present time, many decisions appear to be made on an ad hoc basis.

The situation in Narvik and Stavanger is different from the one in Trondheim. The research at these university colleges can only cover a small part of what is done in Trondheim. Since the number of research personnel is smaller at these universities, and many departments have difficulties in recruiting internationally known researchers, it becomes important to have strong leadership. It is important to formulate a strategy where the universities build up competence in research areas that are of interest with regard to the regional needs. With an industry supporting the research, both with respect to funding and applied research problems, it should be possible to form a competent research organisation.

Leadership culture
The reorganisation of NTNU is an example of positive leadership. However, a reorganisation must be followed up and leadership must be ongoing. At this stage the principal ideas of the reorganisation have not yet penetrated to all levels of NTNU. Instead the old structure with individual researchers still predominates in many departments. The situation seems to have a long tradition and is probably partly linked to Norwegian culture. The impression is that the researchers act quite individually and cherish their freedom. The lack of strong leadership appears to be appreciated by most of the faculty members, who at the same time decry the inconsistent and uneven outcomes that follow.

The Panel believes that stronger leadership on all levels would be beneficial. More particularly, strong leaders will need to make use of management analysis tools such as vision documents, strategic plans, annual reports, evaluations and follow ups. In order to carry out strategic plans, leaders will need to be given resources to reward achievement and effort related to established plans.

We believe that the work initiated by the NRC in preparation for this evaluation makes a good start towards this goal through the self-evaluation reports at the departmental and research group level. The organisation of NTNU is quite new and it

is the hope of the Panel that the new leaders soon will come to grips with these questions. An important part of leadership is the communication among leaders at various levels and also with employees in order to inform them of the ambitions and intentions of the leaders. It is also important for a leader to be kept informed of the progress and problems of their employees in their work. For the university to respond to new needs in research and education, a stronger leadership is essential. The leadership must work actively and have authority in promoting cooperation among the faculty by focussing the finances of the university to accomplish common goals.

Success factors

Successful research work aims at progress in understanding and exploiting new knowledge in basic sciences, and transferring such knowledge to applied sciences, engineering, and technology. The Panel concluded that the Norwegian system under-rewards individuals with accomplishments in basic sciences and engineering relative to more applied aspects.

Research success should be based on criteria specific to the goals of the endeavour. In basic research, the publication of scientific articles in peer-reviewed journals is an essential factor. No other avenue offers an equal ability to disseminate basic knowledge. Furthermore, citations to such articles are the best current indicator of how widely such results are used by others. No other standard has the weight of this aspect. For engineering and design oriented research, whether it is basic or applied there are additional indicators. Then "publications" also emerge via design rules, coding activities, computational software products, new design methodologies, new prototype developments etc; while "citations" have the form of application of these rules etc. by the professional community.

Considering the benefit of the research activities for Norwegian society, the evaluation Panel will point out some additional criteria, which could be considered by the university leadership. These criteria could, in parallel, be regarded as success factors. They need to be quantitatively appraisable, with qualitative interpretation, thereby allowing measurement of the success and the perspectives of research activities within regular periods. Furthermore, these same measures must be well-known and understood by those being judged. This procedure ensures a transparent evaluation of research efficiency and, by linking it with the financial rewarding system, to stimulation of the highest quality work and high productivity in various research fields. For an evaluation of the research activities the items listed below in detail could serve as criteria:

- Profoundness of research (as judged, for example by the quality of the journal publications, national and international awards, honors, and prizes, invited keynote lectures at international conferences, and other such measures)
- Broadness of research, synergy with other groups, interdisciplinary cooperation (judged by connections with other research groups, other disciplines and particularly international cooperation. Industry-university interactions, and external research funding – from industry and government bodies)
- Long-term application potential (number and value of patents, royalties from patents, use of new design rules, use of computational software e.g.)

- Basic financial support and number of employees (the manpower and budget for each project should be transparent to administrators and researchers in order to assess overall productivity and for comparison with activities competing for fixed resources.)
- Equipment (quality and quantity, and useage factors (percentage time in use))
- Production rate of PhD-students/doctorates (with quality judged by their placement in desirable jobs, international opportunities offered, and so on.)

An exact definition of the factors and determination of the weighting can only be carried out by the research institutions in cooperation with the Research Council.

Relationship to SINTEF

The relation between NTNU and SINTEF is not transparent to the Panel, and apparently not to university leaders and researchers. That is true both for personnel questions and financial matters. This obscurity makes evaluation of productivity and efficiency nearly impossible. However it is evident that the co-operation is handled with little bureaucracy. Also the co-operation with industry, whether it is handled through SINTEF or directly with the departments, runs smoothly. The contacts between industry and NTNU are good and NTNU was judged by the Panel very useful for Norwegian industry regarding education, research and consulting support. The new organisational structure will improve the situation further when the leadership manages to accomplish integration among the research groups in the departments and to increase the cooperation between the departments.

It is clear that the relationship between NTNU and SINTEF has been both long and fruitful and that the financial, social and physical structures are closely related. The relationship with SINTEF provides some unique benefits to NTNU in terms of large-scale laboratory facilities, adjunct faculty, student training and the provision of a mechanism for industrial collaboration and related research.

One way to revitalize and reinvigorate the collaboration with SINTEF while promoting less-applied research would be to clarify and modify the financial reward system for researchers from the universities and government agencies. Today the incremental financial rewards for faculty researchers seem almost entirely to derive from SINTEF, which is by its nature focused on applied research. This leaves a vacuum for basic research.

Current funding situation

Success in research cannot be attained without sufficient and consistent financing of teaching and research. Financing of research seems however to be the least critical issue for NTNU. The Panel even heard faculty members saying that finance was abundant and too easy to obtain. The Panel suspects that in this abundance the faculty choose those projects which are the most profitable and not the ones being of the greatest academic interest with respect to publishing in refereed journals or leading to academically interesting projects for doctoral students.

When the Panel examined the sources of research funding it observed a wide spectrum of responses. Some groups made serious efforts to obtain EU funds and develop valuable long-term international collaborations. Others were content to accept established routes with simpler internal procedures and thus to ignore possible new

funding sources. The culture of each department and group seems to be well-established and to be the principal determinant of whether they are outward looking at international standards, or are more locally focussed. If NTNU is to pursue successfully the strategic areas it defined in 1999, it needs to develop a funding system that rewards productivity and interdisciplinary collaboration. From the Panel's view, the reward system for faculty seemed independent of objective indices of productivity. Neither NTNU nor the Research Council provided such objective information to the Panel.

It must be recognised that NTNU has made major structural changes in the past 4 to 5 years. In fact, several faculty noted repeated changes that took attention away from fundamental issues. The changes have resulted in new groupings of departments and activities, and clearly need some time to become established and gain acceptance. However in the Panel's view, the structural changes can only contribute to the defined research and educational aims in conjunction with more systemic development of leader, reward systems, and effective management within the institutional framework. What is needed is leadership that is catalytic and encourages the renewal of curriculum, new research interactions, the exploration of new funding mechanisms, etc.

Future research funding

It is clear that NTNU has a well-developed system of funding including the complex relationship with SINTEF, government funding and direct funding from industry. In addition, some departments have been very competitive in obtaining EU funding. In the future both the new structures developed at NTNU and changes in the pattern of Norwegian industry will necessitate new approaches to funding. As many industries become international in scope, their relationship with NTNU will change and force a more collaborative approach in which the skills of more than one group need to be combined. This will require both encouragement and careful management and leadership on the part of the administration at NTNU since it is not the prevailing research culture.

However in the future Norway and NTNU may require more flexible vehicles for collaboration with the industrial sector and the development of a more innovative and entrepreneurial approach to applied research. The Panel did not examine evidence of NTNU activities in the Leiv Eriksson Nyfotek or the Gløshaugen incubator. In the future it is likely that NTNU will have to serve the research needs not only of large Norwegian companies such as Statoil and Hydro but of many small and medium size enterprises with focused research needs which require rapid responses and a more flexible research portfolio. The senior administration of NTNU seems to have clearly encouraged this future need but it is not reflected either in departmental management structure or in the funding mechanisms of RCN. There is a need to foster collaborative research in the existing structure, to encourage the capabilities of young faculty and to develop new modes of interaction with small and medium size enterprises. The special initiatives for centres of excellence and young investigator awards could be established within the present RCN budget to provide incentives to encourage a more co-ordinated response to the research required in the areas designated both by RCN and NTNU as priority areas.

Similarly it may be appropriate to seek new partnerships with small and medium size industries in areas such as manufacturing methods, design, life predictions, process optimisation, material selection, and particularly nanotechnology and biomaterials. Here the new groupings in NTNU may prove valuable although they need time to reach equilibrium after the recent changes. The future needs will certainly entail a more aggressive approach to obtaining EU funding and the development of partnerships with other major institutions both in Europe and elsewhere to foster both research and educational opportunities for students.

The relationship to SINTEF is clearly complex but the development of Gemini Centres may be a useful way of developing more flexibility in the research effort at NTNU. Consideration should certainly be given to extending the number of Centres of Excellence – it was astonishing to the Panel that Materials was not already such a centre in view of the outstanding assessment of their activities.

A general comment relative to funding is that the current culture is based on individual rather than group activity and much of the funding depends on older faculty. In order to develop a more flexible response in terms of research effort and in order to foster the development of young faculty, attention should be given to the administration developing a system of informing faculty of funding opportunities and fostering the writing of proposals.

Innovation and entrepreneurship

The Panel was pleased to see that innovation has been emphasised. However during the evaluation interviews innovation was not very visible. The Panel noticed that patents were more commonly given prominence in the materials related groups than in others. It worries the Panel that the strong influence on research from SINTEF and industrial companies imply that researchers at NTNU lose ownership of their research results and discoveries and as a consequence they might lose interest in pursuing an innovation and start up process. If innovation and start-ups are not within the core business of SINTEF or the big industrial companies, valuable innovation ideas will be lost.

The Panel suggests that the university management emphasize the implementation of an innovation strategy that encourages the participation of the faculty. Industrial use of research results and patenting of these should be part of the reward system of the university. For students and employees, annually organised innovation competitions is a way to focus on the importance of practical use and patenting of research results.

The university managements should undertake benchmarking studies with universities well known for successful innovation and licensing

Personnel and Recruitment

The success of university departments depends on the ability to attract and to develop engaged, goal oriented, and proactive staff which takes its part of personal responsibilities and thrives in an environment where values, achievements and professional qualifications are highly valued.

It was made clear for the Panel that it is not always easy to attract a sufficient number of qualified Ph.D. students and research staff. This seems to be a special problem

within engineering disciplines where there is a strong competition in salaries and benefits from the industry. Partly in response to this situation, but also to become more integrated in the global research network, the departments interviewed have chosen to employ an increasing number of foreigners as Ph.D. students and in academic positions.

The age profile of many researchers in the research groups evaluated is such that NTNU will need to hire a significant number of new staff over the next five to ten years.

To attract and to develop qualified personnel, the Panel recommends that

- Time-limited, non-tenured positions should be established as a position between post-doctoral researchers and permanent faculty positions. These positions should be given teaching responsibilities and used for recruitment of new faculty.
- The regional universities should develop hiring policies based on forming strong competitive research units with a clear research agenda.
- The universities should make their importance for the Norwegian society better known and publish their strategy and visions in a form that increases the awareness of the importance of technical research.
- Pro-active recruitment campaigns should be utilized to attract engineering students. The experience from the Department of Structural Engineering could be used.
- A more result oriented salary-system should be introduced to attract and to keep the most prominent researchers.

At almost every interview the Panel conducted, it was pointed out that there were few, if any, women in the research group, and that it was very difficult to recruit women researchers. The Panel was informed that there were few women pursuing Ph.D. degrees. Countries and institutions will find it increasingly difficult to compete internationally if only half of the available talent is utilized effectively. It is important to take effective steps to get women more interested in graduate studies at the doctoral level. The leadership of the universities should take measures to change this state of affairs.

Graduate students

Overall the research students are satisfied with the graduate school system. During the interviews it was obvious that Ph.D. students as well as faculty felt that their research and their institutions are extremely important for the Norwegian society and they also felt that they have good working conditions. In general, they have regular interactions with their thesis advisor. On those occasions results are discussed and future activities planned. The students also participate in general discussions and can take part in the planning of future activities of their department. At regularly held seminars within the department they have the possibility to present results for faculty and other students. For example, presentations are held before students attend a conference. In addition to going to international conferences, students are also encouraged to study at foreign universities for a period of time. The possibilities for financing these activities are generally good.

Many students have good contact with the industrial sector during their studies, and many do part of their work in the companies that finance their studies.

The projects from which the students are funded normally last for 3 years (or 4 if they have teaching duties). However, the time required for a PhD is normally 4 years. This gives problems for financing of the last year of the doctoral studies.

The main problem related to graduate students is the lack of information, especially at the start of the studies. The students are keen to get a flying start to their research, but the administrative information is vague. It is difficult to find information about routine work; instead the students actively have to look for the information needed and slowly acquire knowledge of the system over six months or a year, during which time they can be confused and anxious. Norwegian students appeared to adapt to the system rapidly but foreign students are disadvantaged. Considering that international students now make up a considerable part of the total number of PhD students the information system should be improved. In particular, web-based information dissemination, in English, should be developed and emphasized to put all students on an equal footing.

The students almost universally reported that they are quite isolated in their fields of research. Information within the departments is available, but there is little research cooperation between graduate students in different departments. Moreover, information about seminars and research at other departments than their own generally does not reach the students. In order to improve this situation, NTNU should consider organizing courses and seminars related to the doctoral students in graduate schools including several departments.

The Panel later discovered that there is a requirement that individual study plans for students have to be agreed upon between the student and the supervisor within one year after the registration as a graduate student. This does not seem to function in many situations and, in any case, it is recommended that the time limit should be shortened to about six months.

Systematic evaluation measures

Most departments were not familiar with the concept of a self-evaluation system. As a consequence, the Panel found several inconsistencies on the broadest level in the stated goals of improving research productivity, quality, and relevance. For example, most departments did not report the criteria by which they evaluate whether the research has reached expected standards. A greater understanding of the criteria by which research quality is rewarded will improve the quality and strategy of departments. These criteria can, for example, be included in the annual reports of departments and should be available on web sites to anyone interested.

There is a large disparity of the level of international standards sought by the various groups studied by Panel 2. Some groups have little knowledge of, or interest in, the internationally-accepted indicators of significances and quality, of peer-reviewed publications in international journals, of international awards and honours, and so on. Other groups clearly have developed a culture and tradition of looking outward and adhering to high standards.

During the evaluation the Panel came up with some specific recommendations related to evaluation measures:

- No group, department, or individual that was questioned used "impact factors" to assess the value of various publications. Similarly, no group or department systematically uses "citations" to assess the impact of an individual's work. While such measures are by no means perfect or complete, they are much better than ignoring them. These measures are used routinely in many countries, although caution in overemphasizing them must be exercised. Some local colour in measuring citations and publications should be allowed when engineering and design oriented research is considered.

- Although one of the Panel's important goals was to assess research productivity in a general sense, this was impossible in view of the very limited and inconsistent budget information available. In particular, ignoring the effect of SINTEF seems to distort the picture significantly. Perhaps future evaluations should include more detailed financial information.

- The university wants to promote publishing in peer-review journals, but it rewards only the publishing in international conference proceedings via travel grants. The Panel notes that both venues are important, the latter one for establishing international contacts and collaboration, the former for disseminating research results widely and over long time periods.

- In relation to research outputs, it was noted that graduate students at NTNU are expected to produce a number of papers on their work during their period of research, but it appeared that similar targets and incentives are typically not specified for members of faculty. In order to increase research productivity and outputs a review of targets and incentives should be considered. Consideration should also be given to the production of annual or biennial research reports in which research outputs and achievements are recorded in a systematic way.

- More broadly, there seems to be little internal review of individual faculty accomplishments. Some groups had apparently not been asked for this kind of data before the Panel evaluation process began.

Evaluation of the departments and research groups

The following sections summarize the evaluations of the departments and research groups within Structures, Materials, Product development and Design in engineering research at Norwegian universities and colleges. The evaluations are based on self-evaluation reports and on information provided during 4 days (March 1st – March 4th, 2004) of interviews in Trondheim.

For every department there is a summary of the research profile, number of graduates and equipment given, followed by an evaluation of:

- Organization,
- Scientific leadership and research strategy,
- Equipment and infrastructure.

For every research group there is a summary of the research profile given and personnel, followed by an evaluation of:

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

In the grading of "Scientific quality and productivity" the Panel has chosen to give high weight to publication in refereed international journals. For "Relevance and impact" high weight has been given to the importance for the Norwegian industry and society at large in addition to the impact on the international research community.

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 Natural Science and Technology

1.1 Department of Materials

Departmental profile

The Department for Materials is organised into four research groups: Inorganic chemistry, Electrochemistry, Extractive metallurgy (below ExM) and Physical metallurgy (PM). In the group evaluations only the two latter will be evaluated. In terms of personnel they make up about half the department.

Totally the department has 25 professors (including 7 emeritus), 4 associate professors, 13 professor II, 20 post-doctoral researchers and 58 doctoral students. The department has only one female professor. During a three years period 41 doctoral students and 53 M.Sc. students graduated.

Of the total financing of the department 47% is external. The total expenditure for the year 2002 was 48 MNOK. During the three years period 2000 to 2002 both the university and the external funding have doubled. In spite of this, the average budget of the professors is as low as 1,2 Million NOK or excluding the 7 professor emeritus 1,4 Million NOK. The department finds itself under strong pressure to reduce the number of staff.

Department evaluation and recommendation

This department has world class research effort with outstanding activities in both process metallurgy and physical metallurgy. It has very effective leadership that has provided a forum for discussions and developed a strategic plan for the future. The new structure that includes inorganic chemistry and electrochemistry provides a unique platform to expand the range of activities of the department. However the department will have a problem to gain full advantage of the available synergies between chemistry and metallurgy without locating them in close proximity (in the same building or adjacent buildings). Moreover the administration – having designated materials a thrust area and made the group of Materials, Inorganic chemistry, and Electrochemistry – should give real consideration to the faculty numbers needed and the support staff needed for instrumentation etc. This is a new grouping with a very rich potential for the future – it needs to look at ways of developing the curriculum to exploit its potential and to serve the basis for a science based manufacturing effort in NTNU which could be a Centre of excellence which is complementary to the Nanoscience Centre which is developed in Oslo.

Another two serious obstacles exist – there must be a plan for faculty renewal so that the number of faculty does not fall below its current level and space must be provided or renovated to encourage new synergetic activities such as the development of micro- and nanostructures. There is also a need to examine whether teaching loads could be reduced by curriculum rationalisation and a more collaborative approach to research in some areas e.g. the interaction of materials science and mechanics. The

Panel considers the department's productivity excellent in terms of both research and teaching, yet they are being asked to work harder. That cannot be a stable situation. The department has excellent international collaboration and has hosted summer schools and short courses to project the image of NTNU research in a very positive manner. This could perhaps also be said in the area of new technologies for production of nanoscale material at some point in the future. It is astounding that the department was not designated as a Centre of Excellence and this aspect should be reconsidered at some point in the future. An excellent example of the productivity and collaboration at the department is the solar cell project that has been achieved through collaborative work with other departments, from basic science to Norwegian products.

The department should consider whether a name change would be appropriate to better cover the research at the department. At NTNU "Department of Materials Science and Engineering" is particularly good. The department is located in the science faculty, and combines chemistry and materials. The same is true of the research groups – "physical metallurgy" is older and does not recognize composites, silicon, intermetallics and other topics that are covered by the group. Also "extractive metallurgy," could for example consider the name "materials processing" that better covers existing and future research.

1.1.1 Physical metallurgy

Group profile

The group consists of several "dynamically organised sub-groups". These groups have co-operation with other departments in NTNU, especially the Department of Structural Engineering, Department of Physics and also the Department of Engineering Design & Materials.

The main research topics are aluminium alloy technology, physical metallurgy and welding of steels and ferrous metals, magnesium alloys and silicon and scanning electron microscopy. Priority areas are "casting of light metals" and "alloy design" with future emphasis on computer models and simulation for coupling of micro-structural properties to deformation behaviour and spatial variations. The ambition is to become the leading European academic group in these areas.

Collaboration with the Norwegian metallurgical industry is strong, especially with the light metals industry. Example of this is NorLight working for downstream application of light metals, Prosmat, FREMAT, FORMLAB all jointly funded by RCN. The group also take active part in different EU-projects: Brite-Euram (REAP), VIRCAST, VIRFAB, VIRFORM. The group is also a strong partner in several Nordic projects funded by Nordisk Industrifond and with industry and university participation from all Nordic countries.

The group also collaborates with industries and universities in Europe at large, Australia, China, Japan and the Americas. Out of 9 post-docs 3 and out of 18 doctoral students 5 are from abroad. International faculty exchange on professor, post-doc and doctoral student level as well as participation in international boards etc. is continually occurring and is given high priority.

During the nearest past 4-year period 25 doctors have been graduated. The publication rate of professors and post-docs is very high. A significant proportion of the publications is in international journals.

Group evaluation and recommendation

In academic terms this group functions very well. It is very productive and produces high quality research and also has a well-established international and industrial network. For example, a summer school with high scientific impact does exist. The group also functions very well in respect of how work is divided. It is especially pleasing to see that all research personnel contribute to research. In addition the production of doctoral students is high.

Group grades

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

1.1.2 Extractive metallurgy

Group profile

The Norwegian Ferroalloy Producers' Research Organisation, FFF, has since 1989 funded projects with 130 MNOK, mainly carried out at ExM and SINTEF in co-operation.

RCN has together with industry started "Knowledge-building projects", KMB, and "User-led innovation projects", BIP, with ExM as a strong partner. Under the KMB:s 24 PhD-students have so far graduated. Within the BIP-projects 7 patents have been granted. Some of these projects have now come to an end and ExM is planning new activities. These are however in their initial stages. One such project is FerroVision where the focus is on materials engineering rather than materials science. This seems a natural step to go further from the earlier research direction. It will however require extensive co-operation with other scientific fields, outside the own department, e. g. for computer simulation and modelling of material processing and material properties. The research group has many international contacts in the form of guest researchers and post doctors (average 2 per year), joint publications with international colleagues (average 4 per year). ExM faculty also are visiting scientists and have research co-operation abroad. Some doctoral students spend part of their time at research institutions abroad.

The group has graduated 10 PhD:s during the period 2000 – 2002 (3 years).

Group evaluation and recommendation

One of the group's biggest problems is renewal of the faculty – three out of five professors are emeriti and a further one is close to pension age. This problem should be given serious attention. The reduction of staff over the years has also affected the funding for the group. Proactive steps should have been taken earlier to secure industrial funding. In the future the group could get into difficulties in attracting industrial money.

Most members of the faculty have significantly high publication rate, some even impressive for being so applied and connected to industry in their research. The publications are mainly in the form of internal NTNU- and SINTEF - reports or as conference publications. The output from the group in the form of patents is also good (7 patents during a 10-year period).

Group grades

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

Faculty of Engineering Science and Technology

1.2 Department of Structural Engineering

Departmental profile

The Department of Structural Engineering is organised into three groups:

- Concrete with subgroups: Concrete structures and Concrete materials.
- Steel and light metals (SIM lab).
- Structural mechanics, which includes computational mechanics, earthquake engineering, wind loading, timber structures and biomechanics. Solid mechanics has recently been brought to this group.

Further there are also plans for creating a "timber group".

The department consist of 25 faculty, 7 external professor II, 4 post-doctoral students and 50 doctoral students. The total budget of the department is 45 MNOK of which 53% is external. The laboratory and administrative staff consists of 22 persons. The department has graduated 19 doctoral students and 119 M.Sc. during a three-year period.

Main co-operating partners are SINTEF and other departments within NTNU. Strengths of the department are laboratories, scientific and laboratory staff, industry cooperation and financing,

The department has a laboratory consisting of five units, but with co-ordinated leadership. The laboratory consists of equipment for studies of traditional technical problems. The goal of the department is to extend its research to new research areas such as biomechanics, micro- and nano-mechanics.

Department evaluation and recommendation

The Department is well staffed and has well-equipped laboratories. The structural engineering laboratory consisting of several halls, workshops and areas for student activities is found to be well managed and functions as one laboratory serving all parts of the department.

The Department of Structural Engineering has a number of excellent adjunct professors and has good relations to industry. In general the research is driven by industrial needs and more basic curiosity driven research has low priority. This is to some extent due to funding problems. However in order to play a more significant role in the international scientific community the research in fundamental research should be strengthened.

There is a weak leadership at the department level. The head of the department has little formal power. Moreover, the groups do not want a strong leader, since independent research strategies are preferred. It seems that there is confusion between leadership and management. Instead of utilizing the advantages that the group configuration gives, with respect to funding opportunities and common

research goals, every group does what it finds interesting. The personnel conclude that, a democratic leadership is needed at the department level.

Two other weaknesses are the age distribution of scientific staff (43 % above 60 years of age) and of technical staff (67 % above 60). Proactive steps should be taken, otherwise important knowledge could be lost due to retirements.

It has been one year since the last group merged with the department, but so far a common research strategy has not been developed. The combination of competences from civil engineering and applied mechanics offers many new and interesting research possibilities and should be explored. Especially the knowledge from the structural mechanics group could become better integrated with the other groups. With respect to doctoral courses the department works well. Doctoral students take courses from all disciplines within the department. This gives a better understanding of the groups research, which integrates the department.

The department has good combination of experimental, numerical and theoretical work that should also be maintained in the future. If new research areas are established the department should consider if new equipment is needed, or alternatively research cooperation should be established, particularly in relation to biomechanics and micro/nanosystems.

1.2.1 Steel and light metals (SIMLab, Structural Impact Laboratory)

Group profile

The laboratory was re-organised in 1999. Today, the group has 4 professors, 1 associate professor, 1 external professor II, 1 post-doctoral research fellow and 16 doctoral students. Its main emphasis is on structural impact, energy absorption and penetration problems. The research profile is a combination of mathematical modelling of metallic materials, material testing and implementation of these models to large-scale structures. Experimental facilities have been developed for dynamic testing of materials, components and structures.

Actual applications are crashworthiness of automotive systems, penetration mechanics with application to protective systems in oil and gas industry and protective military systems. Financiers are Norwegian industry, RCN and the Norwegian Defence Estates Agency. The group has extensive co-operation with the European automotive industry, with the EU-laboratories in Ispra and on computational modelling with the Livermore Cooperation in USA. The SIMLab group also cooperates with many European universities on specific problems.

SIMLab publishes frequently its results in international journals. Since 1995 the group has graduated 13 Ph.D.s, of these 3 during the period 2000-2003.

Group evaluation and recommendation

The SIMLab Group is the most homogeneous group within the Department, with common strategy and aims. The group cooperate well together and are very productive. There is a good balance between industry and university funding. Overall the group activities are well planned, and cover the areas of: structural impact, energy absorption and penetration problems in an integrated way. This has resulted

in several well-balanced projects, where both industrial interests and basic research are covered. International and external cooperation exist and work well.

It is a strength that the group has many publications and publishes its research results in international journals. The group also has a reasonable number of Ph.D. students.

The SIMLab group has developed and built some unique experimental facilities for penetration and impact testing and balances experimental and theoretical research in an excellent way.

The group has considerable knowledge of mechanics of structures with focus on impact problems, especially connected to aluminium structures, but there is very little research related to civil engineering problems, which also should be covered by the department. The Panel recommends that the SIMLab group in cooperation with the colleagues in the department develop a strategy for structural research related to civil engineering structures.

The internal cooperation within the rest of the department and the metal forming group at the NTNU Department of Engineering Design and Materials could be better.

Group grades

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

1.2.2 Structural mechanics

Group profile

The group has 10 professors, 3 associate professors, 2 external professor II, 1 post-doctoral research fellow and totally 19 doctoral students. The group was involved early in the development of finite element method applications to mechanical and structural analysis and subsequently in advanced shell element theories, error estimation and incremental-iterative solution schemes for highly non-linear problems. Strong areas of research are:

- non-linear analysis and dynamic analysis,
- finite element technology, program development and numerical analysis
- material mechanics and rheology,
- biomechanics, fatigue and fracture mechanics

The group cooperates with SINTEF and is supported by RCN. It has many industrial projects for national and international companies.

The faculty publishes their work frequently in international journals. Within the group 5 Ph.D.s have been given in 2000-2002.

Group evaluation and recommendation

The group has for many years successfully worked with civil engineering structures, fatigue, fracture and damage problems. The computational and experimental resources are up to date for the present activities. However, for new research areas such as MEMS and biomechanics the laboratories are less well suited.

The organisation of the group is diversified, mainly because the group is inhomogeneous. It is a shortcoming that there is a lack of coherence between the various projects within the group. The projects do not seem to be solving the pieces of a big puzzle. While each project is worthwhile by itself, collectively their value would be further enhanced if they were to fit into an overall scheme.

There is however a common interest in computational mechanics. With some strategic planning this fact can be utilized in research, especially in cooperation with the other groups in the department. The group makes basic research within mechanics of materials. Thus, the group can supply the theoretical ground for constitutive modelling for the rest of the department and also for other NTNU departments such as the Department of Engineering Design and Materials.

New computational techniques involving coupling between electro-magnetic fields and thermo-mechanical fields and fluid structure interaction problems are areas which could be future research topics where the excellent computational expertise of the group could be a good starting point.

The group has relatively few graduate students. Here a well-balanced research strategy could possibly make the group more attractive for external research funding and for potential graduate students.

Group grades

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

1.2.3 Concrete Structures and Materials group

Group profile

The group has 6 professors, 2 external professors II, 2 post-docs, 2 external post-docs II and 15 doctoral students. The group consists of two interacting subgroups, covering concrete materials and concrete structures respectively. This permits a multi-scale approach starting from basic material properties up to full-scale structural performance. In this process the group both inserts modelling tools as well as experimental testing. Examples of recent topics include constitutive modelling of reinforced concrete, early-age cracking in concrete materials and full-scale bridges, development of new high-performance concrete materials, and durability research related to moisture, reinforcement corrosion and service life prediction.

The group closely cooperates with SINTEF and has many national as well as international contacts. This is evidenced by acquired project funding from several sources including the Norwegian Research Council, four European projects and a number of projects with the industry (e.g. with Statoil, the Norwegian Public Roads Administration and industrial partners in the IPACS project).

The group publishes its work in conference proceedings and in materials-oriented international scientific journals. The group has produced 6 PhD's and 54 MSc's during the period 2000-2002.

Group evaluation and recommendation

Since 1970, Norwegian research into concrete and concrete mechanics was driven by the concrete off-shore platform business. This period ended around 1990-1995. Consequently, the Concrete Group had to adapt to the new situation and shift its focus, which was not an easy task. The group has been at least partially successful in this.

A decade ago, the group was one of the first internationally to start with experimental as well as simulative research on early-age cracking, hydration and moisture effects, including the resulting stress-strain development at macro-structural level, e.g. for bridges. In this area the group is in the front line internationally. This work has critical mass and the scientific quality is evidenced by a significant number of publications in accepted journals for concrete and materials. It is internationally embedded in a series of four European projects, while the inclusion of industrial partners demonstrates the societal relevance and impact.

Regarding other topics, the picture is less clear. The impression is that the relatively small group has tried to cover a broad field of maybe too many topics, ranging from advanced computational modelling of coupled problems, dynamic loading, fire loads, work on other materials like masonry and fibre concrete, stress resultant and strut-and-tie modelling, laser scanning of structures, etc. For these diversified topics, the scientific quality and productivity appears to be less, although the national societal relevance is still significant given the interest of industrial partners and funds acquired. Clearly, the small group has been active in finding new directions beyond the off-shore platform period, but the time has come to sharpen the focus and strengthen selected topics. Otherwise, international visibility and high scientific standards cannot be achieved. Perhaps, a more active co-operation with at least the mechanics group in the department, but also with the steel and light metals group may help in this respect. This may generate more critical mass in the area of computational modelling and testing. As concrete bears similarities with other cohesive-frictional materials like soil and rock, re-activation of contacts with soil and geo-mechanics departments (not evaluated by the present Panel) might be considered too. New infrastructural works are likely to call for coupled soil-structure research. It is suggested that a follow-up to the multi-disciplinary CMC project should be considered.

Strong points of the group are the contact between materials and structures (micro and macro), the contact between modelling, laboratory and field testing (e.g. for creep and young hardening concrete), the number of national and international collaborations, the proper staff/MSc and staff/PhD ratio's and the tradition of close

cooperation with SINTEF. However, in line with the general findings of the Panel, the precise outputs by NTNU and SINTEF regarding concrete research cannot be clearly identified, as the cooperation has many forms. Regarding staffing, the required follow-up to retiring professors in the concrete materials group should be anticipated in due time.

Group grades

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

1.3 Department of Marine Technology

Departmental profile

The department is organised into two research groups, Marine Structures and Marine Systems. The department is situated in the Marine Technology Centre, MTC, together with MARINTEK, a research company within SINTEF with 110 research staff and 70 additional employees. Annual turnover of MARINTEK is 200 MNOK.

Close cooperation with MARINTEK including common use and development of laboratories exist. The department and MARINTEK are both members of the Centre of Excellence on Ships and Offshore Structures, which was created and is supported by RCN. Points of strength of the department are:

- the cooperation and co-location with MARINTEK, which gives synergy effects and excellent market contacts,
- the superb laboratories at MTC,
- the task of serving the most important export industry in Norway, namely offshore petroleum activity, shipping and shipbuilding, fishery and aquaculture,
- a strong international university network (MIT, UC Berkley, Univ. of Michigan and others),
- an excellent library and
- a large fund from the Norwegian Shipbuilders Association.

The total expenditure at the department is 63 MNOK (2002), of which 38% is from external funding.

The department graduated 20 doctoral students and 215 M.Sc. students during a three-year period.

Department evaluation and recommendation

It should be noted that Panel 2 has only had the chance to evaluate the Marine Structures group, whereas the other half of the department, the Marine Systems group, is evaluated by another panel. However, in spite of this somewhat limited knowledge of the integrated department, the panel will offer the following observations.

The strengths pointed out by the department in their self-evaluation report make a very strong foundation for its future development. The large, competent staff at MTC which has been engaged in research over many years and the excellent research facilities makes the department unique in the world.

The main weakness at the department level is lack of leadership of the integrated department. Other weaknesses are the very low scientific activity in some technical important research areas, the male dominance in the faculty and the geographical position of MTC some distance away from the other engineering departments of NTNU. The latter makes cooperation less attractive.

According to the strategic plan of the university marine/maritime research and energy and environment are thematic areas at NTNU. Many possibilities for interesting research are seen here.

The department gives priority to cooperation with MARINTEK, and the panel appreciates that priority also is given to EU supported research.

The publications of the department are of high quality, but show a strong overweight of conference contributions as compared to journal papers.

Regarding personnel there are difficulties in recruitment of Norwegian PhD candidates - 50 % of the students are from abroad. Female students are few and strong efforts are needed to increase the "marine research" interest among women.

Although world-class laboratory equipment exists at the department, the Machinery Laboratory needs large modifications (cost 20-40 MNOK) in order to serve its purpose satisfactorily. Potential problems are also seen with the need for continuous maintenance and upgrading of all the laboratories.

1.3.1 Marine structures

Group profile

The Marine Structure group was formed in 2001, by a merger between Department of Marine Structures and Department of Marine Hydrodynamics. The group has 10 professors, 1 associate professor, 4 professor II, 1 post-doctoral research fellow and 17 doctoral students. In addition there are 10 people in the technical staff. The group has a close cooperation with Centre of Excellence on Ships and Ocean Structures (CeSOS).

Research work includes theoretical, computational and experimental work. Research in the group is divided into four disciplines,

- Marine structures
- Marine hydrodynamics
- Marine cybernetics
- Nautical science.

Group evaluation and recommendation

The research performance of the key researchers in the Marine Structures group is of very high quality. The research of the group focuses on applied and pre-normative research, and addresses mainly scientific and methodological problems, rather than industrial or commercial product development.

The names of the active researchers involved in the group demonstrate academic excellence and scholarship.

The group has world leading competence within their areas. This is demonstrated by the fact that the research group in the field of marine structures constitutes an essential part of the top level scientific international community, where it has received

continuous appreciation, as testified by the appointments in top level congresses such as the International Ship and Offshore Structures Congress (ISSC), International Towing Tank Conferences (ITTC), PRADS, BOSS, OMAE, etc.

It is therefore important to maintain that competence. A potential problem is arising since several of the professors are older than 60 years. The retirement of these professors could have a large effect on the department research profile, and competence within the area could be lost. The group should therefore consider how it can maintain its high level research. This is a potential problem since research strategies are very individual at the department. Common research collaborations are very much personnel driven.

The research is well integrated with Marintek, authorities, maritime industry and international cooperation partners. The group also actively seeks new areas of research, where their competence can be used. A novel and very successful example of this is the integration of the marine cybernetics discipline with hydrodynamics and structural mechanics research. In this combination of disciplines the group has established a world-class competence.

The area of research has high impact on Norwegian society and the group is to a large extent responsible for the strong position Norway has on research and education within basic research for rational design of marine structures. However, the strategic plan for future research by the Marine Structures group is lacking and seems to be completely substituted by the research plan for CeSOS. The Panel recommends that a strategic plan is formulated for the group.

The standard on the doctoral students graduating from the department is high; especially since new research ideas are implemented on a regular basis. The average PhD graduation is however not very high per faculty member. Considering that two professors graduate a large proportion of the students, strategies for the others should be considered.

Group grades

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

1.4 Department of Engineering Design and Materials

Departmental profile

The Department of Engineering Design and Materials was merged from the departments of Machine design and Materials technology in 1994. The department aims at combining engineering design and materials technology. For this it is divided into four research groups. The focus is on development and integration strategies for the major stages in product engineering.

During the last 3-4 years, a lot of effort has been put into development of the new study program Product Development and Production. This gives an opportunity for the department since Norwegian industry has lost competitive power within this area during the last decade.

The department consist of 11 professors, 3 associate professors, 6 external professors II, 4 post-doctoral research fellows and 24 doctoral students. In 2002 the total funding was 21 MNOK. This is an increase by 50% from year 2000 to 2002. Out of the total funding 43% is external (year 2002), which is an increase from year 2000 when the external founding was 39 %.

During a three-year period only 7 doctoral students graduated. The goal is to produce 10 PhD's per year within year 2005, which is a considerable increase. During the same three years period 71 MSc students graduated, of these 47 were from Product development.

The department has good infrastructure regarding laboratories and offices. The laboratories cover 1800 m^2. Equipment for mechanical testing, manufacturing and machining of metals, prototype manufacturing, a design studio, computer labs and a polymer and composite lab etc exist.

Department evaluation and recommendation

The organisation at the department is diverse. The potential to integrate engineering design concepts exist, but this goal is not realized. The research organisation does not work as one research unit. In the educational system there is however good cohesion between the groups, but when it comes to research they work separately. The goal set up by the department to integrate the research is thus not fulfilled. Administrative leadership for the department is also weak, and a resistance against the new organisation is clearly present.

The research strategy for the department is good. It has however not been implemented. The research at the department needs to be focused, where the groups cooperate to achieve progress within engineering design. The methodology of the engineering design should be utilised also as a framework to synthesise the different research areas. There is research related both to polymers and metals at the department. There are however little interaction between the groups. Since competence for several material classes exists at the department, material and process selection should be a topic for research.

The PhD graduation rate has been very low at the department. The department goal is to graduate 10 PhD students annually. Since 7 students graduated during 2000-2002, and there are 24 enrolled currently, the goal seems unrealistic. The department should therefore reconsider the PhD situation. In many countries there is the system called industrial PhDs. The department should study this system and consider how to use the strong industrial cooperation to increase PhD funding and education.

In spite of the large laboratories the department has a small technical staff, totally 6.5 positions (3 in workshop/testing, 1 in material lab, 1 in product design lab, 1.5 ICT). The age distribution of staff in the workshop/testing is a serious potential problem, since they are older than 60 years. No proactive steps have been taken with respect to this threat. Such action is very important because the simulation research needs laboratories for verification.

Even though engineering design can gain from cooperation with other departments at NTNU, the cooperation on research issues is almost non-existent. The co-operation with SINTEF is however close. The Panel had difficulties in separating the research done by the department and by SINTEF. How equipment and research cost were shared was also unclear. However, the groups of the department have good industrial cooperation.

The university management should consider supporting the departmental leadership with strategically directed funding. The goal of the department is important for the success of Norwegian industry.

1.4.1 Product development

Group profile

The group has 4 professors, 2 associate professors and 1 externally founded professors II. Currently the group has 9 doctoral students. Research covers mainly product simulations and distributed platform design, while research within automatic design has recently started.

The group has had a high workload in teaching, and the research has been diverse. The future high priority areas are:

- Product simulations and automatic design tasks
- Distributed product platform design.

Group evaluation and recommendation

The Panel is positive towards the research strategy that the group has chosen. The theoretical foundation for the group is simulation techniques and design methodology. The simulations include kinematic control of mechanical systems. The international cooperation for the group is good. The cooperation has been strengthened through the sabbatical leave positions in universities abroad (6 professors since 1997).

The group publishes mainly in conference proceedings, so more emphasis should be given to peer review journals, patents and PhDs. Traditionally the engineering design

area disseminates research results in conference papers, developed software, and realised engineering design results. But archived, peer reviewed journals give better international visibility. The distribution of publications is uneven; some faculty members have a good number of conference papers, while others have not listed anything. Some published conference papers are at the level for publishing them in journals. This possibility should be utilised. The scientific role of the faculty members in the FEDEM software should have been presented because software has had international impact, for example as ESA selected simulation tool.

The group has listed many research projects and also participates in the NorLight project. Those research projects should be utilised to produce academic results.

The research areas cover several product areas; a good alternative would be to focus the research into fewer areas.

Group grades

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

1.4.2 Metal forming

Group profile

The metal forming group consists of 2 professors, 2 externally funded professors II, 1 post-doctoral researcher and 3 doctoral students. The activities in the group cover metal forming, casting and welding. These three areas are independent and work with very little contact.

The group works closely with the Norwegian aluminium industry, and is largely financed through funds from there. The future high priority area is forming of light metal components for the mass production industry.

Group evaluation and recommendation

The metal forming activity is quite strong and productive; results are published in peer review journals. Casting and welding activity is however poor, and is closely related to research at other departments. The group considers mechanical aspects of casting and welding, while the metallurgical aspects are covered by the Department for Materials. However this advantage is not utilized in research collaboration. A reason for this is said to be that research money is available without cooperation. However a more focussed view of this is needed for the future.

Group grades

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

1.4.3 Plastics and composites

Group profile

The plastics and composites group consist of 2 professors, 1 associate professor, 2 professor II, 2 post-doctoral research fellows and 9 doctoral students. Three major research areas are identified within the group, namely: advanced composite structure, composites from renewable materials and polymer processing and properties. The group has increased during the last few years, both with respect to faculty and post doctoral research fellows. The proposed future research areas are:

- Advanced composite materials and structures for offshore applications and green energy production.
- Composites from renewable resources
- Innovative processing

Group evaluation and recommendation

The publication rate is higher than average. It is also done in peer review journals. However, this is not necessarily seen in the official documentation from the group. The reason is said to be that publication in general is not rewarded by the university.

The international cooperation also is extensive.

Besides the scientific work professors have utilised results for technology products e.g. a self-limiting electric floor heating system. The industrially important area is composite metal interfaces for composite risers. Two spin-off companies have been established which is today thought to be a valuable part of the university's impact.

The nanosize fibers in composites seem an important research area because characteristics of composites can be highly improved utilising renewable resources.

The research group is quite small and full professors are working in different research areas. The claim with regard to the broadness of the manufacturing processes cannot be met with the available staff resources and, in particular, the available equipment. With the exception of a twin-screw extruder, a major part of the research facilities for the processing of plastics and fibre composites is no longer state-of-the-art. It is recommended that the group focus on selected research fields by integration of analysis and simulation of processes and structural properties. In addition, the equipment for evaluation of structure and properties of plastics and composites should be completed or provided by research co-operations.

The group has a good competence to improve the research cooperation on the departmental level. The group studies materials but the implementation area is in engineering design.

Group grades

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

1.4.4 Structural integrity

Group profile

The group activities can be divided into the four research areas: Fracture and damage mechanics, Fatigue, Tribology and Corrosion and coatings. Totally, there are 3 professors, 1 externally funded professor II and 1 post-doctoral research fellow supervising 3 doctoral students.

In January 2004 the group was strengthen with a new professor, who will work in the area of surface engineering. The future priorities of the group will be fatigue, fracture, wear and surface engineering in energy and offshore systems.

Group evaluation and recommendation

The research group covers a large range of topics, by individually good researchers. However, the scientific base of the group is well formulated. There is a tendency for doing more basic research than product development, which can be in conflict with the department goals. But the group could offer to the other groups the necessary analytical tools and thinking pattern for combining them to synthesis and innovative engineering design processes.

The group has some long lasting international cooperation.

The group sees industrial needs for its research results. Partly the cooperation is established. For instance two research students are developing lifetime assessment for automotive structures.

However the group has not a common strategy and it lacks the man-power to effectively deal with the current broad range of research projects. The Panel notes that the group is determined to formulate a strategy.

With a good strategy the group can be an important part of the research power of the department.

Group grades

Scientific quality and productivity: 2
Relevance and impact: 3
Strategy, organisation and research cooperation: 1

1.5 Department of Product Design

Departmental profile

To establish a link between mechanical engineering and architecture the department of Product Design was established in 1994. The same year 3 PhD-students were engaged in projects related to design methodology, eco-design and interaction design. These areas have thereafter been important in building the research environment at the department. The challenge for the department lies in a strengthening of the research activities by approaching design related issues from different points of view than done by the traditional industry or other research areas. Due to the small size of the department, it is defined as one research group. The aim of the department is to develop competence, methodology and tools within design related topics.

The department is relatively small with 6 associate professors, 1 professor (vacant), 3 post-doctoral research fellows and 7 doctoral students. There are also 3 technical positions. The total funding at the department has increased during the last years. Year 2002 the total funding was 11 MNOK, of which 31% was external. During the years 2000-2002 two doctoral students and 42 MSc students graduated.

The facilities at the department are currently up to date, and include a workshop for models and prototypes and several computer labs.

Department evaluation and recommendation

This is a unique department with a base in aesthetics and design from the art and humanistic viewpoint. It attracts very capable students and also about 50% of its intake is women. This is a very valuable vehicle both for collaboration between engineering and the social sciences and with a wide variety of private sector entrepreneurs.

From the discussions it was clear that the department has had an intensive ten years' development period. The department has built totally new facilities. It has created its own identity, which differs from other departments at NTNU. The department is in the transition period because its ten years' leader, the full professor has left the department, and new challenges arise. Thus the Panel would like to make some suggestions not as criticism but to try and stimulate a broad discussion on the development of this group as a very valuable asset to NTNU.

The department has a good identity. It gets excellent students. It has well-established industrial cooperation, which differs from that of other departments; it has cooperation mainly with small and medium sized enterprises. It also has excellent opportunities to widen its area to bigger products as process plants, working machines etc. Today industrial designers are important in the product development process of paper machines, mobile machinery as tractors and forest harvesting machines etc. The department's three research areas fit these bigger challenges. However, the department is very small and the design teaching needs more hands-on guidance than traditional engineering areas.

The committee suggests that the department should consider a new matrix organisation for working more closely with engineering science but also with selected

groups in information technology and maybe reliability research. The matrix organisation should ensure the identity and more resources.

There are many approaches to product design some more quantitative and analytical than the approach of the group at NTNU. It would also be valuable for the students to be exposed to these alternatives either by experience elsewhere as part of an international collaborative integration or by a series of invited lectures as an integrated part of the design curriculum.

Despite the roots of the department being in aesthetics and humanistic studies, the department needs to develop a more structural approach to defining its productivity and impact. This could be done in part by participation in design competitions, journal publications and other media articles but also in activities which promote design in relation to regional and national enterprises in which design has a central role, in sports equipment, toys, in activities related to patient care in hospitals and other institutions, textiles, furniture etc. Perhaps an annual or biannual exhibition and conference to promote the work of both students and faculty could be considered and fostered by NTNU and the Trondheim community.

1.5.1 Product design

Group profile

The projects at the department are often closely connected to industry, both with problem formulation and research activities. Within the field design methodology the intention has been to develop work methods to support creativity. Ecological aspects are studied within eco-design. The interaction design is the area where user interfaces are studied, and is linked to information technology. The long-term goal is to establish a toolbox for industrial designers to integrate these issues.

Group evaluation and recommendation

The group is too isolated in its viewpoints and for its development it needs external input from other product design groups. Concerning the curriculum, this could be gained through contacts with university groups in Denmark, United Kingdom or USA. Insight into the use of design in industrial products could be gained through contacts with globally working enterprises like Sandvik Tamrock, Metso Paper and John Deere Timberjack.

The group should also strengthen its co-operation with other departments inside NTNU. One interesting partner should be the Engineering Design and Materials department, and especially its Product development group, which is studying distributed design environments and processes. In this connection interaction also with the researchers of the Information department would be valuable.

In general the group should consider integration of its current activities into more multi-disciplinary collaboration. It should employ more analytical and quantitative methods of applying product design. This would give the students a broader experience and also lead to an increase of research quality and productivity.

Group grades

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

**The Panel finds it impossible to grade the scientific quality of the group since the work of the group work concerns aesthetic rather than scientific aspects. The Panel will as a consequence refrain from grading the scientific quality of the group.*

2 Narvik University College

2.1 Department of Computer Science, Power and Space Technology

Departmental profile

Narvik University College (NUC) is organized into four Departments (Institutes), the Department of Computer Science, Power and Space Technology being one of them. The basic and applied research of the department is organized into two research groups, Electromechanical Systems and Homogenization Theory, while a third group on Simulations has recently been added. The group on Homogenization Theory is evaluated here.

NUC has a regional function, but also a national function within its fields of special research, both in education and in R&D. Research groups are formed within priority areas following the strengths of existing staff and have a maximum existence of three years. The department is not authorized to assign PhD-degrees, but closely collaborates with NTNU and Luleå University of Technology to enable the employment of PhD students.

The department has 6 professors, 3 associate professors, 2 professors II, and totally 3 doctoral students. There are also 2 technical positions. The total expenditures in 2002 were 3.5 MNOK, 18% of which was external. The amount of external funding has been quite constant also the two previous years. At the department 7 doctoral students graduated during 2000-2002, of these 3 were at the Homogenisation Theory group. During the period 2000 to 2003 totally 73 MSc students graduated, among these 23 graduated from Engineering Design with close relations to the Homogenization Theory group.

Department evaluation and recommendation

The vision of NUC on R&D is to be one of the leading contributors to technology and innovation in the northern part of Norway. Consequently, NUC has a regional function both in research and education and wishes to interact with local industry. However, from the presentations it does not become clear whether such interaction is accomplished.

It then seems to be a conflict of interest to have highly specialised research groups. The two (or three) groups are highly specialised. More traditional engineering disciplines would probably suit the local industry better and thus also be able to better attract external funding. A strategic plan that is representative of the needs of the local industry is missing. Due to the low amount of external funding, highly specialized mathematics does not seem to be the right path to go.

The individual research groups seem to be strong compared to the department. The university college would however gain from a closer cooperation between the groups. From the presentations, it has not become clear to what extent the mathematical groups serve and cooperate with other departments, like the

department of Building, Production and Engineering Design. A common research strategy to attract local industry should be formed.

The equipment at the department consists of computer labs with appropriate software. This appears to fit the purpose of the current research. However, collaboration with other partners having experimental facilities for mechanical testing would be good to verify theoretical and numerical work.

2.1.1 Homogenization theory

Group profile

The group on Homogenization consists of 3 professors, 1 associate professor, 1 externally funded professor II, 1 post-doctoral research fellow and 1 doctoral student. The research is within homogenisation theory, which includes mathematical modelling of composites.

Group evaluation and recommendation

This group can be categorized as being somewhat special or even eccentric. This is because on the one hand, the scientific productivity and quality is very good, whereas on the other hand the relevance and impact of the work on the regional industry is poor.

The researchers produce very good scientific research within their field. The international cooperation is also very strong. Considering that the group is isolated in Narvik it still attracts international research collaboration partners with good reputation. The research is very individualistic in character since it depends on professors with established international contacts. The publication rate of the small group is impressive with many papers in international refereed journals.

The group has very little funding available, and no own doctoral program. The group does however supervise PhD students in cooperation with other universities. The impact of the homogenisation theories on the Norwegian society is low, due to its specialisation. Local industry probably has difficulty to adopt the results. An exception might be the work on the application of homogenisation algorithms to cellular solids, where the homogenisation group works together with engineering design and with Natech A/S and TAM A/S. The impact of that work on local industry has however not become clear from presentations. The presentations emphasized the scientific and internationally oriented aspects.

The strategy of the group is two fold. The group has established a good international network that is used within research cooperation and acquisition for a European project. On the other hand, the strategy for the local industry and academia is poor or lacking, which is in conflict with the department vision and leadership at college level. The group members pursue a further strengthening of the international scientific contacts that may conflict with the need for serving local industrial needs, bearing in mind that the size of the group is small.

Similar considerations hold for many mathematical departments in universities. It depends on the university policy whether such unbalance would be accepted.

Group grades

Scientific quality and productivity: 4
Relevance and impact: 1
Strategy, organisation and research cooperation: 2

3 Stavanger University College

At the time of preparation for the research evaluation, Stavanger University College was undergoing a radical re-organisation, with the creation of three new Faculties from seven former Schools. The Faculty of Science and Technology now consists of five Departments, of which two, the Department of Industrial Economics, Risk Management and Planning and the Department of Mechanical and Structural Engineering and Materials Science, were evaluated by Panel 2. This evaluation refers to the new research groupings.

3.1 Department of Industrial Economics, Risk Management and Planning

Departmental profile

The department was formed by a merger of staff from the Group of Risk Analysis and Societal Safety and the Group of Economic Risk Management from the former Department of Petroleum Technology, together with the Group of Technical Planning from the former Department of Civil Engineering. The research in this new department is divided into two main areas, namely risk management and technical planning, but the structure is made more complex by the existence of a wider Risk Management Research Group which was established in 2001 and was accredited to award PhD degrees in 2003. This Group includes staff from the Faculty of Social Sciences.

Department evaluation and recommendation

The creation of this new Department combining staff with related research interests from the Department of Petroleum Technology and the former Department of Civil Engineering has the potential for enhancing research in the areas of safety, reliability and risk management, but the Panel considered that the overall management of this change had been weak and that the new structure was not yet well established. This situation is clearly made more difficult by the fact that the main research group includes key staff from another Faculty. This cross-disciplinary interaction has significant research benefits, but the management of the new Department needs to be carefully reviewed in order to achieve these. Consideration should also be given to the effect of the re-structuring on the accreditation of research degrees.

3.1.1 Risk Management Research Group

Group profile

The Risk Management Research Group comprises staff from the Department of Industrial Economics, Risk Management and Planning working in the areas of: (A) Risk Analysis, (B) Economic Risk Management, and (C) Societal Safety, strengthened by the involvement of staff from the Department of Mathematics and Natural Science, and staff from the Faculty of Social Sciences.

In total, the Risk Management Research Group comprises 7 professors, 12 associate professors, 11 adjunct professors and 2 post-doctoral research fellows, of which 4 professors, 10 associate professors, 7 adjunct professors are members of the Faculty of Technology and Natural Science. Only the latter are included in this evaluation.

The total department budget for the former Department of Petroleum Technology, of which the Risk Management Research Group was part, was 27 MNOK in 2002, of which 40% came from external funding, an increase from 14% in 2000. However, the proportion of this relating to the Risk Management Research Group is not known. During the period 2000-2002, 4 doctoral students and 50 MSc students graduated in the areas of safety and risk management. The Group currently has 7 doctoral students.

Group evaluation and recommendation

The three main research areas covered by the Group are risk analysis, economic risk management and societal safety. The Group has a strategy of interdisciplinary research and this is entirely appropriate for the nature of the work undertaken. However, if the areas being covered are too broad and researchers need to have expertise in too many areas, the quality of the output may suffer. The Panel therefore considered that the breadth of the research undertaken by the Group needs to be more carefully managed and that the benefits of interdisciplinary interactions need to be weighed against those of fundamental research in single disciplines.

Much of the research in the Group corresponds to immediate industrial problems, and it is considered that some of the applied research is academically not very strong, and has a relatively low impact on the wider research community. However, the Group has extremely good relations with, and support from, local industry, especially in the areas of offshore oil and gas production, and there are significant contributions from the adjunct professors.

The average publication rate for the Group is good, but in some areas the output is dominated by a small number of key researchers.

It was considered by the Panel that the Group needs to develop much better strategies for future research, in order to manage the issues of funding, uneven staff loading, staffing, interdisciplinary interactions and overall management.

Group grades

Scientific quality and productivity: 3
Relevance and impact: 2
Strategy, organisation and research cooperation: 1

3.2 Department of Mechanical and Structural Engineering and Materials Science

Departmental profile

The Department of Mechanical and Structural Engineering and Materials Science has recently been created. It is organised into three groups:

- Mechanical engineering
- Structural engineering
- Materials science

The Structural engineering group previously belonged to Department of civil engineering but has recently joined this department, and is therefore evaluated as a research group within this department.

There are 5 professors, 8 associate professors, 8 professors II and 6 doctoral students performing research at the department. In addition there are 4 technical positions supporting research, and 3 assistant professors and 5 technical positions involved in teaching only. The main task of the department has been to develop and maintain study programs. The department has BSc programs in Mechanical Engineering and in Structural Engineering and MSc programs in Offshore Technology (Mech. Eng., Offshore Structures and Mat. Sci.). In total there are about 30 students/year in these programs. During the three years period 2000-2002 the department graduated one doctoral student and 78 M.Sc. students (13 materials science, 39 mechanical engineering and 26 construction).

For the Materials science and Mechanical engineering groups (the two groups that earlier formed the department) 20% of the total funding was external 2002. The same year the total expenditures were 11 MNOK. For the structures group no information was provided since data was given for the whole Department of civil engineering of which the group were one out of two research groups.

The department has one scanning electron microscope and one transmission electron microscope that is used by the materials science group. In addition the department has a metallographic laboratory and computers for finite element analysis. RCN has also approved an application for a new scanning electron microscope that will be purchased during 2004.

Department evaluation and recommendation

The leadership of the research at the department has been weak. In the future there will be a full-time professional having total responsibility for administration e. g. the economy, personnel, engineers and for the educational programs. This is an improvement. The central leadership of the department should also take a greater interest in the organisation of the research and introduce a strategy where the different groups work together in projects related to the interests of the local industry. The newly formed department has a competence well suited for this. The department's involvement in graduate education should also be increased.

The department is well staffed with competent professors of which most have good publication records, however mostly in the form of conference contributions and internal reports; a few of the professors also publish in refereed journals. The department has good contact with the local industry among other things through the many adjunct professors. In spite of this, the department does not seem to have a common research strategy. In the future, the different groups should cooperate better to establish new research areas where the competence of each group can be utilized. It is also good if the regional industry can be even better incorporated in the research activities.

3.2.1 Mechanical engineering

Group profile

The group consist of 2 professors, 7 associate professors, 3 professors II and 4 doctoral students. The research within the group is organized within the areas: Mechanics and machine design, Energy, Marine and subsea construction and Operations and maintenance.

Group evaluation and recommendation

During the last year the productivity in the group has been low. The group however has good connection with the local industry. Some of the sub-groups are very small and better integration within the group of mechanical engineering is desirable. It is the feeling of the Panel that the group tries to cover too broad subjects.

The comments given for the department also applies to this group. For example, it should be better integrated in its projects with the other research groups of the department. It should increase its graduation of PhDs. The recent increase of doctoral students is a step in the right direction.

Group grades

Scientific quality and productivity: 1
Relevance and impact: 2
Strategy, organisation and research cooperation: 2

3.2.2 Structural engineering

Group profile

The group consist of 2 professors, 2 professors II and 1 doctoral student. One of the professors is however on a sabbatical period in industry and is only working 20%. The research in the group is very individual and closely follows the work carried out by individuals. The topics cover structural dynamics and integrity of welded structures.

Group evaluation and recommendation

The group has little publishing in peer-reviewed journals and other publishing is not impressive. Its research is applied and fits the local industry well. The faculty is active in finding funding from business and public sector and should be able to collaborate closer with the mechanical engineering group. The group should increase its number of doctoral students.

Group grades

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

3.3.3 Materials science

Group profile

The group consist of 2 professors, 1 associate professor, 2 professors II and 1 doctoral student. The group has good experimental facilities for research. The research is closely related to the electron microscopes that the group is using. The main publication topics have been within synchrotron X-ray diffraction and age hardening of aluminium alloys. But also work within electron crystallography has been done. Moreover, work on other materials such as duplex stainless steels, ceramics and composites have been performed.

Group evaluation and recommendation

The faculty has good productivity of research reports. Some of the faculty has a good publication rate in peer-reviewed international journals. It has good contacts with industry in the region and a good international network. It should increase its co-operation with the other groups in the department and intensify its work to get funding for more doctoral graduate students

Group grades

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

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.

1. 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?

2. Academic departments

Organization, management and strategic plans

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

Recruitment and mobility

- Do the scientific staff play an active role in stimulating the interest among young people, in particular women, for engineering science?

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

3. Research groups

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

Relevance and impact

- Do the research have a high relevance judged by impact on society, value added to professional practice, and recognition by industry and public sector?
- Do the research groups have contracts and joint projects with business and public sector, are they awarded patents, or do they in other ways contribute to innovation?
- Do the research group contribute to the building of intellectual capital in industry and public sector?
- Do they play an active role in dissemination of their own research and new international developments in their field to industry and public sector?
- Do they play an active role in creating and establishing new industrial activity?

Strategy, organization and research cooperation

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

- Do they take active part in international professional committees, work on standardization and other professional activities?

Appendix 2. CV for each Panel member

Prof. Janne Carlsson, Royal Institute of Technology (KTH), Sweden

E-mail: jannec@kth.se

Janne Carlsson received his education from KTH where he got his MSc- degree in Engineering Physics 1957 and later a PhD in solid mechanics. Janne Carlsson's research field is fracture mechanics. He has published several papers in this field and written some books on the topic.

Janne Carlsson was head of the department of solid mechanics 1966-1988 and supervised during this period around 30 PhDs and Licentiates. He held during this period several different leading positions within KTH, Dean of the School of Vehicle Technology, Dean of the Faculty of KTH and Vice Rector. During the years 1988-1999 he was Rector (President) of KTH. Later he has held positions as Vice President of the Royal Swedish Academy of Engineering Sciences and as President of the Royal Swedish Academy of Sciences each during a three years period. Janne Carlsson is a member of the Royal Academy of Engineering in London. He is honorary Doctor of lÉcole Centrale in Paris and of the Technical University in Tallin, Estonia.

Janne Carlsson has during his employment at KTH done many investigations for the government. He has been a chairman of the board of the Swedish Defence Research Institute.

Janne Carlsson is at present chairman of the board of the University College of Mälardalen and a member of the board of the Wallenberg Foundation. He is a member and chairman of some boards of industrial companies.

Prof. Preben Terndrup Pedersen, Technical University of Denmark (DTU), Denmark

E-mail: ptp@mek.dtu.dk www.mek.dtu.dk/ptp

Preben Terndrup Pedersen received a Ph.D. degree in Mechanical Engineering in 1969 from the Technical University of Denmark (DTU). In 1971-72 he was Research Fellow at Dept. of Engineering and Applied Physics at Harvard University, Mass., USA and in 1973 visiting researcher at Det Norske Veritas, Norway. In 1973 he was appointed Professor of Strength of Marine Structures at Department of Naval Architecture and Offshore Engineering at DTU. He was Vice-president of the Danish Academy of Technical Sciences 1998-2002. During 1992 – 2000 he was Leader of the Mechanical Engineering, Energy and Production Sector of DTU and since 2002 Head of Department of Mechanical Engineering.

He is member of The Danish Academy of Technical Sciences, Foreign member of the Norwegian Academy of Technical Sciences, Fellow of Royal Institute of Naval Architects, and member of Society of Naval Architects and Marine Engineers, US. He is also a member of the editorial board of 4 journals. He is at present vice chairman of the Board of Danish Research Councils on Independent Research, member of the

Danish Patent Appeal Board, Committee of Int. Ship and Offshore Structures Congress, the Steering Group for Science for Peace Programme of NATO, the Board of Directors of FORCE Technology, and the Otto Mønsted Foundation and he is member of the Danish Defence Research Board.

He has been advisor to the Builders on risk management for the Great Belt Link, the Øresund Link and the Fehmarn Belt Link feasibility study. He has authored or co-authored 12 books and around 100 papers in refereed journals and other major publications on structural strength, dynamics and risk analyses of marine structures. He teaches Marine Structures for M.Sc. students and has educated about 30 Ph.D.'s.

Prof. David Embury, McMaster University, Canada

E-mail: emburyd@mcmaster.ca

David Embury is university professor at McMaster University in Hamilton Canada. He was educated in the U.K. obtaining a B.Sc. in Manchester in 1960 and a Ph.D. in Cambridge in Metallurgy in 1963. His industrial experience includes service in the U.S. Steel research centre in Monroeville USA and numerous consulting activities for both Steel and Al companies both in Europe and North America. As a professor at McMaster University he has taught in a wide variety of areas including Mechanics Metallforming and Materials Science. His research interests include the mechanical properties of steels and Al alloys, high strength composite materials, phase transformations and studies of damage and fracture processes. He has numerous collaborations with the Los Alamos National Laboratory in the USA and with universities in Europe. He is a fellow of the Royal Society of Canada and a foreign Member of the Academy of Engineering in USA.

Prof. Robert H. Wagoner, Ohio State University, USA

E-mail: wagoner.2@osu.edu

Robert H. Wagoner holds the George R. Smith Chair at The Ohio State University, with appointments in materials and mechanical engineering. He chaired the Department of Materials Science and Engineering from 1992 to 1996. Before joining Ohio State, he was Staff Research Scientist at General Motors Research, 1977-83, and did post-doctoral research at the University of Oxford, 1976-77.

Professor Wagoner is a member of the National Academy of Engineering, Fellow of TMS, and Fellow of ASM International. He is currently President of the American Institute of Mining, Metallurgical, and Petroleum Engineers, and was President of TMS from 1997 to 1998.

Dr. Wagoner's research focuses on sheet metal forming and finite element modelling. He is the author of over 200 technical articles, 2 proceedings volumes, 2 combined proceedings and authored books, and 2 text books in the areas of metal forming, plasticity theory, finite element analysis, mechanical behavior of materials and micro-mechanisms of deformation. He has presented over 90 international and invited papers on these research topics, and has advised 21 masters and 16 doctoral student theses.

Prof. Michael J. Baker, University of Aberdeen, Scotland, UK

E-mail: mjb@eng.abdn.ac.uk

Michael Baker is the first holder of the Chair of Safety Engineering at the University of Aberdeen, which was endowed in 1990 following the 1988 Piper Alpha disaster in the North Sea. Prior to that he was Reader in Structural Reliability at Imperial College, London. He originally graduated with first class honours in civil engineering from Imperial College, returning there in 1965 to undertake postgraduate work in concrete structures and technology, before undertaking research in the area of structural safety with Professor Sir Alfred Pugsley.

His early research led to the development of methods for assessing safety factors for structural design, now adopted in various UK codes and standards. Current research is in the use of reliability methods to assess the criticality of ageing structures, the stochastic modelling of fatigue crack growth and fracture processes and reliability updating. In 1997 he was awarded Teaching Company Directorate's Royal Academy of Engineering Prize for Engineering Excellence for work on reliability-based offshore inspection, and in 2002 was given a Technology Pioneer Award by the Offshore Energy Center, Houston, for his work in the reliability-based design and assessment of offshore and marine structures.

Professor Baker is currently Head of the Graduate School of the College of Physical Sciences at the University of Aberdeen, and is responsible for the co-ordination of research and teaching in the area of safety and reliability engineering. He has served on numerous national and international committees, including the UK Technical Advisory Group on the Integrity of Nuclear Plant, the UK Government's Marine Technology Foresight Panel, and the International Joint Committee on Structural Safety.

Prof. Alois K. Schlarb, University of Kaiserlautern, Germany

E-mail: alois.schlarb@ivw.uni-kl.de

Professor Schlarb studied mechanical engineering at the University of Kaiserslautern, specializing in production engineering and company organization. After his graduation in 1984 he relocated to the University of Kassel, working as scientific assistant for Prof. Dr.-Ing. Dr. e.h. Ehrenstein. He was awarded a doctorate in 1989 for a thesis on polymer processing. From 1988 until 1989 he also was head engineer at the Institut fuer Werkstofftechnik at the university.

From 1989 until 1995 Professor Schlarb held positions as material scientist and project manager in the plastics laboratory of BASF AG, in the research of composites. From 1995 until 1997 he was the head of development at SULO Eisenwerk Streuber & Lohmann GmbH & Co. KG, Herford, and from 1998 until 2002 in different management functions, last as Vice President and head of marketing, research and development with B. Braun Medical AG, Emmenbrücke, Switzerland.

In November 2002 Alois Schlarb was appointed a full professorship for „composite materials“ at the University of Kaiserslautern and at the same time Chief Executive Officer of the Institut fuer Verbundwerkstoffe GmbH. Professor Schlarb is a member of VDI, the German Hochschulverband DHV and the Scientific Alliance of Polymer Technology WAK. Since February 2004 he is President of Society for the Advancement of Materials and Processing Engineering SAMPE Deutschland. Prof. Schlarb currently serves on the Editorial Board of the Journal of Composite Materials. He is married and father of two daughters.

Prof. Asko Riitahuhta, Tampere Unversity of Technology (TUT), Finland

E-mail: asko.riitahuhta@tut.fi

Asko Riitahuhta received his education from TUT where he got his MSc- degree in Mechanical Engineering 1974 and later a Lic.(Tech) and PhD. Asko Riitahuhta's research fields are machine design, CAE, product development, and modularisation.

After the graduation Asko Riitahuhta worked for industry as project manager, design manager, R&D director and member of board of management. He established of R&D unit of 5 PhDs and 60 staff members, and new R&D Center facilities for the development of new processes for power generation.

Since joining back to TUT Asko Riitahuhta is Professor of Machine Design. He was head of the Institute of Machine Design 1991-2003, Dean of Mechanical Engineering department 1995-1997. He was visiting researcher at Stanford University and member of TAC and IAB in CIFE, 1989-1990, and visiting professor at Denmark Technical University, 1997-1998. He has supervised around 10 PhDs and Licentiates and over 200 MSc.

Riitahuhta has been researcher in global GNOSIS-project of the Intelligent Manufacturing Systems program, in EU-projects, been director in several research projects funded by Finnish Academy, TEKES, The Finnish Work Environment Fund, industry, and Finnish Offset Committee and MDA (Boeing). He has been a member of Scientific Advisory Board for Defence appointed by Council of State of Finland and chairman of its Material Section. He has been evaluator of Technology Programmes of VTT.

Asko Riitahuhta is a member of editorial board of the Journal of Engineering Design-Taylor & Francis, president of ICED 97, chairman of NordDesign 2004 and member of the Design Society Advisory Board.

Prof. Jan G. Rots, Delft University, The Netherlands

E-mail: J.G.Rots@bk.tudelft.nl

Jan Rots graduated from the faculty of Civil Engineering at Delft University of Technology in 1982. Subsequently, he continued his research into the mechanics of concrete and concrete structures in a combined position at TNO Building and

Construction Research and Delft University of Technology/STW. He passed his Phd in 1988. Next, he was awarded a five-year KNAW Research Fellowship (academy researcher), followed by a five-year NWO/STW Pionier Research Fellowship, addressed to the subject of computational modelling of building materials and building structures, in particular masonry and concrete structures. Again, these tasks were performed in a combined position at TNO and Delft University. He has contributed to the development, use and support of the DIANA finite element program. In the period 1994-1998 he chaired the TNO section of Computational Mechanics, the DIANA Foundation, CUR-projects on brick/block masonry and underground structures, and a number of Phd-projects. Since 1999, he is a full professor in Structural Mechanics at the Faculty of Architecture at Delft University of Technology. His research interests are innovative building materials, innovative building structures as well as the preservation of historical buildings. His group contributes to the development and practical use of computational models for simulation of e.g. high-performance masonry, free-form shaped structures (architectural Blob's), CAD-FEM-CAM couplings and settlement-induced damage in historical structures.

Appendix 3. Letters to the institutions

Institutt for materialteknologi
NTNU
Alfred Gets vei 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 materialteknologi
NTNU
Alfred Gets vei 2
7491 TRONDHEIM

Att.:Professor Hans Jørgen Roven

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 2. 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 5 personer. Høringsmøtene for de største instituttene vil gå over flere timer. Instituttet bestemmer selv om deres representanter skal delta under hele høringsmøtet eller om de skal komme til ulike tidspunkt.

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

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

Generelle spørsmål i tilknytning til høringsmøtene rettes til:

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

Praktiske spørsmål rettes til:

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

Panel 2 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.	**Vår ref.**	**Oslo,**
Dag Kavlie, 22 03 7361		02.02.2004
	Deres ref.	

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 2

Evaluation of Research in Engineering Science in Norway
Time schedule for meetings of Panel 2

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 Engineering Design and Materials**	• Product Development • Manufacturing of Metals • Plastics and Composites • Structural Integrity
	1200 - 1300	Lunch	
	1300– 1400	**Department of Engineering Design and Materials cont.**	
	1400 - 1415	Break	
	1415 - 1500	**Department of Product Design**	
	1500 - 1600	Panel's hour	
	1600 - 1630	*Departure for site visit at NTNU*	
	1630 - 1800	*Site visit*	

Evaluation of Research in Engineering Science in Norway
Time schedule for meetings of Panel 2

Date	Time	Institution/department	Research group
Tuesday March 2 2004	0900-0915	Panel's 15 minutes	
		Faculty of Engineering Science and Technology	
	0915– 1030	**Department of Structural Engineering**	• Concrete • Steel and light metals • Structural Mechanics
	1030 - 1045	Break	
	1045 - 1200	**Department of Structural Engineering cont.**	
	1200 - 1300	Lunch	
	1300– 1400	**Department of Structural Engineering cont**	
	1400 - 1415	Break	
	1415 - 1530	Panel's hour	
	1530 - 1600	*Departure for site visit at NTNU*	
	1600 - 1800	*Site visit*	

Review of research in Engineering Sciences in Norway
Time schedule for meeting of Panel 2

Date	Time	Institution/department	Research group
Wed March 3 2004	0900 - 0915	Panel's 15 minutes	
		Faculty of Engineering Science and Technology	
	0915 - 1005	**Department of Marine Technology**	• Marine structures
	1005 - 1020	Break	
	1020 - 1105	**Department of Marine Technology cont.**	
	1105 - 1130	Panel's 25 minutes	
	1130– 1230	Lunch	
		Narvik University College	
	1230 - 1245	*Presentation of the College/Department*	
	1245 - 1315	Department for Computer Science, Power and Space Technology	• Homgenisation theory
	1315 - 1330	Break	
	1330 - 1500	**Meeting with Ph. d students**	
	1500 - 1530	Panel's 30 minutes	
	1530 - 1600	*Departure for site visit at NTNU*	
	1600 - 1730	*Site visit*	

Review of research in Engineering Sciences in Norway
Time schedule for meetings of Panel 2

Date	Time	Institution/department	Research group
Thur March 4 2004	0900-0915	Panel's 15 minutes	
		Faculty of Natural Science and Technology	
	0915– 1015	**Department of Materials**	• Physical metallurgy • Extractive metallurgy
	1015 - 1030	Break	
	1030 - 1130	**Department of Materials cont.**	
	1130 - 1200	Panel's 30 minutes	
	1200 - 1300	Lunch	
		Stavanger University College	
	1300 -1315	*Presentation of the College/Department*	
	1315 –1345	**Department of Petroleum Technology**	• Safety management/risk analysis
	1345 - 1400	Break	
	1400 - 1530	**Department of Mechanical Eng., Structures and Materials**	• Mechanical Engineering • Structures • Materials
	1530 - 1600	Panel's 30 minutes	
	1600 - 1630	*Departure for site visit at NTNU*	
	1630 - 1800	*Site visit*	

Review of research in Engineering Sciences in Norway
Time schedule for meetings of Panel 2

Date	Time	Institution/department	Research group
Friday March 5 2004	0900 - 1200	*Panel's final meeting*	
	1200 - 1300	Lunch	
	1300-1500	*Panel's final meeting(cont.)*	