The Research Council of Norway

Basic and long-term research within Engineering Science in Norway

Report from Panel 3: Civil Engineering and Marine Structures

Evaluation
Division for Science

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Statement from the panel

The members of evaluation panel no 3 - Civil Engineering and Marine Structures for the review of basic and long term research within Engineering Science in Norway hereby submits the following report.

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

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Dr. Manfred Kleidorfer, University of Innsbruck, acted as the scientific secretary of the evaluation panel

1. Executive Summary

The sub-panel 3 within the international evaluation of engineering science in Norway assessed the field of Civil Engineering and Marine structures in universities, university colleges and relevant research institutes.

According to the terms of reference the framework of the evaluation is the comparison of the performance against an international standard. The benchmark used in this evaluation is the performance that is to be expected from a university type research institution active in the specific field with about 40% of the staff resources devoted towards research. Thus the ranking “3” for scientific quality and productivity and “C” for relevance and impact defines the performance that is to be expected from a university institution active in this specific field, in an international comparison.

As an overall observation the research performed in the evaluated sector gives a good impression. The scientific quality is app. par to the international standard, while relevance and impact to society is somewhat above. The performance of the whole sector is more homogenous than scattered. While this makes for rare instances of underperforming institutions, it also indicates that only few research groups (less than 10% of the units) are performing at a world leading level. An impressive example of the latter are the units working in the area of marine technology, providing expertise to a key sector of the Norwegian industry.

On the other hand, it is obvious that the field lacks strategic planning. Research is performed more on the basis of opportunities and personal expertise/interest than based on a convincing strategy. This leads to scattered and widespread research, in parts repetitive more than complementary. It is also to be questioned if research efforts should be carried out at all at New Universities and University colleges.

Related to above it is observed that the current organisation and structure at the universities lacks (opportunities for) leadership. Careful restructuring of the groups and a strategic replacement strategy towards retiring academic staff could enhance the scientific output. In the special case of SINTEF a more transparent mode of cooperation with NTNU could be envisaged.

Overall, the sector performs at a quite good level in an international context, but could fare even better given the advantageous boundary conditions in terms of funding, resources and industry interest.

2. Overall description and conclusions

2.1. Introduction and terms of reference

2.1.1. Introduction and mandate

The Ministry of Education and Research of Norway has decided to evaluate basic research within engineering science in universities, university colleges and relevant research institutes during 2014. This is to follow a previous evaluation in engineering science that was carried out in 2004. The general objective of this evaluation is to review the overall state of basic and long term research in engineering science in Norway, in order to set future priorities, including funding priorities, within and between individual fields of research. The evaluation is organised and coordinated by the Research Council of Norway (RCN) and carried out by an international expert panel. This report pertains the activities of sub-panel 3: Civil Engineering and Marine structures.

According to the terms of reference the panel based its evaluation on self-assessments provided by the departments/research groups, a bibliometric analysis provided by the Research Council, as well as on interviews and presentations given in meetings with the involved departments/research groups. The self- assessments from the institutions include factual information about the organisation and resources, future plans, CVs, and publication lists of their scientific staff.

According to the mandate, the panel is expected to

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

2.1.2. Terms of Reference and evaluation benchmark

Since the evaluation comprises a number of institutions that are quite different in setup, scope and organisation, the panel had to define a standard for evaluation. According to the terms of

reference the framework of the evaluation is the comparison of the performance against an international standard. The benchmark used in this evaluation is defined as a university type research institution with about 40% of the staff resources devoted towards research. Thus the ranking 3 for scientific quality and productivity and C for relevance and impact defines the performance that is to be expected from a university institution active in this specific field, in an international comparison.

Taking the grades 3 and C as a benchmark for performance makes clear that such ranking is by no means negative, but instead the international standard. Only few institutions are able to outperform this standard on all levels and the top level ranking 5 and A is indicating a world leading position. A comparison of this assessment with earlier evaluations must take into account this framework.

It is also clear, that research institutions that are devoting less staff resources to publication of results like e.g. SINTEF and MARINTEK will not fare equal in such framework as a university institute. It must be expected that the scientific productivity is less, but quite often the relevance and impact might compensate for that. Likewise University colleges that put emphasis on teaching instead of research will hardly be able to have a scientific output as compared to the benchmark. Again this is not an indication of inferiority but reflects the overall strategy of the institution.

Defining one benchmark, common for all evaluated institutions was a deliberate decision to allow for comparison. To make compensations for the different types of institutions would have opened up for ambiguity in the evaluation results.

Another aspect that has to be mentioned as terms of reference is that the evaluation was based on the documented performance within a given period. Visible improvements (or also shortcomings) that are clearly taking effect within the years to come are not taken into account in the ranking but are indicated either in the text or in the recommendations.

2.2. General description of the evaluated research fields

2.2.1. Description of the evaluated sector

Panel 3 evaluates the research performed on the topics Civil Engineering and Marine structures within universities, university colleges and relevant research institutes – 25 units in total. The scientific and technologic areas covered in this report comprise predominately traditional engineering aspects, mostly dealing with buildings and structures. While these might be seen as conservative in terms of innovation, the field comprises the bulk of engineering science and is thus providing mandatory expertise for society.

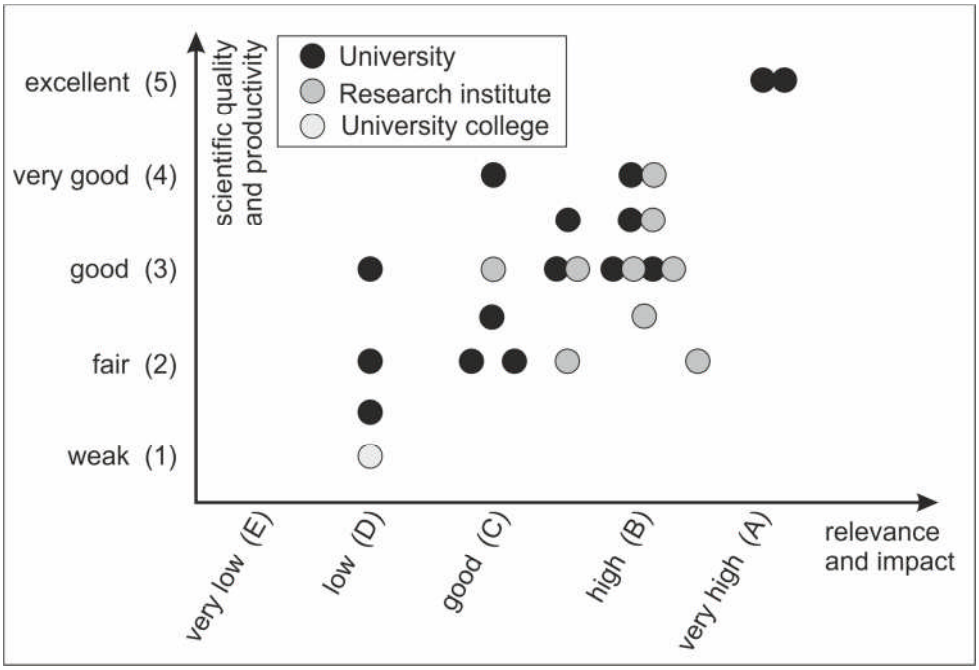
In terms of units evaluated, by far the biggest institution is the Faculty of Engineering Science and Technology at NTNU (Norwegian University of science and Technology). The evaluation covered 3 more Universities, i.e. Norwegian University of Life Science (NMBU), University of Agder and the University of Stavanger. Note that the different smaller research groups at

the University Stavanger have been treated as one. Moreover the Østfold University College participated as the only University College. In terms of Research Institutions different research groups of the 3 institutions SINTEF, MARINTEK and NGI were part of the evaluation. In quantitative terms this reads as follows:

Name	Type	Number of units evaluated
NTNU	University	12
NMBU	University	1
University of Agder	University	1
University of Stavanger	University	1
Østfold University College	University college	1
SINTEF	Research institute	3
MARINTEK (SINTEF)	Research institute	3
NGI	Research institute	3

General performance

As an overall observation the research performed in the evaluated sector gives a good impression. The scientific quality is app. par to the international standard, while relevance and impact to society is somewhat above. The performance of the whole sector is more homogenous than scattered. While this makes for rare instances of underperforming institutions, it also indicates that only few research groups (less than 10% of the units) are performing at a world leading level.



The Figure gives a graphical impression of the overall performance. As expected the Universities are performing better in terms of scientific quality and productivity while research institutions have – in general – better ratings as related to societal impact and

relevance. Likewise to be seen that smaller Universities and University colleges do not have the resources to research at an international level and are underperforming with respect to the benchmark.

Another aspect to be noted is the absence of high-risk research, i.e. science at highest level but still awaiting practical implementation. Such a research unit would be – in extremis - graded 5 and E. There are two possible reasons for none such a group appearing in the evaluation: One is that those efforts are usually smaller in scale and thus its effect is being lost in the averaging effect of the evaluation of bigger units. The second reason is that the sector is too applied by nature for promoting high-risk research – at least in the Norwegian context.

2.2.2. Organisation

Generally speaking the leadership at the department level is not strong, which leads to unclear structures and strategies. In the case of NTNU it is additionally noted that resources (academic staff and PhD positions) are not always allocated according to the output of the respective unit. The lack of structure leads to isolated research units at the department level (example Biomechanics) and scattered expertise (e.g. Materials) at NTNU.

Another aspect where leadership is generally missing is the renewal of the faculty. Academic staff is mostly hired to replace current expertise. The employment policy is not aligned with a research strategy.

Last, the collaboration between SINTEF and NTNU is not transparent and easily understandable from an external point of view. Given the strong role and influence of SINTEF there should be a much clearer structure and stronger diversification.

2.2.3. Strategy

A strong point is the strategic effort towards national research in the area of marine technology. The combination of excellent university research (NTNU) together with the strong partners in research institutions (MARINTEK) makes for a world-leading role in this field. Such expertise is of key importance for the Norwegian society and industry.

On the other hand, frequently the research focus seems to be more driven by opportunities and current expertise than by strategic planning. This leads e.g. to instances of replicate research efforts at different institutions and extremely widespread research. Notwithstanding the need of the Norwegian society for national expertise, it must be questioned if Norway can research all scientific issues in the field. An alternative is to cover targeted areas on a very high scientific level and leave other aspects to external expertise – either industry or international.

In the same line of thinking, the research at the new Universities (Stavanger and Agder) and at the Østfold University College is to be strongly questioned. It is a clear result of the boundary conditions with respect to resources that the research output at those units is below the benchmark. Unless drastic measures are taken, this situation will not change. A more

convincing model should be envisaged, e.g. providing regional expertise by focussing on innovation instead of research.

2.2.4. Teaching workload

A consistent statement during the evaluation was the high teaching load of the academic staff that prevents time resources for research. While the actual number of courses given is not exceeding the educational obligations in an international comparison, the supervision of student projects (MSc. level) is certainly substantial. On the other hand the teaching modes do not seem to take advantage of latest developments and opportunities. The benefit of clustering student projects, (student) peer reviewing, increased external expertise etc. should be evaluated.

2.3. Impact of national excellence centres

There are a number of different schemes for national centres and clusters, provided for by RCN, Innovation Norway and SIVA. Most important, the sector has been granted two Norwegian Centres of Excellence (SFF) that is CeSOS and AMOS as well as the following Centres for Research based Innovation (SFI): SAMCot, SIMLAB and COIN.

It is obvious that these centres have a huge positive impact on the development of engineering science in Norway. All of the research groups responsible for the centres are at least well above the benchmark for scientific output and both “marine structures” and “SIMLab” are the two world leading research units within the evaluation. It is clear that the funding instrument of national centres for excellence is a huge success and provides excellent incentives for top class research.

2.4. Research co-operation nationally and internationally

The sector has a strong and successful cooperation on a national basis. This is due to the applied character of the research conducted in the field but also influenced by the application driven structure of the funding scheme. The success is seen also in the detailed evaluation where the grades given for impact and relevance of the research are outperforming the ones for the scientific quality.

On a general basis international cooperation is sound as well. It is clear that such efforts benefit from internationalisation of the staff, size of the unit and collaborative funding but in general the sector is by no means encapsulated but instead fares well above international standard.

2.5. Funding and infrastructure

The funding situation of the evaluated sector seems to be quite comfortable in international standards. According to the national strategy all institutions stated their intention to apply for

international (mostly European) funding schemes (e.g. EU Horizon 2020, Joint Programming Initiative, ERC grants) but these activities are only starting up slowly. National sources (most important RCN) and industry provide for alternatives and make for a more application-driven funding scheme.

The impression is that funding is not the key bottleneck in Norwegian research in this sector but available resources could be better spent. There is an obvious lack in incentives that make for a more structured and guided research effort.

Research infrastructure has not been stated as fundamental problem in the course of the evaluation. In some instances the lack of laboratory facilities is apparent and must be solved at department/university level. In the case of infrastructure that is a) needed at a national level and b) exceeding the means of the institution, there are means in place to provide for national funding (for example the Ocean Space Lab in Trondheim).

2.6. Training, recruitment, gender balance and mobility

Recruitment of academic staff, both PhD's and senior scientists is key to the further development of the sector. This is hampered by a number of factors:

- There is a general lack of national students in the engineering sector. This is a general picture all over Europa, however, must be solved to guarantee the engineering expertise needed in society.
- The salary situation in Norwegian industry is detrimental for hiring faculty. Reason being that academic salaries are app. par to an international level – but industry is clearly outperforming.
- The geographic situation (e.g. in Trondheim) is less appealing for international recruitment. Under those circumstances the internationalization in the sector is quite good.
- At the professorial level the mode of operation with respect to extra University activities seems to be not transparent and done on an individual level.
- Gender balance in recruitment of staff in engineering is nearly impossible given the gender distribution of the applicants. Efforts are already in place to increase the number of female students in the sector.

Overall, recruitment of qualified academic personal, balancing expertise, internationalisation and gender distribution, is the key for the development of the sector and the decisive factor for scientific quality in the long run. It is acknowledged that the sector takes measures to account for that, but the relevance of the issue cannot be ranked high enough.

3. Overall recommendations

- The evaluation exhibited a lack of high-risk research, meaning the investigation of novel aspects at highest scientific level but without present practical use. Even if the sector is very applied by nature, opportunities and incentives for such high-risk research should be established.
- The national funding schemes are very successful. As the instruments regarding centres of excellent promote top quality research, these should be further enhanced. A dedicated funding scheme for promotion of publications could further boost the output.
- Fundaments for stronger leadership should be installed at the department level. The aim must be to provide for clearer structures in the institutions and coordinated research strategies at a national level.
- Increased effort should be given towards the national strategy to increase the Norwegian participation in international funding schemes. At present first steps are done towards application but the effort should be monitored and evaluated.
- In quite a few institutions there is not enough incentive to publish in highly respected top impact journals. In the light of present evaluation criteria this is missing chances.
- Research at new Universities and University colleges should be re-evaluated. There is not much to gain at the current pathway.
- At a national level it must be evaluated if Norway wants to distribute its research resources (both economy and personal) evenly over the whole field. A viable alternative is the focus on strategic key aspects of national importance. Such strategic focus could promote the scientific quality and output.
- As already stated in the earlier evaluation 2004 the key bottleneck in the sector is the recruitment of academic staff. Measures must be taken on a national basis to work against the common trend and promote engineering science in education.
- Modern teaching modes should be evaluated in terms of reducing teaching load of the senior academic staff.
- The role of SINTEF and its collaboration with NTNU is a result of the historical development. Time has come to investigate in clear and transparent structures and novel modes of operation.

4. Description and evaluation of the Institutions and Research Units

4.1. NMBU Norwegian University of Life Sciences

4.1.1. Department of Mathematical Sciences and Technology

The Norwegian University of Life Sciences (NMBU) was first established in 1859 as the Norwegian agricultural post-graduate college. The organisation has undergone several changes since then and from 1.1.2014 it is denoted Norges miljø- og biovitenskapelige universitet (NMBU). NMBU has three faculties and 13 departments. The Department of Mathematical Sciences and Technology (IMT) is one of the seven departments under the Faculty of Environmental Sciences and Technology.

Evaluation Units:

IMT has 5 research sections, where the Environmental technology and Building technology is one of them. This section has again two research groups: Water and Environmental Technology (which is being evaluated) and Building Technology.

General comments on the department level:

The Department of Mathematical Sciences and Technology is currently into a process of revising its strategy. The idea is to work strongly on the following issues: Attracting international funding due to participation in Horizon2020, ensure that IMT has a relevant outreach in the Norwegian society and engineering due to various forms of partnership and increase the Ph.D. candidate population within 5 years. Further, the publication activity at IMT is currently low and emphasis is given towards an increase.

IMT will focus on four main research areas, which are: 1) Secure, clean and efficient energy, 2) Biorefinary (bio-economical processes) 3) Key enabling future technologies for environmental sciences and 4) Mathematical modelling of biological and environmental systems.

Follow up from previous evaluations:

In the evaluation 2004 IMT – at that moment denoted Department of Agriculture Engineering – has been encouraged to reorganise to form a group on environmental engineering, with a focus on recycling of organic and municipal waste and waste water including small scale bio-energy systems. This recommendation has been followed in parts, but the focus of the newly found organisation Water and Environmental Technology is on water issues.

Recommendations to the department/institution:

- Further efforts should be taken to establish the research strategy at all levels of the Department. That includes establishing a reasonable balance between teaching duties and time for research.

- Notwithstanding the benefit, it will not be possible to research in all teaching subjects. The research vision regarding areas should reflect the strength and expertise of the staff members, which is not obvious at all instances.

4.1.1.1. Water and Environmental Technology

Description of the research unit:

The group is of moderate size with 6 permanent staff members. The staff members are heavily engaged in teaching. The group was successfully attracting funding, which resulted in 7 external financed PhD positions (2013). The group has fairly limited access to lab facilities – especially with regard to water analysis. There is also no technical staff supporting lab activities.

Strategy, organization and research cooperation:

The strategy of the group is to cover the whole field of sanitary engineering, from conventional treatment processes, resource allocation (water reuse), holistic modelling to water quality and microbial risk. This is largely due to the individual research interest and experience of the staff members, but is also encouraged by the group leadership in order to support teaching. The research interests are mostly in the area of applied research. There is a clear strategy to apply for international research funding. Likewise the group is active as partner in recent SFI application in the field – together with NTNU. What is to be noted is the high number of students finishing MSc education in the field which has a distinct national relevance.

Since the group has a number of activities that will only take effect after the evaluation period, it is clear that the performance will increase. Thus the group is strongly encouraged to pursue its activities. The group is subcritical in size to cover the whole field in terms of research. Likewise it is neither necessary nor promising to overlap in activities with the established water and wastewater group at NTNU.

Scientific quality and productivity: **Grade: 2**

The research output in the evaluation period is below an international standard. Most important there was no PhD graduating (2011 – 2013). There is obvious emphasis to increase the activities towards publications but the number of accepted/published papers as well as the impact of the corresponding journals gives room for improvement.

Societal and industrial relevance and impact: **Grade: D**

The group was successfully attracting funding from mostly national and international sources but the impact and outreach is clearly below the defined benchmark performance. Likewise is the engagement in academic services and international organisations moderate. The group members are not leading experts in the international community.

Recommendations to the research unit:

- The group is encouraged to rethink its strategy. It seems to be more promising to thrive for a niche policy in terms of research and to complement already present activities at the national level instead of replicate them.

4.2. NTNU Norwegian University of Science and Technology / Faculty of Engineering Science and Technology (IVT)

4.2.1. Department of Hydraulic and Environmental Engineering

The Department of Hydraulic and Environmental Engineering (IVM) is quite sizable with more than 50 persons employed, among them 13 internally financed Professors. The research activities of IVM focus on the following two areas, which also establish the research groups in terms of organisation:

- Hydraulic Engineering (HE), covering the fields of hydrology and water resources, ecohydraulics, sediment transport, computational fluid mechanics and hydraulic structures
- Water and Wastewater Engineering (WWE), covering the fields of water and wastewater treatment and urban water systems

Until end of 2011 the department also hosted a research group in Waste Engineering and Industrial Ecology covering life cycle and material flow analyses. This group was reallocated to a different Department as a result of an evaluation of the Department in 2011.

Evaluation Units:

Both research groups: Water and Wastewater Engineering and Hydraulic Engineering are evaluated.

General comments on the department level:

With reference to the Faculty's strategic plan the Department of Hydraulic and Environmental Engineering has been given the responsibility for two areas of priority: 1) Hydropower to Norway and the World (HE group) and 2) Clean Water to Norway and the World (WWE group). These ambitious strategic plans are in line with the importance of the Department in a national context, as representing the scientific key expertise in these fields. The Department is well aware of its strategic role and has a clear strategy to maintain its profile.

The situation with respect to both the upgrade/maintenance of the laboratory and increase of PhD students is improving due to a number of measures and efforts taken within the evaluation period.

Follow up from previous evaluations:

While the evaluation panel in 2004 suggested a strengthening of the solid waste group, the evaluation in 2011 recommended reorganisation. The Department followed this recommendation, resulting in a clear picture regarding focus and organisation. Also further suggestions to increase the number of PhD students are taken up in the strategy of the Department.

Recommendations to the department/institution:

- The Department does not give the impression of being an entity, but 2 units. While this (being an entity) is not a necessity, a clear strategy should be developed in this respect. Collaboration could strengthen the Departments outreach.

4.2.1.1. Water and Wastewater Engineering

Description of the research unit:

The group comprises a team of 23 persons, led by 6 permanent staff members (internally financed at professor level). 10 members of the team have submitted their CV. The group has access to 3 laboratories (analytical, wastewater and drinking water) as well as to advanced monitoring equipment for experimental work.

Strategy, organization and research cooperation:

The strategy of the group is centred around the priority area “Clean Water to Norway and the World”. The research portfolio is widespread and covers most areas in urban water management from microorganism, treatment technology, urban hydrology, ICT, integrated asset management and resource recovery.

The group is organized as flat hierarchy, where each of the faculty members pursues his/her own research, but with shared access to laboratories. Funding is sought from both national and international sources and the group has traditionally very good contacts internationally. Especially noteworthy is the collaboration with Minnesota (NTNU-UMW), Forschungszentrum Jülich and TU Berlin, but there are many others.

Due to a difficult generation shift in key personal some years ago the group had to struggle to maintain its international standing and relevance. The group has made good progress towards profiling themselves but quantitative results remain to be seen.

The group has been recently successful to increase the number of PhD students, which should further increase the impact in the future, but this cannot be taken into account directly in this evaluation period.

Scientific quality and productivity: Grade: 3-4

The productivity of the group with respect to scientific publications is somewhat above the international standard. The group has increased the publications steadily over the last years but likewise has the whole field. According to the bibliographic analysis the citations to the publications are on par with the world average. The number of publications listed in the NRC database is app. 15/year for the whole group. It is also to be seen that the biggest share of publications (especially the ones in journals with higher impact) comes from one subgroup – that is the membrane group. Further, the number of PhD finished within the evaluation period is not impressive (one per year).

Besides publications the group has been quite active and successful in international collaboration and partnerships. The group has maintained its profile as international research partner and is thus successful in collaborative research.

Societal and industrial relevance and impact: **Grade: B**

The group has both national and international outreach. This is well documented with a number of projects and collaborations. E.g. the group was instrumental in the application for a national SFI centre denoted Clean Water, which documents the relation of the group in a national context. The same holds true internationally, where the group is e.g. instrumental in the field of asset management. Likewise the group has positioned itself quite soundly in terms of EU funded projects and has been very successfully applying for grants in that scheme. Further to mention is the outreach of the group with respect to innovation, a key example being the patented technology HyVAB (hybrid vertical anaerobic biofilm bioreactor):

Recommendations to the research unit:

- The research focus of the group should be sharpened, especially with respect to the wastewater field. It is not entirely clear what the group stands for in terms of key expertise. The high scientific output of the membrane subgroup should be taken as a good example.
- Efforts should be made to focus on publications in journals with a higher impact on the academic world.

4.2.1.2. Hydraulic Engineering

Description of the research unit:

The group has in total 21 members, of which 9 delivered their CV. The group comprises of 6 permanent staff members with one additional position currently not filled. The group has access to laboratory facilities and operates 2 hydrology field stations.

Strategy, organization and research cooperation:

The group has been given the priority area within NTNU “Hydropower to Norway and the World”, which is researched in collaboration with other groups. A significant amount of activity is happening within the Center for environmental design of renewable Energy (CEDREN), which will last until 2017.

The group covers an impressive amount of topics, ranging from details in hydropower operation, sediment transport, and environmental issues to numerical hydraulics. The strategy of the group is less to focus on and excel in one particular issue but rather to cover the total field. This makes for widespread activity. On the downside, the scientific profile of the group is not obvious.

Scientific quality and productivity: **Grade: 4**

The group is educating a significant number of MSc and PhD students (75 and 8 in the 3 year assessment period) with numbers increasing. This also leads to a substantial publication

output for this field. The group has successfully shifted its traditional publication profile from conference proceedings to high ranked journal. The faculty members are internationally active both in terms of collaborative research and in international organisations. Overall the group has a substantial scientific output well above the standard.

Societal and industrial relevance and impact: Grade: B

The relevance of the group is obvious in the Norwegian context. The group is fulfilling the role as national expertise in the field of hydropower and thus its performance is vital for the Norwegian hydropower industry. The activities in the centre CEDREN and the newly founded Norwegian Centre for Hydropower underline the relevance. The activities of the group are widespread also in international terms. It is difficult from the material to get a clear profile but it is obvious that the group is an active and recognised player also in international organisations.

Recommendations to the research unit:

- The group is encouraged to sharpen its scientific profile while still fulfilling its role to provide knowledge to the Norwegian society on the whole field.

4.2.2. Department of Structural Engineering

Evaluation Units:

Concrete
SIMLab
Structural Mechanics
Biomechanics

General comments on the department level:

The department is a traditional structural engineering department with some specialities into new directions. The tradition is rooted in the disciplines of mechanics and materials applied to structures via a combination of computational modelling and experimental lab testing. Examples of new directions are nano- and biomechanics.

Faculty members express a strong commitment to the Norwegian industry and have a leading national position. The department's global role was perhaps less well articulated, but subgroups like SIMLab and concrete technology have a strong international outreach supported by effective CRI schemes for fundamental research.

The department leadership is loose with a flat organisational structure, encouraging bottom-up activities from multiple individuals. The style is pragmatic in dealing with existing staff and personalities and opportunistic in selecting topics that follow funding possibilities. Although this can be called a strategy, it does not follow from a coherent sequence of vision, mission and action at department level.

The committee hardly found any joint publications, joint projects or joint fund raising activities amongst the four units. Although there was some dialogue about the science plan at

institute level, the connectivity within the department is poor. Possibly there was no need for collaboration up till now as funding came without considering overarching themes. Whether this is a sustainable approach to the future is questionable.

The department has improved its age balance, gender balance and international diversity of staff. Lab facilities and computational tools are above standard and operated in connection with SINTEF.

Follow up from previous evaluations:

The 2004 evaluation addressed the balance of fundamental versus industry driven research, the age distribution of staff, the future development of lab facilities, the leadership, the lack of a common research strategy. At all items steps have been made. The generous RCN funding of the CRI's SIMLab and Coin has boosted fundamental research and now industry and public sector understand that such combination is effective. The age distribution of staff has significantly improved but pro-active replacement strategies with possible strategic redirections still deserve attention and action. The department has decided to install new lab facilities for nano- and biomechanics rather than seeking for cooperating with other partners. There was leadership in filling the matrix of existing disciplines within the department versus the 16 thematically oriented priority themes within the institute, but the next step of interweaving the traditional mechanics based subgroups into a powerful larger framework remains a challenge.

Recommendations to the department/institution:

- Encourage focused dialogue among faculty from the different subgroups and even among individuals within some subgroups, to achieve cross-fertilization, to promote collaboration and to unlock even greater potential. For example a question like "Who will be the structural engineer of the future?" could help the department to further define a shared vision on the future research and education agenda.
- As emerging subgroups like nanomechanics and biomechanics pass from the embryonal stage to maturity, the department is recommended to decide whether these activities – that are of high calibre but outside the main strategy and scope of structural engineering – should stay within the department or better be moved to another field where they would possibly benefit from a better access to their industrial contacts, market and related tools.
- In connection to the above, it is recommended to discuss and decide on priorities for maintenance, upgrading and further development of lab facilities, across the scales – from the larger structural scale to the nano and bio scale –, and in a wider context together with other departments, SINTEF and other institutions.
- Continue the pro-active replacement strategy and link new tenure track decisions to a shared department vision and strategy.

4.2.2.1. Concrete

Description of the research unit:

The “Concrete” group consists of 6.3 Prof/Associate Prof, 1 Post Doc, 3 Adjunct Professors (20% positions), 10 PhD candidates, and 2 laboratory technicians. The concrete group has expertise on both materials science, advanced computational mechanics and structural design and applies combinations of experimental and modelling tools. The research can be grouped into the following research topics:

- Rheology of fresh cement based materials
- Hydration, material property development, and volume changes and cracking
- Durability and service life including reinforcement corrosion and ASR
- Low temperature; frost and ice damaging and engineering properties
- Concrete types with given properties (FRC, LWAC, SCC)
- Structural design, FE analysis and material modelling of structural properties

Strategy, organization and research cooperation:

The “Concrete” Group has a good strategy to combine material science and structural design to improve the long-term performance of concrete structures. The scope of their research varies between materials research at fundamental level, and applied research at structural level. The results are relevant for the Norwegian industry and are visible at the International level. The teaching activities of the Concrete Group are based on this active research. The group wants to be at the forefront on a few selected topics. The group is taking the opportunity of some upcoming large projects (e.g. ferry-free link) to initiate new research while serving industry and society. On an international level, the “Concrete” group is involved in European research projects and networks.

Scientific quality and productivity: **Grade: 3-4**

The publication output of the Concrete Group is at a good level, with a good number of publication points per staff per year. According to the Publications Report, the research group Concrete performs better than the other groups in the department in terms of citations. It is clear that the scientific quality and productivity is mainly coming from the ‘materials’ sub-group, which is visible and well respected at an international level. The international cooperation in this respect is very good (e.g., Nanocem network, DTU, Stanford, Princeton, TUDelft). The scientific quality and productivity of the ‘structures’ sub-group is below standard. Overall, the scientific quality and productivity of the Concrete Group is slightly above standard.

Societal and industrial relevance and impact: **Grade: C-B**

The ‘materials’ sub-group, in close cooperation with SINTEF Concrete Group, has a clear impact on the Norwegian society and industry. The COIN centre was an important initiative in the recent years, coordinating many efforts in a clear and visible way, with significant outreach. As this COIN centre has now come to an end, the challenge is to find an adequate

follow-up initiative. The outreach of the 'structures' sub-group is low, and not relevant in competition with engineering consultants. Overall, the societal and industrial relevance and impact of the 'Concrete' Group is slightly above standard.

Recommendations to the research unit:

- The group is encouraged to continue efforts in joining international projects and networks.
- The group is also encouraged to maintain the coupling between materials science and structural behaviour, although the organization of the structural concrete research needs further improvement (see next bullet).
- The role of the 'structures' sub-group is neither very clear nor visible. The Department is encouraged to reconsider the positioning of the 'structures' sub-group of the Concrete Group. It might be more relevant to regroup the 'structures' groups within the department, or at least to significantly increase the interaction and cooperation in-between these groups.
- It is recommended to clarify the roles of the NTNU Concrete Group and the SINTEF Concrete Group. Both groups are intensely cooperating, and seem to be at a comparable scientific level and have similar societal and industrial outreach.

4.2.2.2. SIMLab

Description of the research unit:

SIMLab is a research group within the NTNU Structural Engineering department working in the field of structural modelling of materials and structures with emphasis on impact, energy, absorption, and penetration problems. The research group, which was founded in 1999 was granted a SFI together with SINTEF by the NRC in 2007 and is presently a group with a total of 10 academic staff of which 7 are full time professors and 3 are adjunct professors (20% positions). SIMLab is a research group within the department of structural engineering but has to a large degree the status of a department at university level.

Strategy, organization and research cooperation:

The research group has developed and implemented a strategy to provide a technology platform for the development of safe and cost efficient structures in a close collaboration with the industry through basic research on materials, solution techniques and structures synthesized through demonstrators. The clear distinction between basic and applied research within the group provides a good platform for the combination of university research, institute applied research and developments as well as a basis for interrelation with the industry.

The research group has been organised in a matrix structure with the activities related to the basic research and demonstrators in the verticals and the projects in the horizontals. This approach appears very structured and facilitates that research leadership may be distributed to relevant experts. Moreover, the organisational structure of the group enhances interdisciplinary collaboration.

SIMLab benefits from the interaction with an international advisory board and this is a strong feature for SIMLab, which could be utilized more broadly across NTNU and SINTEF. Moreover, SIMLab has extensive collaborations with the NTNU department of Material Science and Engineering as well as faculty members within the department of Structural Engineering. In addition substantial industry collaborations have been engaged in with the industry including as examples Aker Solutions, Honda R&D Americas and Hydro. SIMLab has by choice only a rather moderate engagement in EU funded projects as more appropriate and targeted funding has been achievable from other sources. This strategy may not be viable in the long run and mechanisms for engagement into EU funded projects should be considered.

The academic staff of SIMLab is largely of Norwegian origin, but international academic guest have been attracted to the centre. SIMLab is conscious about the challenge in achieving an appropriate gender balance. Presently 1 out of 6 of the faculty and 17% of the 22 PhD students at the centre are female.

The age group of the core faculty of the centre is close to 50 years and there is some focus on the necessary generation shifts.

SIMlab formally ends in 2014, but the research group has been granted a new centre – CASA - funded by the NRC.

Scientific quality and productivity: **Grade: 5**

The scientific production and quality corresponds to world leading. The researchers show excellent ability to work across disciplinary boundaries to adjacent research fields.

Societal and industrial relevance and impact: **Grade: A**

The impact of SIMLab is very significant as reflected by the interest that has been attracted from the industry. The research group provides a wide range of services to the industry including leading industry standard software solutions for the automotive industry. Finally it should be mentioned that SIMLab is very visible in the media even at international scale.

Recommendations to the research unit:

- Broadening of scope to include stochastic mechanics – possible by engagements of faculty members from within the department.
- More active acquisition of EU R&D funding.

4.2.2.3. Structural Mechanics

Description of the research unit:

The group has a permanent staff of 8 professors who are working within civil engineering structures with material research on all scales, load modelling, and numerical simulations

Strategy, organization and research cooperation:

The strategy of the group is to perform research within the classical civil engineering fields and also to be active in new emerging engineering fields. Among these new fields is oil-water flow in the presence of nanoparticles for nanotechnology enabled petroleum engineering. That is, a topic outside classical civil engineering. The group states in their self-evaluation report that they want to concentrate its efforts on a few strategic and key research fields. This will require that they find a way to cope with new and promising ideas from the Nano-mechanical Laboratory, which are outside their main strategy.

The group is organized in a flat project based structure where the scientific leaders of the subgroups are active in the research, responsible for decisions related to the projects within their subgroup, and for obtaining external funding to the subgroup. Interaction between groups and on the department level is not significant.

There is a good mixture of fundamental research and applied research. The direct funding by the industry is reasonable but not exceptional.

The group has research cooperation with a large number of universities abroad, but collaboration with other research groups at NTNU seems to be limited.

Scientific quality and productivity: Grade: 3

The research topics include nano-mechanics, fracture mechanics, structural dynamics, computational solid and structural mechanics, timber structures, and structural reliability and risk assessment. That is, the number and diversity of research topics is large seen in relation to the number of permanent staff and there is a considerable difference in activity and output between the different sub-groups. Altogether the group has a good number of publications. However, the number of citations to the papers published in journals is below the national average.

The external research funding is mainly national and most projects have modest budgets. The group has limited experience with larger international projects such as EU projects.

Societal and industrial relevance and impact: Grade: C-B

Civil engineering structures are important for the society and it is essential that candidates within this field receive a research-based education. The group has a fair number of Ph.D. graduates and a good number of M.Sc. candidates.

The research topics of the group are highly relevant for the industrial as well as the public sector. Several group members participate in national and international standardisation bodies.

The cooperation with governmental bodies such as Norwegian Public Road Authorities and the Norwegian National Rail Administration are very relevant for dissemination of the research results from the group

The international visibility of the group has been enhanced in 2014 by hosting the 20th European Conference on Fracture with more than 600 participants.

Recommendations to the research unit:

- The research topics are quite different and the responsible subgroups are small and comparatively independent. In order to function as a more integrated group the group could concentrate its efforts on a few strategic and key research fields. This would also make it easier for the group to participate in large international research projects such as EU projects. Larger projects will also reduce the administrative burden associated with getting external funding
- Efforts should be made to focus on publications with a larger impact on the academic world, i.e. where one can expect a higher number of citations.

4.2.2.4. Biomechanics

Description of the research unit:

The group was established 10 years ago and is still quite small in size. There are 3 permanent staff members, but no postdoc. Presently there are 2 PhD positions filled. A lab facility is currently being developed but until now external infrastructure (Eindhoven, Graz) had to be used.

Strategy, organization and research cooperation:

The group is focusing on biomechanics in relation to health aspects. As such also the application area is the medical field. Key topics are the application of continuums mechanics to simulate the behaviour of cardiovascular and orthopaedic systems. The funding of the group is mostly from national sources and NTNU itself.

Research cooperation is documented with NTNU departments (e.g. physics, biotechnology, Medicine), SINTEF (Materials and Chemistry) and Norwegian Hospitals.

Also the group has very little documented collaboration with the other groups in the department and seems to be isolated. On a larger scale the groups seems to lack the opportunities given in an international context.

Scientific quality and productivity: Grade: 3

The scientific productivity is about average level in an international context. There is substantial effort on publications but both the amount and also the quality is restricted by the size of the group. There is a missing outreach in international terms and applications to EU research programs have been made only after the evaluation period.

Societal and industrial relevance and impact: Grade: D

The relevance and impact of the group is fairly limited, both in a national and international context. This might be a problem in the field itself as the problem owners i.e. the health industry, is slow in picking up the benefit of collaboration. On the other hand, there seems to

be an international demand on such expertise as can be seen by successful groups in the same domain elsewhere.

Recommendations to the research unit:

- Despite huge personal effort that has been put into its establishment, there is little to gain if the group follows its current track. A reorganisation and restructuring is recommended.
- At a department level it is to be questioned if this group is positioned correctly or should be even moved (e.g. to another Department) where the group would benefit from a better integration and more direct access either to the problem or the tools.

4.2.3. Department of Marine Technology

Evaluation Units:

Marine Structures

General comments on the department level:

The department is organized into two research groups: Marine Structures and Marine Systems (evaluated by panel 2). The department is located at the Marine Technology Centre, together with the SINTEF group MARINTEK. The personnel comprise 115 persons of which about half are financed by external funding. Laboratories are operated in close connection with MARINTEK.

Both groups addresses the research activities laid out by the IVT faculty in “Science plan 2012-2020”. The Marine Structures group is responsible for the area “Marine operations and installations in hostile environments” and the Marine Systems group for the area “Green Shipping” The groups also contribute to other segments of the faculty strategy. The Department has a clear strategy.

The research leadership of the Department has a clear structure and leadership is exercised in an appropriate manner.

The cooperation between the two groups in the Department has been significantly improved in recent years and several of the strategic projects have collaboration of both groups. It is also noted that the Department have extensive cooperation with other Departments at NTNU as well as with high-ranked international universities.

The Department has recruited several new professors in recent years; however, there are still key positions to be filled in.

At the evaluation by the Research Council in 2004 the Marine Structures group was marked 5 (Excellent) in both Scientific Quality and Productivity, and in Relevance and Impact, and the Marine Systems group was marked 3 (Good) in Scientific Quality and Productivity, and in Relevance and Impact the group was marked 4 (Very Good). Similar results were obtained during the evaluation in 2011.

The recommendations from the two panels have been followed up by the Department.

Recommendations to the department/institution:

- Continue focus on key personnel replacement.
- Exploit the fact that MARINTEK is nearly entirely dedicated to applied research and applications to focus more on the fundamental aspects of Marine Technology.

4.2.3.1. Marine Structures

Description of the research unit:

The group has nine internally funded and four externally funded professors and has submitted CVs for an academic staff of 15 persons, i.e. 13 professors, one senior researcher and one professor emeritus. The research group has by December 2013 altogether 81 persons financed by external research grants including 65 PhD students. The research is divided into three sub-groups: Marine Structures, Marine Hydrodynamics, and Marine Cybernetics.

Strategy, organization and research cooperation:

The group has developed a long-term strategy document defining main disciplines and thematic application areas. This strategy is adopted based on departmental, faculty and university strategies, which again build on national research strategies.

The research group is to a large extent autonomous. It has its own strategy for definition of main research disciplines, focus areas, research projects, collaboration with external units, resources etc. The large numbers of externally funded long term projects will to a large extend govern the short-term decision-making.

The permanent staff includes a number of internationally well-known professors with a relatively high average age, especially within structures

The research group has strong research cooperation with a number of other NTNU departments, with internationally leading Norwegian companies within marine technology, and with many university departments around the world.

Scientific quality and productivity: Grade: 5

The group is relatively large and its activity is very high. The research group has a high number of academic publications in the best international journals and societies. The staff has a very high scientific level which has led to a large number of international awards and keynote lectures around the world.

The research is to a large extent financed through external funding and it is noteworthy that after completion of the successful SFF project CeSOS the researchers succeeded in attracting a new SFF project AMOS.

At present the group has 80 Ph.D. students of which a large percentage is international candidates. Many of the Ph.D. students are employed in projects with direct industry funding in close cooperation with the industry.

Research within marine structures is by nature applied research and the large percentage of external research funding tends to further emphasize applied and programmed research.

The group is on the forefront of the international research within marine structures and the productivity is excellent.

Societal and industrial relevance and impact: Grade: A

The research topics relates to key industries in Norway, i.e. naval architecture, offshore structures and aquaculture. Therefore, the research area is highly relevant both nationally and internationally.

Besides the Norwegian Research Council financed projects the research group also manages and participates in a large number of other externally financed research projects within Marine Structures. This reflects the importance of their field of research for the Norwegian society but also the central role this research group plays within their field of expertise.

The research group educates a large number of M.Sc. candidates and Ph.D, candidates which goes out in the society and can disseminate the knowledge and the research results generated by the group.

Recommendations to the research unit:

- The Group and NTNU must formulate a plan to continuously bring researchers into a position where they can take over leading roles as key professors and project managers in order to maintain this group.

4.2.4. Department of Civil and Transport Engineering

Evaluation Units:

Building and Construction
Geotechnics
Marine Civil Engineering
Road, Transport and Geomatics

General comments on the department level:

The department holds a somewhat unusual combination of two large groups that are in a transition from an education to a research oriented profile, viz. the Building and Construction and the Road, Transportation and Geomatics group, and two smaller but more focused groups in established research areas, viz. Marine Civil and Geotechnical Engineering. Hence, the diversity of applications, the underlying disciplines and the number of objects under study (buildings, roads, tunnels, wind turbines, arctic offshore structures, coastal areas, soils and rocks) are very wide. The collection might be rather termed a division than a department.

The leadership of the department has focused on creating research habitus in the two larger groups that both were mergers from previous groups. This effort is praiseworthy and the vector is in the positive direction. A balanced set of incentives was placed to increase publication output of existing staff, soft pressure on writing and delivering national and EU proposals, stimuli to embrace postdocs, PhD's and MSc's jointly around research themes, and an active international recruitment strategy. Results in terms of productivity over the period 2004-2014 are apparent: a significant increase in publication points, in number of PhD's, number of national and 20 EU proposals submitted and a role in three centres of excellence. Nevertheless, the current outreach is mainly at national level, while international academic presence of the two larger groups is poor though slightly better than before.

Actions were labelled under the 16 strategic research areas of the Science Plan of the IVT Faculty, but there is no evidence of a joint framework or common research ground at Department level. Collaboration between the four units is marginal as is the number of joint publications and joint projects.

There is an active recruitment strategy with a proper 'verticality' in searching for the full range of full, assistant, associate and adjunct professors as well as postdocs, and an effective national/international, gender and age balance. Fresh members enter the department and add to the research culture.

At the Department the distribution of resources between research and teaching is a challenge.

Follow up from previous evaluations:

Strategy and actions are in line with suggestions from the 2004 and 2010/11 evaluations but there is still a way to go to reach the NTNU and IVT goals.

Recommendations to the department/institution:

- To achieve balance between education and research, the current response is to raise research. It is recommended to also think the other way round. Educational load may be reduced and research in certain places – if proven not to reach international standards – may be closed down. Four possible options are to
    a) share educational modules with other Scandinavian or European universities via modern on-line ICT based open courseware,
    b) transfer educational tasks to University Colleges that have their prime focus on education,
    c) obtain design and engineering education from professional practice, via e.g. professor II positions or other collaborations with the sector,
    d) regulate influx of students in MSc tracks, e.g. by putting a numerous clausus or alike on poorly research based tracks and move students to strong research based tracks.

This recommendation is general but applies particularly to subfields within BAT that traditionally lack science orientation, both within the university and within the sector. It may

solve the dilemma expressed by faculty members that feel responsibility of being the sole supplier of education in Norway versus pressure of becoming an internationally renowned research player. Decoupling of research and teaching cannot be postponed further once choices have to be made regarding limited budgets.

- Further monitor the success rate of proposals, the productivity and quality of publications, the citations and then decide whether research in the transitional subgroups is viable or not, with the consequences of the above bullet.
- Either accept that the Department is a management oriented organisational grouping with little common research ground, or move subgroups to other parts in the IVT faculty or NTNU where they would benefit from better fits with markets, disciplines and students profiles. Think for example of relations between Marine Civil Engineering and Marine Technology, and between Building and Construction and Architecture.

4.2.4.1. Building and Construction

Description of the research unit:

The group is a merger of Building Materials and Technology and Project Management and Construction Engineering in 2012. The fairly large team of 21 staff members and 16 PhD's addresses a variety of applied research topics under four headers of the IVT faculty science plan, including hydropower, safe efficient and sustainable road and rail transportation, energy efficient and functional buildings, and management of complex projects. The educational tasks are significant with 60 MSc's on average annually.

Strategy, organization and research cooperation:

Coming from an educational background with isolated researchers the group gradually moves to a mode of academic teamwork where staff members collaborate with MSc's and an increased number of PhD's.

The strategy written down in the self-evaluation was not sharp, neither were the answers to the committee's questions. Nevertheless, the group evolves to a better balance between teaching and research, an improved publication record, an increased number of proposals submitted and a stronger participation and leadership in connecting IVT's science plan to industrial needs for the building sector. Some synergy between the two former groups has been exploited in environmental impact assessment and life cycle analysis of tunnels.

The national role is strong with many projects and links to governmental and municipal agencies and SME's typical to this sector, but the international position is not clear yet. The weakness is a lack of focus. The research is an amalgam of different topics, which is at striking terms with the ambition to reach international excellence and profiling.

The department shares laboratories with SINTEF, but the natural roles of NTNU and SINTEF are not transparent. Four new positions at the department were filled with former SINTEF members, suggesting that there is overlap between SINTEF and NTNU.

Scientific quality and productivity: **Grade: 2-3**

The productivity of the group in terms of PhD's delivered over the 3-years period (10), publications over the period (108 for 14 persons according to the bibliometric analysis) is fair to good, while the normalized field citation index is good. However, these numbers are unevenly distributed over the individuals, indicating that some subgroups perform better than others. Also there are signs of some double counting at NTNU and SINTEF, due to the interwoven roles. Overall, from an international perspective the position is fair to good, with the contributions in building physics and tunnelling being probably most visible. The trend for this traditionally education oriented group is in the upward direction, with enhanced international presence and accepted EU proposals being the next challenge.

Societal and industrial relevance and impact: **Grade: C**

The group has a strong position towards national governmental and municipal agencies as well as SME's typical to this sector. A variety of joint projects, links and knowledge dissemination activities exists, well documented in the report. A key aspect is the stable production of a large number of MSc's to Norwegian society, better attached to research than before. The group also actively participates in more science oriented and larger programme initiatives as e.g. the Ferry free E39 case with PhD's, the project Norway, Klima 2050, SYMBIOSIS and EU proposals. If successful, this will also develop international outreach of the group.

Recommendations to the research unit:

- Focus more. After the current process of lifting the entire department base up to research, a moment comes that research in the most successful sub-areas should be continued while other trials should be stopped. Excellence is not likely to be reached over the full spectrum of this broadly oriented group. This relates to the possible decoupling of teaching and research, as mentioned in the recommendations to the department.
- Further clarify the missions and roles of SINTEF versus NTNU in this field.
- Continue the focus on high-quality publications and PhD's, in addition to quantity.

4.2.4.2. Geotechnics

Description of the research unit:

The group is rooted in the established discipline of soil mechanics. It focuses on constitutive modelling and numerical methods supported by lab and field testing, the outcome of which is transferred to design in geo-technics, foundations and geo-hazard risk assessment. The fairly small team of 4 full time professors and 2 part time professors has increased its number of PhD's in recent years up to 17 at present.

Strategy, organization and research cooperation:

The group is well aware of its strengths and weaknesses and acts accordingly. The strategy was and is to be internationally strong in computational geotechnics, supported by lab and field testing of geomaterials. This strategy profiles the group and provides continuity. The international networking is very strong, evidenced by jointly organized courses, joint publications, joint projects and joint dissemination of e.g. modelling software.

The weakness is a lack of papers in peer-reviewed journals. Although this can be partly explained from the somewhat closed and conference oriented geotechnical community, the group has defined an adequate strategy to improve the publication rate by significantly raising the number of PhD's and coaching these PhD's to produce high-quality journal papers on the run towards their final thesis. In addition, experienced post-docs are now being employed in projects to make rapid production. First signs of improvement are apparent from the publication output in 2013. The vector is in the positive direction and should be monitored the coming years.

The strategy towards national positioning is adequate, with many and also collaborative multi-disciplinary projects devoted to Norwegian geotechnical challenges. The role versus other national institutes like NGI is clear in the sense that the NTNU university group in addition to applied research also undertakes basic research into deeper understanding of the soil characteristics, e.g. into micro structural behaviour of clay failure or physics of frozen soil. The role of this university group versus NGI is perhaps more clear than it is for other NTNU groups in their relation to SINTEF.

Due to an active recruitment strategy over the past years, the international diversity and age balance of staff is adequate. The gender balance deserves attention, with opportunities as more than 50% of the PhD's is female and talents can be scouted. However, the group being the only university group in geotechnics in Norway remains rather small and viability and timely replacement of staff should have continuous attention.

Scientific quality and productivity: Grade: 3

This is typically a group of low productivity, but high quality. The number of papers in peer reviewed journals is very small, as are the citations. The bibliometric study mentioned only three journal papers with 6 citations. Four PhD's finished their work in the past years, which is fair. However, while the quantity of the output is thus low, the quality and the international prominence of the group is judged to be high. This is proven by examples of a best paper award, many international cooperations and joint publications, membership of the Alert Geomaterials network, a stable organization of international PhD courses with reputed guests, and an EU FP7 funded project on creep of geomaterials, in addition to a balanced set of Norwegian projects including NFR projects, participations in a centre of excellence for geohazards, a centre for research based innovation, projects on offshore wind foundations and frozen soils for the arctic. The different judgement of quantity and quality leads to an average grade of 3.

Societal and industrial relevance and impact: Grade: B

The large number and diversity of projects and the large number of PhD's that are funded externally are indicators of a strong relevance of the group's research to the Norwegian industry and public organizations. The group properly anticipates on new challenges from e.g. climate change, arctic engineering or offshore wind foundations. The group is strong in transferring their computational and constitutive models to practice, via inclusion in e.g. Plaxis finite element software and design software and supports that via courses to end users and publications and presence at conferences. Also, MSc's and PhD's delivered by the group find their way to e.g. NGI and via them to other places in industry which keeps the knowledge ball running and has impact.

Recommendations to the research unit:

- Increase the publication rate in peer reviewed journals. Reshape conference papers as typical to the geotechnical community, into a format suited for international journals. Strategy and actions have already been defined in this direction, first results are there, but this should be strictly pursued and monitored continuously for PhD's and staff. In addition to publication rates, also citation rates should be monitored and improved. This will help to further identify the high international standing and intrinsic quality of the group.
- Scout female talents under the increased number of PhD's and from elsewhere and improve the gender balance in the higher academic ranks. This to be combined with the group's active recruitment strategy, to sustain the viability of this over the past years variably sized group in the Department

4.2.4.3. Marine Civil Engineering

Description of the research unit:

The group consists of 6 fulltime and 2 part-time staff (2 Professors, 3 Associated Professors, 1 Post-Doc, 2 part-time (20%) professors). The main research effort is to model how the physical environment affects the design and operation of marine structures. The research plan is based on research within Ice, Waves and Wind.

Strategy, organization and research cooperation:

The strategy of the group corresponds well to the strategy of NTNU. The group has decided to focus on the application areas: Arctic Offshore and Coastal Technology, Offshore Wind Technology, and Coastal Technology. The need for research within these topics is identified by most societies.

The committee noted that the Department does give only a 0,22 full Prof. position to the group. However, 3 associate professors are funded internally in addition.

The group has strong research collaboration with other applied research groups within their area both at national and at international levels. Especially, the group has collaboration with the Department of Structural Engineering and with the Department of Marine Technology. The group collaborates with the Hydraulic Engineering group at Department of Hydraulic and Environmental Engineering in teaching and the hydro-technical laboratory facilities at Valgrinda. The links to and cooperation with the other groups within the Department do not seem be very strong. That is, the panel is not sure that this research group is positioned correctly.

Scientific quality and productivity: Grade: 4

The group has been able to attract considerable external funding to relevant projects and the group has a large number of Ph.D. students and postdocs per faculty member. They have a strong publication rate. However, the research publications are mainly in proceedings from international conferences such as International Conference on Port and Ocean Engineering under Arctic Conditions. Even if research within the arctic area may not be well covered by journals the limited number of NCR (journal) publications by the group is cited much less than average for the field and for the journals where the papers are published. To gain a better international research reputation the group should make an effort to publish research results in respected journals and make an effort to publish papers, which has so much new scientific findings that they can be expected to be referenced more extensively by the research community.

Societal and industrial relevance and impact: Grade: C

The research topics addressed by the group are highly relevant for the Norwegian society. The group has been able to win significant research contracts from the Norwegian Research Council and some major players within their research area and they have in general strong links to industry. The number of M.Sc. candidates from the group is quite modest but the research results are disseminated by the large number of Ph.D. candidates.

The group is very active in presentation of research results at professional conferences in order to reach out to the industrial world and the group is also active in dissemination to the general public through popular science media.

Recommendations to the research unit:

- To direct more of the publications to journals with a high impact factor, possibly at the expense of the very large number of conference publications.
- The relations of this group to the Department of Marine Technology and to the Department of Hydraulic and Environmental Engineering should be clarified for the future where a strong Ocean Space Center is assumed to be present at NTNU.

4.2.4.4. Road, Transport and Geomatics

Description of the research unit:

The group "Road, Transport and Geomatics" consists of 6 professors, 5 associated professors, 2 assistant professors, 2 senior engineers, 3 laboratory technicians, 3 adjunct professors, 1 senior research scientist, 1 visiting research professor, 1 part-time (20%) senior research scientist, 2 post docs, 12 PhD students, and 2 research assistants. The following research topics are especially considered:

- Traffic modelling, traffic safety, urban transport infrastructure, traffic engineering and ITS (intelligent transport systems and services)
- Pavement technology
- Railway, High speed intercity, Improved supply in densely populated areas, Freight transportation
- Sustainability, rehabilitation, operation and maintenance
- Opportunities in geomantic (GIS, ITS and BIM)
- Satellite technology in road and transportation engineering

Strategy, organization and research cooperation:

The strategy of the group is rather vague and unclear. This is to a large extent caused by the fact that the composition of the group has been mainly based on teaching programs. The setup of the group is not well sorted out, and is lacking any consideration about common disciplines. There does not seem to be any sound common scientific basis for the very broad grouping of the different subgroups. The main focus of the group seems to be on teaching activities. The main research focus of the pavement subgroup is on winter problems, and winter maintenance of roads. The other subgroups do not seem to have any clear research focus.

Scientific quality and productivity: **Grade: 2**

The group seems to be sub-critical with respect to transportation engineering. The research position of the geomatics subgroup seems to be extremely weak. The subgroup working on pavement technology is having a good scientific performance including publications, with some recent involvement in European project proposals. Also the Railway subgroup was involved in European project proposals. The overall scientific level of the entire group is below standard.

Societal and industrial relevance and impact: **Grade: C**

The main societal impact of the group is through teaching. Furthermore, the group seems to be an important partner for the road and railway authorities, taking over somewhat the role of previously existing SINTEF groups. The ferry-free link E39 is giving further opportunities to improve the outreach. Overall, the societal and industrial impact is considered to be at standard level.

Recommendations to the research unit:

- The structure of the group should be seriously re-thought, considering the underlying disciplines.
- In particular, the position of the geomatics group should be reconsidered. It is recommended either to move the geomatics group to another department or faculty, or to let it fade-out.
- The teaching policy should be reconsidered, as some teaching activities seem to be impairing the research performance of the entire group. The teaching concerning some specific topics maybe be outsourced, e.g. in an alliance with other universities possibly on an international (Scandinavian) level. See recommendations to the Department level.

4.2.5. Department of Engineering Design and Materials

Evaluation Units:

Materials

General comments on the department level:

The department has reorganized its research activities into two units, Materials and Design, Analysis and Manufacturing (DAM) (evaluated by Panel 2), covering a wide range of topics and supported by ten laboratories. The areas are application-driven materials science, product development and metal forming or selection of manufacturing processes.

The strategy of the department was written down mainly in terms of quantitative objectives and goals, with e.g. targeted numbers of publications, projects, PhD's and funding. This in itself is positive, but a vision and mission from the viewpoint of content and future research directions for the department were less well articulated. Particularly the synergy between the two groups and the potential strengths and benefits of having them both in one department could be formulated and exploited in a better way. For example, knowledge from different materials and degradation processes could be integrated in product development, but there was little evidence of such joint strategy and joint projects have not been reported. It seems that the department is in two minds as to whether fundamental materials science should be carried out or integration of materials research with design and manufacturing. In the educational programme such integration and quality has been achieved over the past period.

The department's recruitment and replacement strategies have been adequate with a good influx of international tenured professors, an improved gender balance and an increase of technical laboratory staff. Over the period 2011-2013 the grants as percentage of total expenditure was reported to only 27%, which is low compared to other departments. For 2014, however, a significant increase of new projects and newly recruited PhD's has been reported indicating that the vector is in the positive direction.

Follow up from previous evaluations:

Also in 2004 the evaluation committee reported little research interaction between the groups and between individuals. In that period, the department held 4 research groups, which have now been merged into two, which is a good development although further focus or collaboration between individuals within the two groups is still advisable. Integrative challenges like materials selection in the design and manufacturing were mentioned in 2004 as a possibility for the department too. It seems that such integration has been realized in education but not in research. The warning of 2004 as to an uneven age balance for technical staff has been addressed properly.

Recommendations to the department/institution:

- Either focus on joint projects and integration between the two research groups, or start a strategic discussion within NTNU as to whether the materials-related research in this department should be merged or partly merged with the more fundamental materials science elsewhere within NTNU. In the interview it was mentioned that such discussion is ongoing and opinion varies - it should be continued. This rethinking of the structure should be done in relation to upcoming retirements of individuals within the small subgroups.

4.2.5.1. Materials

Description of the research unit:

The group consists of 6 professors, 1 associate professor, 3 part time professors II, 1 postdoc and 18 PhD's. It covers offshore materials with 5 focus areas: composites and polymers, corrosion and corrosion protection, fracture mechanics and fatigue, nano-mechanical testing and modelling, and tribology. The department operates one laboratory that is also used by the materials group and the laboratory is well equipped for the special topics covered by the group. The group has access to external labs in other NTNU departments, SINTEF and abroad.

Strategy, organization and research cooperation:

The strategy of the group is to understand and control damage and degradation mechanisms for mainly off-shore materials. The group covers the wide range of 5 topics by only 6 professors. This means that the subgroups must be small and probably consist of only a single professor with a few PhD's. The ambition is to be excellent in modelling, e.g. FEM and atomistic modelling, as well as experimental testing. The group reports to have a large number of relatively small and diverse projects with interdisciplinary links outside the group. The strategy is to continue this and keep all key research areas in house also after upcoming retirement of two professors. Considering the limited overlapping between professors and the widespread portfolio, it is doubted whether such approach is sustainable for the future. It is recommended to reduce the five focal areas to for example three, to make these subgroups more viable and concentrate other areas within other groups in NTNU and/or SINTEF.

Materials are always related to structures, loadings, products and applications and therefore the group has many interdisciplinary contacts, industrial contacts and participations in larger projects. Results are utilized by industry and two spin-off companies originated from the group. The organization of international seminars and conferences like ECF20 has contributed to the group's international visibility.

Scientific quality and productivity: Grade: 3

The performance of the group within an international context is fair. Ten PhD's have been rewarded in the three years of evaluation. An increasing number of journal papers has been produced both in the field of (multi scale) modelling and experimental work. Citations are fair according to the bibliometric study. As the group relies on a small number of professors with different expertise, the prominence and international status of the group as a whole is not dominant, although recent conference organization and projects improved the visibility.

Societal and industrial relevance and impact: Grade: B

The group clearly serves Norwegian offshore materials industry, proven by a variety of JIP, NRC and EU projects where new applications of polymers and composites, corrosion protection techniques, test methods for hydrogen effects, improved fracture and fatigue models, new surface and wear models have been developed. Two spin-off companies originated from the group and for self-lubricating coatings two patents and an innovation postdoc have been gained.

Recommendations to the research unit:

- A research portfolio of 5 different topics for 6 professors is not viable and sustainable for reaching international excellence at group level. It is recommended to focus and bring down the number of research activities, strengthen those and give them more mass, while developing other area's via other materials-related departments in NTNU and/or SINTEF. The upcoming retirements of two professors in this department and professors in other departments provide an opportunity for such restructuring of materials research.
- Also, it is recommended to investigate whether finite element, atomistic and multi-scale modelling can be shared amongst departments rather than trying to maintain a high level within each small individual group. Educational ties between materials and structure/products groups can be maintained at supra department level.

4.3. University of Agder

4.3.1. Department of Engineering Science

Evaluation Units:

Civil Engineering and Offshore Construction

General comments on the department level:

The department is quite ambitions and is on several issues moving well towards its goals in accordance with the strategic goals of the faculty, in close collaboration with regional industry and with strategic utilization of funding possibilities facilitated by the NRC through SFU, SFI and SFF's.

The research leadership from department level to research group level is not very visible and should be strengthened. There seems to be only little strategic consideration behind the choice of research focus within the department other than personal interests at research group level. Moreover, there is only very moderate real interdisciplinary collaboration across the research groups within the department.

The teaching activities are perceived to occupy a significant part of the available time. Instead of covering all educational topics/courses within the individual educations locally it is recommended to rethink the teaching concepts. This could include the utilization of collaborations with other universities in combination with IT supported teaching concepts as well as rationalization of the thesis project advisory support through topical thesis student group clusters and utilization of student peer groups.

The research groups within the department are relatively small and the group on civil engineering and offshore constructions is sub-critical in size and capacity. This group is critically dependent on its leader, a personality with a strong personal relationship with the local industry as well as many other stakeholders to the group at especially national level. This person is approaching pension and no equivalent successor has been identified why the viability of this group is at risk. It is recommended to take a principle decision with respect to the future of this group to either strengthen it significantly by new faculty, by formalized strategic collaboration at national or international scale - or to close it down.

Follow up from previous evaluations:

The University of Agder was not part of the evaluation carried out by the Research Council in 2004.

Recommendations to the department/institution:

- Establish strategies at faculty, department and research group levels, in coordination with other research and teaching institutions in Norway, with due consideration of short, mid and long term objectives, milestones and performance indicators and with a

targeted balance between focused and interdisciplinary research, teaching, innovation and entrepreneurship.
- Consider rethinking educational concepts such as to utilize collaboration with other and stronger educational institutions at national and international scale as well as IT supported teaching on topics falling beyond the research focus of the department.
- Take principal decision with respect to the future of the research group on civil engineering and offshore constructions. This group must urgently be strengthened to survive.

4.3.1.1. Civil Engineering and Offshore Construction

Description of the research unit:

The civil engineering and offshore construction group is one of three groups under the department of engineering sciences at the University of Agder. The small sized research group is divided into two research units i.e. the structural engineering unit and the sustainable buildings and infrastructure unit.

Strategy, organization and research cooperation:

The strategy for the research unit is expressed in terms of which subject matters the research and activities shall focus rather than how to reach desired objectives or approach challenges.

The size of the research group is presently sub-critical, not least considering the significant teaching responsibilities held by the staff. The group is critically dependent on the networks and reputation of its leader.

Good collaborations have been established between the research unit with research groups and industry at both international and national scale. Several projects with some degree of multi-disciplinarity have been undertaken in contract for industrial stakeholders at European scale.

Interactions on research through international networks, visiting researchers and joint publications with external researchers appear to be at a low but reasonable level compared to the number of staff and available resources.

The researchers are moderately active in national standardization activities.

Scientific quality and productivity: **Grade: 1-2**

For international university standards the scientific quality and productivity is very low.

Societal and industrial relevance and impact: **Grade: D**

The societal relevance and impact at international scale is rather low. Some projects have been undertaken for the industry and this is a good basis for further developments.

Recommendations to the research unit:

- Staff needs more research time – consider rethinking educational concepts such as to utilize collaboration with other and stronger educational institutions at national and international scale as well as IT supported teaching on topics falling beyond the research focus of the department.
- Define objectives for the research in coordination with industry and other research groups at national scale.
- Develop a clear and distinct profile for the research unit compared to other research and education institutions within Norway.

4.4. University of Stavanger

4.4.1. Department of Mechanical and Structural Engineering and Materials Science

Evaluation Units:
Mechanical and Structural Engineering and Materials Sciences

General comments on the department level:
It is stated in the self-evaluation report that there is no research leadership within the department and this is clearly a weak point. Despite a relatively clear idea that a main potential for the department would be related to sub-sea installations the focuses of research groups within the department do not reflect this. Initiatives for new research and on the prioritisation of ongoing research originate from the individual research groups. There are no incentives for collaboration across research groups and interdisciplinary activities across research groups are hardly taking place.

The focuses in research and also teaching of the department has a very strong resemblance with research and educational offers which may be found at NTNU and for the research capacity at national scale it is not obvious what the department aims to contribute with – besides being a partner closer to the industry in Stavanger. It seems not efficient to allocate faculty solely on the basis of a need for teaching. Other options for covering teaching need to be investigated and implemented so that faculty may be strategically selected to promote the strategy on research.

Follow up from previous evaluations:
The department was evaluated in 2004 and it was recommended that initiatives should be taken to strengthen collaboration across the research groups. This did not take place due a wish from the university management to engage in a new activity related to energy research and teaching.

Recommendations to the department/institution:
- Consider to focus research on fewer topics with less overlap with other Norwegian universities and a higher potential for excellence and impact.
- Identify approaches for teaching which do not necessitate dedicated faculty across all topics of teaching.
- Do not employ faculty by a replacement strategy – but instead with consideration of the needs of the department in the long run, the potential for excellence as well as research leadership in general.

4.4.1.1. Mechanical and Structural Engineering and Materials Sciences

Description of the research unit:

The research group comprises 13 professors working in the areas related to marine technology, industrial assets management, offshore wind, mechanical engineering, structural engineering and materials science. Besides research the department has the responsibility to provide resources for the teaching on the educations constructions and materials, offshore technology – assets management and offshore technology – marine and sub-sea technology. The target teaching workload is around 10-20 ECTS point per faculty per year (each member has to lecture two courses per year).

Strategy, organization and research cooperation:

A coherent strategy for the development and focusing of the departments activities has not been formulated and implemented. The latest external research review of the department recommended that cross-going activities over the research groups of the department should be established, however, this has not been done as of yet. There is a strong declared focus on increase of scientific production as well on acquisition of external funding. This has to a large extent been accomplished.

The department is informally organised into three research groups (although confusingly it is indicated in the organisation diagram that there are four), i.e. mechanical engineering, offshore technology and civil engineering. Their sizes in terms of professors are 4.5, 5.5 and 3.2 respectively, i.e. relatively small groups. Each of these groups has sub-groups with 2-"several" focus areas. This partly appears overwhelmingly distributed and does not provide critical mass to several of the research areas.

Recruitment appears difficult but more recently three new faculty members have been gained. There is no specific gender policy besides active encouragement for women to apply for all open positions. Replacement rather than strategic selection seems to be the main model.

The research groups within the department are well connected at the national level and collaborate in several projects. Moreover, they are well connected through international networks and exchanges of guest researchers and teachers.

The research focuses are strongly driven by industrial needs and personal interactions with local industrial stakeholders.

Scientific quality and productivity: **Grade: 2**

The present assessment takes basis in an evaluation of the entire department as a whole and does not pay justice to the variability over the different research sub-groups within the department. However with this mentioned the department is doing relatively well at an international scale.

Societal and industrial relevance and impact: Grade: C

The department has a strong relation with local industry and contributes to this actively. Considering the strong wish of the university to promote entrepreneurial activities the department could do much better.

Recommendations to the research unit:

- Mobilize all researchers to contribute to high quality publishing.
- Achieve synergy across the various research groups.
- Establish stronger links and coordination both with respect to research and teaching with other universities in Norway and abroad.
- Rethink teaching approaches – using IT support, collaborations between universities within Norway and new schemes for thesis project advisory support.

4.5. Østfold University College

Evaluation Units:
Engineering

General comments on the department level:
The Faculty of Engineering at Østfold University College has 500 students. The college offers BSc within biomedical, civil, electrical, chemistry, mechanical engineering and industrial design; additionally innovation and project management. The faculty is led by the Dean, the International Coordinator is managing formal international relations, the Study Leader is in charge of all the studies offered at the faculty, and in 2013 the Research Coordinator became Research Leader and responsible for all research activities of the faculty. The Research Leader is now part of the senior management together with the Dean. These changes in research organization have been made in order to increase the research activities.

Research activities at Østfold University College have traditionally been very low and the research groups established in 2013 are still in a start-up phase. Only 6% of the permanent staff is professors, the rest of the permanent academic staff is divided equally between associate professors and assistant professors. More than 1/3 of the staff is 60 years or older.

Østfold does not have any major research infrastructure.

About 40 % of the staff within engineering is women.

During the interview the Dean expressed that Østfold University College is one of few colleges which want to remain college i.e. does not want to become a university. Nevertheless, the college has external pressure to establish research activities.

Follow up from previous evaluations:
Østfold University College was not part of the evaluation carried out by the Norwegian Research Council in 2004.

Recommendations to the institution:
- The panel does not recommend to establish new research units at university colleges

4.5.1.1. Engineering

Description of the research unit:
The self-evaluation report contains CVs for 13 faculty members (out of a total staff of 60). Østfold has in the fall of 2013 established five different research areas within engineering: Smart Energy, Biomedical Technology, Innovation Processes and Online Teaching, Atmosphere Physics, and Buildings and Environment Group.

Recently, Østfold has received significant funding for a cooperation project: ”Micro-encapsulated phase change materials in concrete”

Strategy, organization and research cooperation:

The research leader is participating in all research groups and is at the same time part of the senior management of the faculty. This may be a good idea considering the limited research experience of the groups. But it may also reduce the time the research leader has available for own research and her possibility to build a strong group of her own.

Østfold University College has not recruited sufficient new qualified researchers to the academic staff who can lift the scientific quality and productivity and at the same time attract external funding. Here it could be helpful to have a formal cooperation with a Norwegian university for MSc, PhD education and for research training of the staff. But such a link has not been established.

Scientific quality and productivity: Grade: 1

The staff includes one person, the research leader, with an excellent research background, and five with proven research experience. With this limited staff Østfold has established a very high number of research topics.

By all measures the research productivity is very low. During the period 2009-2013 the 13 persons produced 17 publications and the publications indexed in NCR only received 6 citations. This may be understandable when the majority of the staff have been employed without an obligation to do research.

To change the situation with the existing academic staff may be difficult due to the relatively high average age. After many years with a fulltime teaching obligation it is often difficult to start doing research with the normal scientific quality and productivity requirements, even if the time for research is allocated. For those persons on the staff who has a real desire to do research as part of their job it could be a solution to engage in formal cooperation with an established university.

Societal and industrial relevance and impact: Grade: D

The research topics are all relevant and a large number of B.Sc. exam projects are made as cooperation projects with the local industry. But the impact in the scientific arena is limited and the staff does not seem to have much research cooperation with neither national nor local industrial partners

Recommendations to the research unit:

- Provided Østfold University College has to pursue a research path, then it is recommended to establish a formal cooperation with a Norwegian University for training of Ph.D. students and for gaining research experience for the staff.

4.6. MARINTEK Norwegian Marine Technology Research Institute

Evaluation Units:

Hydrodynamic Modelling
Structural Engineering
Seakeeping and Control

General comments on the department level:

MARINTEK is a not for profit company in the SINTEF group which performs research and development for companies in the field of marine technology. The activities are organized in five departments: Marine Transport Systems, Energy Systems and Technical Operation, Ship Technology, Offshore Hydrodynamics, and Structural Engineering. Each of these departments is led by a research director and operates a laboratory specialized to the subject. Altogether 197 people from 24 nations work within MARINTEK.

The Institute is situated at the Marine Technology Centre together with the NTNU Department of Marine Technology.

MARINTEK has a close and formal cooperation with NTNU's Department of Marine Technology and has been active in the SFF (Centre of Excellence) project CeSOS and is now active in AMOS.

MARINTEK has demonstrated a significant technical capability when comparing to similar research institutes around the world. This is also confirmed by the customer satisfaction which again has led to a sound financial situation for the company.

To some extent MARINTEK serves as an entity where the more basic research results from NTNU can be translated into applications for the industry.

Together with NTNU, MARINTEK is in a process with the Norwegian Ministries to develop a new major research infrastructure, Ocean Space Centre, which shall expand the existing facilities and have functional capabilities to meet the future challenges.

Follow up from previous evaluations:

MARINTEK was not part of the evaluation carried out by the Research Council in 2004.

Recommendation to the institution:

- MARINTEK, like many institutes of its type, comprises a particular blend of capabilities involving computational methods, experimental facilities and experience. In order to survive all the components are needed. For this reason it is important that the experimental facilities are constantly updated.
- It is also important that the scientific level and visibility within the different business areas are enhanced by publications in respected journals.

- The strategy of the involvement of the different groups towards the new ocean space lab is not clearly outlined. Effort should be made towards a dedicated profile for this new situation and taking advantage of the opportunities.

4.6.1.1. Hydrodynamic Modelling

Description of the research unit:

The group on hydrodynamics modelling is a research group within the larger department for offshore hydrodynamics at MARINTEK. The department at a whole comprises of a personell of 61, whereas the hydrodynamic modelling group has 12 members that delivered a CV. The group has access to the model testing facilities and works hand in hand with the expert studies group. On a department level there are close bonds with the NTNU department of Marine technology due to numerous mutual projects and shared lab facilities.

Strategy, organization and research cooperation:

The strategy of the group is the development of models in the following fields: numerical hydrodynamics, ocean wave modelling, vortex induced vibrations and motion as well as advanced experimental methods. The projects are mostly applied research or contracted studies on both a national and international level. There is close research cooperation with NTNU and also internationally e.g., in EU projects. The group is instrumental in the activities around the planned Ocean Space Centre.

Scientific quality and productivity: **Grade: 3**

The group has a high scientific quality and also potential for high productivity. However, due to the internal focus within MARINTEK on clients' needs and the lower priority towards scientific output also the publication record is slightly less as possible. The group makes efforts to increase the productivity, but there is a traditional focus on publishing at conferences, where clients can access the information easily. Overall the scientific performance is par to international standard.

Societal and industrial relevance and impact: **Grade: B**

The group has a healthy relevance and impact. The scientific merits and achievements are internationally known and acknowledged. Likewise the group has a national reputation and is instrumental in the activities of the department. The group is developing and releasing novel computational tools. The group is of high relevance to the Norwegian maritime technology.

Recommendations to the research unit:

- The group has more potential with respect to scientific productivity. More efforts should be given to publications in highly ranked journals.

4.6.1.2. Structural Engineering

Description of the research unit:
The research work of this section within MARINTEK is divided into the following application areas: Marine structures; Risers and umbilicals; Offshore pipelines; and Laboratory testing. The academic staff consists of 17 members.

Strategy, organization and research cooperation:
The focus is on problem solutions and on application driven research programs. The self-evaluation report does not present a clear technology plan and direction for the future of the structural engineering group.

Through the cooperation with industry the group has a good overview of needed research and the group has expressed that the internally initiated research work shall focus on both competence building and industry value. The research objectives are results of a largely bottom-up driven process and establishing what is available from various contract activities and then endeavouring to make something of wider value out of it.

The Structural Engineering group has close links with other SINTEF institutes and with the Department of Marine Structures at NTNU where the Department of Structural Engineering was involved with the completed SFF program CeSOS and with the newly started AMOS. A special role of the group is software development with scientific input from NTNU.

Scientific quality and productivity: **Grade: 2**
In general MARINTEK has a good reputation and is ranked very well in comparison with other contemporary marine technology institutes around the world. This group has special focus on enforcing links between analysis, structural testing and software development which can enable the use of small scale testing.

Due to the commercial nature of the work it is difficult to judge the research performed by this unit using the same criteria as used for university sections. The commercial projects undertaken by the group are often classified as confidential.

The staff has quite few journal publications originating from work performed at the department and seen in relation to other SINTEF groups the Department of Structural Engineering has relatively few citations. Most of the publications are at International Conferences on Offshore Mechanics and Arctic engineering (OMAE).

Societal and industrial relevance and impact: **Grade: A-B**
The focus is on slender offshore structures, and the main marked for the research group is the international oil and gas industry. The relevance of the applied research work is demonstrated by the number of international joint industry projects the group is invited to participate in.

One significant result of the knowledge generated by the Department on slender structures has been compiled in a “Handbook on Design and Operation of Flexible Pipes” which has been made available to industry and universities.

Recommendations to the research unit:

- Formulate a technology plan and direction for the future of the structural engineering group in connection with the establishment of the new Ocean Space Center.
- Increase the effort to publish a significant number of scientific articles with high impact and connect such merits to the career system in order to improve recruitment.

4.6.1.3. Seakeeping and Control

Description of the research unit:

This group aims to form an internationally leading independent research group covering seakeeping, dynamic positioning and marine operations in more general terms. Setting social responsibility in focus the research group aims to provide competitive advantages to its clients through innovation and development. The group comprises 11 researchers of broad geographical origin, two are female and all have a PhD degree.

Strategy, organization and research cooperation:

The group focuses on applied research conducted and published on the premises of the clients, i.e. the industry. Publication activities from applied research need to be approved by and be in line with the policy of the customers. Thus it is unlikely that publication activities will be (re-)directed towards high ranked ISI journals. PhD students are engaged into research and development projects but usually in collaboration projects involving NTNU, which is why the research production arising from these are not counted as primarily originating from MARINTEK research. However, such activities give rise to some co-authorship between the group and NTNU.

Some ideas with respect to the possibility to develop capabilities within supercomputing and CFD modelling have been developed but in a rather preliminary form. Potentials for future research and developments related to future activities at sea such as deep sea mining are realized but no initiatives have been taken so far and knowledge about the position of other MARINTEK units in this respect is not available.

In terms of size and organisation the group appears well suited for its purposes and functions within MARINTEK. The group predominantly acquires its projects independently from the other MARINTEK groups but also engages into collaborative projects when feasible. The group has clearly defined and almost standardized tests and software products which it offers its clients at competitive rates. The group has a good appreciation of the other main actors in the market. The group actively engages into collaborative projects at both international and national scale in the form of JIPs, NRC funded projects as well as EU funded projects. However EU funded projects are considered to be work intensive and less attractive for the working mode of the group.

The group sees great potential in the upcoming Ocean Space Centre facilities but has concerns regarding access to the facility for projects with low ability to pay the high infrastructure costs.

Recruitment of staff is in general successful. Focus in this respect is directed on achieving quality rather than on nationality or gender. However, within this perspective it has recently been accomplished to attract two new female colleagues.

Scientific quality and productivity: Grade: 2

The group members all have a basic research education and recently the group has been strengthened by PostDoc students as well. Moreover, the group counts a faculty member of NTNU. The scientific production of the group is, however, rather moderate; in full consistency with the stated objectives and ambitions of the group which aims for publications of applied nature predominantly presented at industry oriented conferences. The group has a strong history and capacity to collaborate with experts from other related engineering fields.

Societal and industrial relevance and impact: Grade: C-B

The impact of the group is rather high, not least due to the proven high quality services developed and optimized over a longer period of time. The group is highly respected for its competences and services within its main field of activity, is keen to disseminate its results and best practises and clearly provides added value both to the industry and public authorities. The group has the potential to engage more proactively to the further development of its research fields and services and this not least in the context of innovation and entrepreneurship.

Recommendations to the research unit:

- Develop a more clear strategy for research and services for the group itself – of course subject to possible boundary conditions imposed by the strategy of MARINTEK as a whole
- Identify and implement targeted strategy and incentives to benefit from the 30% of the total time which is available for scientific production
- Realize and utilize potentials for nurturing and promoting entrepreneurship in connection with PhD and PostDoc activities
- Take benefit from EU funding schemes

4.7. NGI Norwegian Geotechnical Institute

NGI is non-profit organisation undertaking applied research and consulting in the market areas offshore energy, building, construction and transportation, natural hazards and environmental engineering. NGI was originally founded by the NRC in 1953 and later reorganised into a private foundation operating within the Norwegian institute sector. Only a small part (5.94% in 2014) of the funding for NGI originates from the base funding from NRC. The rest is coming from R&D and consulting for the industry and public authorities together with JIPs and NRC and EU R&D funding frameworks. Presently NGI has 220 permanent staff of broad international representation of which 69 are women and a total of 60 hold a PhD.

Evaluation Units:

Computational Geomechanics
Geosurveys
Water and resources

General comments on the department level:

NGI establishes its overall strategy as well as research strategies at institute level for four year periods and these strategies form the basis for the strategies and actions in the market areas and research units. NGI has a strong research leadership with a focus on finding a balanced approach to develop their market and at the same time expanding and deepening excellence within the organisation; an issue which should be kept in focus by the management as a key parameter for the sustained success of NGI. Risk assessment and risk based decision making has been increasingly introduced as a part of NGI research and provides a strong common denominator for it services.

NGI appears to have a targeted strategic and active approach to engage in the research centres facilitated by the NRC, the International Centre for Geohazards (ICG) being a good example. The staff of NGI is actively encouraged to engage into publishing, PhD projects are sponsored internally (overall goal to reach 30% PhD of all staff) and internal funding is also allocated strategically to facilitate engagement and participation in collaborative research and development projects. The research leadership with respect to innovation, entrepreneurship and IPR, appears to be appropriate and viable building on openness, collaborations with external stakeholders and sufficient maintenance of legal rights to maintain excellence in services.

The base for recruitment of staff is broad international providing a good platform for the continuous development and strengthening research capacity. With more than 30% of the employees coming from outside of Norway the staff indirectly also provides a strong network to research organisations and institutions abroad. The staff at NGI has a high level of expertise and also market understanding. It is not evident how this knowledge platform is

utilized in setting the strategic direction of the development of NGI. However, it is evident that the strategic approach of NGI has proven itself over the years.

Two issues for consideration are related to 1) a possible critical dependency of interactions and collaborations between researchers at the Norwegian universities and NGI personnel and 2) the ability to move fast enough in addressing contemporary and future societal challenges. With respect to 1) it could be suggested to expand on direct collaborations with the research groups to which NGI has contacts with through its foreign employees. With respect to 2) a possibly even more aggressive strategy to formulate and/or enter research centre collaborations and possible also a strategic increased utilization of internal funding could be possibilities.

Follow up from previous evaluations:

NGI was not part of the evaluation carried out by the Research Council in 2004.

Recommendations to the department/institution:

- Continue strong collaborations with Norwegian universities, but expand similar collaborations within the international networks represented by the international staff of NGI.
- Engage in a more aggressive approach to develop excellence and market areas addressing societal challenges.
- Possibly a more targeted and direct approach to engagement of the staff of NGI in the strategic decision making at all levels could be beneficial.
- Continue to strengthen research and capacity on risk assessment and use this more aggressively as basis for increased consulting for international and supra-national client organisations.

4.7.1.1. Computational Geomechanics

Description of the research unit:

The research group on computational geomechanics is comprised by 15 researchers, of which three hold a professor II position, nine have a PhD degree and one is presently a PhD student. The focus of the research group is directed on computational aspects of modelling and analyses of soils and soil-structure systems, dynamics of soil and rock and earthquake engineering and tsunami modelling. Each of the three focus areas has been assigned a dedicated discipline leader.

Strategy, organization and research cooperation:

The strategy for the development of research and consulting as well as for the development of specialized analysis tools, builds upon the close interrelation with clients from the industry and an understanding of their needs in the mid to long term. This may be a somewhat conservative approach with limitations on the engagement in new fields and services. Funding through JIPs and EU projects is recognized as a strategic instrument to provide leverage to

boost the group's capacity for research, however, by nature such an approach will be moving relatively slowly forwards.

This strategy is and has clearly been viable so far, but the question is whether a more ambitious and aggressive approach to address societal challenges related to e.g. climate change mitigation/adaptation, deep sea mining and fracking, as well as consulting to the insurance industry, advise services to supranational organisations, could enhance the impact and the groups as well as NGI as a whole.

The research team has a strong dedication to excel within their fields of expertise and are engaged in publishing in high quality journals, present at selected conferences and to disseminate to the wider public through public and popular media. This approach seems appropriate and successful.

The research team has a good track record of interacting and collaborating with other experts within and around their fields of expertise both at national and international levels.

The research group has strong relations with relevant research groups at NTNU. These relations have been instrumental for the success of the group. It is not granted that such a model will continue to provide the same benefit in the future and the research group is encouraged to seek similar strong relations to other university research groups internationally. This could be facilitated through the international staff members of the group.

Scientific quality and productivity: Grade: 3-4

The group has a good publication activity and has a strong reputation at international level.

Societal and industrial relevance and impact: Grade: B

Lead of EU projects, tool developments, engagement in codes and standardization work, engagement in conferences, journal editorships, dissemination in public media, etc.

Recommendations to the research unit:

- Consider more aggressive proactive preparation and marketing of services addressing societal challenges; climate change/adaptation, raw materials from deep sea, raw materials exploitation in sensitive environments, risk and sustainability based decision support advise at high level (insurance, UN, World Bank, etc.).
- Link up with relevant high level research networks to enter new levels of client contact.
- Ensure continued benefit from collaboration with top class universities at international scale.
- Develop and implement more clear approaches to secure technology transfer to industry – based on win-win considerations. Dedicated transfer tasks in projects involving industry collaboration should be utilized.

4.7.1.2. Geosurveys

Description of the research unit:

The "Geosurveys" group consists of 13 persons, including 1 postdoctoral fellow and 2 affiliated researchers with year-by-year contracts. Of the 13, there are 8 with PhD (including the two affiliated researchers) and 5 researchers without doctoral degree. Research and development focuses on implementing emerging, new methods within geoscience consulting in Norway and partly internationally. The section is segmented in three different disciplines:

- Geographic information systems (GIS)
- Remote sensing (RS)
- Geophysics (GP)

Strategy, organization and research cooperation:

The group is operating following the strategic plans of the division, with main focus on industrially applied research and consulting. They have a good cooperation with other groups in NGI, providing internal services with the developed sensing techniques. Although the group is of very small size (maybe even sub-critical size), they are well organized, and have a good view on new developments in their own field. The strategy of the group is to be 'better', not to be 'cheaper' than the commercial consultants. They see rather a role in transfer of knowledge towards other consultants.

Scientific quality and productivity: **Grade: 3**

The scientific quality of the group is good, with a fair productivity, and a potential for further growth. Although the group has to focus rather on consulting and applied projects, the development of new techniques opens up the possibility to publish new results in this respect. The incentive towards publishing, as installed by the institution, is helpful. In the area of Geophysics, they have good international cooperation. The overall scientific performance is at international standard level.

Societal and industrial relevance and impact: **Grade: B**

The societal impact and relevance of the group is considered to be at a very good level. They contribute to many projects, and can even be seen as 'trainers' of commercial consultants. In this respect, their development of new or improved sensing techniques is to be mentioned. Furthermore, they are a relevant partner for the road authorities, e.g. related to rock fall and landslides. The impact could be further improved by cooperating with the NGU (Norwegian Geological Survey).

Recommendations to the research unit:

- The group is recommended to remain dynamic and active. It could be envisaged to aim for some part-time guest positions at a partner university.
- It is recommended to further explore the possibilities of patents linked to newly developed sensing techniques
- Check possible cooperation with NGU (Norwegian Geological Survey)

4.7.1.3. Water and Resources

Description of the research unit:

The group resulted from a reorganisation of the larger department of environmental engineering in 2012. The section of water and resources comprises 14 staff members, including 2 technicians and one postdoctoral fellow. Of the 14, 6 have PhD, and two of these have Prof. II positions at universities. NGI provides lab facilities in the area of contaminant fate and transport, which is in the core focus of the research activities of the group.

Strategy, organization and research cooperation:

Despite its name, the group is focusing on a narrow section within the huge field of water and resources that is on risk reduction in relation to contamination to the geo-environment. This is according to the central focus of NGI. Specific emphasis is given to passive sampling and contamination of soil and sediment. The group is able to balance the activities approximately equally between contract work and applied research. This allows the group to take part in a large amount of national and international research projects with significant outreach. There is also a close collaboration with the University of Oslo – Department of Geosciences.

Scientific quality and productivity: **Grade: 4**

The research is of high quality and the output in terms of papers is significant. The group is consistently publishing in top level journals (e.g. ES&T) and the key members have a very healthy publication record in terms of h-index. Likewise the group has a documented impact in international organisations. Even when taking into account the higher emphasis towards publications in the specific research area, the performance of the group is very good and well above the international standard.

Societal and industrial relevance and impact: **Grade: B**

The high relevance and the impact of the group is documented by both international projects and high end consultancy at a national level. The group is instrumental in the promotion of the field, as well as in continuous education (courses) and as scientific advisor in relevant problem areas (e.g. cleaning of shooting ranges).

Recommendations to the research unit:

- The group should take measures to maintain its very positive example of scientific expertise and activity within the economic boundaries of a research institution.

4.8. SINTEF Building and Infrastructure

4.8.1. SINTEF Building and Infrastructure

Evaluation Units:

Building Physics Group
Concrete

General comments on the department level:

SINTEF Building and Infrastructure is one of eight research institutes within the SINTEF Group. SINTEF Building and Infrastructure was established as a merger of Norwegian Building Research Institute and the building and infrastructure departments at SINTEF in 2006. The institute is organized in 5 departments (3 of which are research departments), totalling about 230 employees.

Each research department is led by a research director. The research departments consist of several research groups, led by research managers. The organization of the research groups within the institution is somewhat diffuse, with researchers working in different departments, headed by different research directors. As an example, the Building Physics Research group is part of all three research departments (Energy and Architecture, Infrastructure, and Materials and Structures).

SINTEF Building and Infrastructure has a very close cooperation with NTNU in Trondheim. They share research infrastructure, and even have common staff members. Both institutes seem to work on basis research projects as well as on industrially applied research. As such, there is no clearly defined separation of assignments of SINTEF and NTNU in this research domain.

The general vision of SINTEF is “Technology for a better society”. This general motto is further detailed in some strategic priority areas of research of SINTEF Building and Infrastructure, namely Energy efficiency and renewable energy, Environmental technology, Adaptation to the climate change – building and infrastructure, and Clean water. The institute is performing well in finding research budgets to achieve the main goals, including European funding.

Follow up from previous evaluations:

SINTEF Building and Infrastructure was not part of the evaluation carried out by the Research Council in 2004.

Recommendations to the department/institution:

- Reconsider the structure or organization of the research group within the institution. Research groups are part of more than one research department, each with different research directors. The structure is somewhat diffuse and unclear.

- Evaluate and reconsider the positioning and roles of NTNU and SINTEF in this research domain, and try to come to a consistent strategy and separation of assignments well-known to everyone involved.

4.8.1.1. Building Physics Group

Description of the research unit:

The building physics researchers are organized in the departments of Materials and Structures and Energy and Architecture of SINTEF Building and Infrastructure. There are 18 researchers in the building physics group, three of which have also a part time position as professor at NTNU. Ten of the researchers have a PhD and three more researchers are currently carrying out PhD studies at NTNU but are also contributing to the research in the group. The main competence areas of the building physics group are:

- Energy performance of buildings
- Heat and moisture transport in building components and materials
- Building materials
- Climate adaption of buildings
- Acoustics and vibrations

Strategy, organization and research cooperation:

The Building Physics Research Group is following the strategic guidelines defined at the level of the institution, focussing on topics such as energy efficiency and renewable energy production. The specific projects depend on the funding from the industrial partners. The overall mission is “Science and technology for a better society”, with no specific goal on e.g. publications. The organization of the group within the institution is somewhat diffuse, with researchers working in different departments, headed by different research directors. There is a close cooperation with NTNU, however with no clearly defined separation of assignments. The Building Physics research group has some international cooperation, e.g. with Fraunhofer Institute.

Scientific quality and productivity: **Grade: 2-3**

The scientific output of the Building Physics research group is limited, and is often in cooperation with other groups, mainly from NTNU. Although the group is internationally active, mainly within the Nordic region, the group is not very visible and not well-known at the international level within the field. The scientific quality and productivity can be considered as fair to standard.

Societal and industrial relevance and impact: **Grade: B**

The Building Physics research group has a very good outreach on the national Norwegian level. The main contribution is the production of ‘design sheets’, explaining how to execute specific construction elements and details in an appropriate way, following the state-of-the-art. This is very relevant, mainly to architects. The ‘design sheets’ have become some kind of standard documents within Norway.

Recommendations to the research unit:

- The group is encouraged to continue and even strengthen the production of design sheets, as they are of major importance for the Norwegian society and industry.
- Reconsider the structure or organization of the research group within the institution.
- Evaluate and reconsider the positioning and roles of NTNU and SINTEF, and try to come to a consistent strategy and separation of assignments well-known to everyone involved.

4.8.1.2. Concrete

Description of the research unit:

The concrete researchers are organized in the departments Materials and Structures, Infrastructure and Energy and Architecture. There are 22 researchers in the Concrete Group. Three researchers are having part time positions in SINTEF, and in addition two of the researchers have a period of leave due to finalizing a PhD at NTNU. In addition, eight laboratory technicians/engineers are carrying out most of the laboratory work in ongoing projects. 15 of the researchers have a PhD. The core competence of the group is within utilization of concrete as a material, and the main competence areas are as follows:

- Concrete technology and concrete structures
- Materials technology and chemistry
- Resource and engineering geology
- Durability and rehabilitation
- Sustainability, resource utilization and environment

Strategy, organization and research cooperation:

The Concrete Group is following the strategic guidelines defined at the level of the institution. Fundamental research is not within the focus, unless paid for, or within the scope of an industrial research project. The organization of the group within the institution is somewhat diffuse, with researchers working in different departments, headed by different research directors. There is a close cooperation with NTNU, however with no clearly defined separation of assignments. The Concrete research group has some international cooperation, with participation in European networks (e.g. Nanocem).

Scientific quality and productivity: Grade: 3

The scientific output of the Concrete Group is good, with relatively good impact, as illustrated by the publication report. The group is internationally well active, and is well recognized for the scientific contribution to the materials science of cementitious materials. The group is involved in the organization of a series of relevant international conferences related to durability and concrete innovation. The scientific quality and productivity of the entire group is at a standard level.

Societal and industrial relevance and impact: Grade: C-B

The Concrete group, in close cooperation with the NTNU Concrete Group, has a clear impact on the Norwegian society and industry. The COIN centre was an important initiative in the recent years, coordinating many efforts in a clear and visible way, with significant outreach. As this COIN centre has now come to an end, the challenge is to find an adequate follow-up initiative. Overall, the societal and industrial relevance and impact of the 'Concrete' Group is slightly above standard.

Recommendations to the research unit:

- The group is encouraged to have an increased involvement in international (European) projects and networks.
- Reconsider the structure or organization of the research group within the institution.
- Evaluate and reconsider the positioning and roles of NTNU and SINTEF, and try to come to a consistent strategy and separation of assignments well-known to everyone involved.

4.9. SINTEF Materials and Chemistry

4.9.1. SINTEF Materials and Chemistry

Evaluation Units:

Material and Structural Mechanics

General comments on the department level:

SINTEF Materials and Chemistry is one of eight research institutes within the SINTEF Group. The institute is sub-divided into six research sectors, one of these is Materials and Nanotechnology.This sector has six departments: materials physics, polymer chemistry, polymer and composite materials, materials integrity and welding, material and structural mechanics, nano and hybrid materials. The department Material and Structural Mechanics is the only one participating in this evaluation.

The overall vision, mission and ambition of the institute are clear and in line with those for SINTEF overall, with a strategic plan-act-evaluate loop. However, the document was rather generic in nature. While the list of disciplines was clear and concrete, covering 13 competence areas, the list of market opportunities was less well articulated and an elaboration as to what interactions and combinations of departments serve what markets could be further developed in this, re-organized institute.

The institute was reorganized in 2013 into a matrix, with disciplines versus markets, capacity versus projects, department heads/research directors versus project leaders. Such matrix organisation is seen more often. The set-up intends to stimulate cross-disciplinary research and cross-disciplinary service to the industry. In the self-assessment there was not yet a clear demonstration of cross-disciplinary projects, successes and interactions over the departments. Hence, after say five years, it is recommended to evaluate this matrix structure and whether targets in terms of better cross-disciplinary service to industry have been met.

The above would also clarify the different roles for SINTEF and Universities. Scientists at universities are allowed or even encouraged to be individuals going deep within a narrow area, while the strength of SINTEF would be integration and collaboration in multi-faceted teams. Such clarification between roles of SINTEF and universities could be made sharper. A positive example of clear roles is that parts of SINTEF Materials and Chemistry focus on software development, transfer of complex knowledge into practical tools, while NTNU focuses on fundamental research, which is mutually beneficial.

The Institute reports an increasing percentage of EC and other international funds for 2013 as compared to 2011 and 2012 (growth from 8% to 15% as percentage of total expenditures). This indicates that actions correlate with the strategy to become more internationally oriented. International excellence is gained in only a limited subset of fields, e.g. solar cell materials, lightweight metals/aluminium (together with NTNU), while at other areas a more a more national follower role is taken, which is a realistic strategy.

The Institute has to deal with dynamics in terms of personnel flowing in the innovation triangle, from university to SINTEF to industry. Hence, good contacts with universities are important and the department invests in that, to keep its level of fundamental knowledge up to date.

Follow up from previous evaluations:

SINTEF Materials and chemistry was not part of the evaluation carried out by the Research Council in 2004.

Recommendations to the department/institution:

- Set targets for, promote and evaluate interdisciplinary actions, in relation to matrix organization.
- Further clarify roles and sharpen position in innovation triangle universities – SINTEF institute – industry. Exploit strengths like software development, transfer of knowledge into practical tools, development of materials solutions to customers, rather than trying to duplicate scientific curiosity driven research at universities.
- Further develop a more balanced portfolio with new markets, already in progress.

4.9.1.1. Material and Structural Mechanics

Description of the research unit:

The department holds 14 employees with expertise in mechanics, computational materials science, multi-scale and particle modelling, solution techniques, experimental-numerical calibration and software development. The department is young and new with 11 out of 14 team members being recruited in the period 2009-2013. The department was the only department selected by the institute for this assessment, as it was seen as one of the most scientifically oriented groups.

Strategy, organization and research cooperation:

In the past, the group was closely identified with the Structural Impact Laboratory, the scientific drivers of which were at NTNU. It played an important role in the successful CRI SIMLab application. The SIMLab group at NTNU has been evaluated separately. The strong point of the SINTEF group was and is the robust numerical implementation of constitutive models in finite element codes, with focus on software development. This is a clear role that fits SINTEF well and is complementary to the scientific curiosity at the university. The group consolidates new knowledge in computer codes, so that it can be utilized and disseminated. Later, the strategy was to strengthen and professionalize this software development competence and make it more generic, i.e. apply it to new markets, e.g. hard-rock drilling and geothermal energy in addition to the SIMLab toolbox market, which then also provides an independent identity to the group. So, there is a strategy, it is good and it is also implemented.

From an HRM perspective, there is some confusion. Success factors seem to be defined in terms of scientific journal publication points, PhD supervision, citation indexes. These factors only partially adhere to SINTEF and it is advised to stronger include other outputs and

competences like software development as success factors in the personnel strategy. This can help to manage the expectations for new personnel, reduce disappointments as were reported in the documentation and improve continuity and viability of the team.

The portfolio is mainly nationally oriented. The group collaborates within the larger SINTEF organization by spreading, co-developing and sharing models and toolboxes with other departments. The international context, though, could be strengthened e.g. by focusing more on EU projects.

Scientific quality and productivity: Grade: 3

A strong point is the prestigious RCN young scientist talent award for multi-scale modelling of aluminium alloys in the group. The scientific publications of the group are often co-productions with NTNU, from collaborations, previous appointments, or from previous team members that left. This list is not impressive. Indirectly, however, the group contributes to the scientific quality and productivity of SIMLab. In terms of SINTEF's mission, the 'publications' of the group are robust and efficient software simulation tools and 'citations' should be measured in terms of the number of end users that apply these tools to practical materials development. As such, the output in terms of quantity and quality is good.

Societal and industrial relevance and impact: Grade: C

The results in terms of validated tools and models for materials development are applied to the SIMLab markets and to an increasing number of other markets, where they have impact.

Recommendations to the research unit:

- Further strengthen the profile and identity in high calibre software development and dissemination, as such role fits SINTEF well and is complementary to the university role.
- Include those competences in the personnel strategy, in addition to pure scientific competences. Improve viability and stability of the team.
- Improve the international orientation.

5. Mandate for the review

5.1. Terms of reference

Introduction

The Ministry of Education and Research has assigned the task of performing subject-specific evaluations to the Research Council of Norway (RCN). The Division of Science has decided to evaluate basic research within engineering science in universities, university colleges and relevant research institutes during 2014.

The previous evaluation of the research in engineering science was carried out in 2004.

The objective of the evaluation

The objective of this evaluation is to review the overall state of basic and long term research in engineering science in Norwegian universities, university colleges and relevant contract research institutes. The evaluation shall provide knowledge and recommendations for future development of basic research within engineering science in Norway, and lay the foundation for determining future priorities, including funding priorities, within and between individual fields of research.

For the institutions that are evaluated, the evaluation will provide knowledge, advice and recommendations that can be used to enhance their own research standards. For the RCN the evaluation will contribute to an improved knowledge base that is used when giving advice on research policies to the Norwegian Government.

Specifically, the evaluation is expected to:

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

Organization and methods

The evaluation will be carried out by an international Evaluation Committee consisting of three sub-panels. Each panel will carry out the evaluation in their field of expertise.

- Energy and process technology
- Product, Production, Project management, Marine systems and Renewable energy
- Civil Engineering and Marine structures

The panels will base their evaluation on self-assessments provided by the departments/research groups, a bibliometric analysis provided by the Research Council, as well as on interviews and presentations given in meetings with the involved departments/research groups. The self-assessments from the institutions will include factual information about the organisation and resources, future plans, CVs, and publication lists of their scientific staff.

The panels are requested to present its findings in written reports. Preliminary reports will be sent to the departments/research groups included in the evaluation for a assessment of the factual information. The Committee's final reports will be submitted to the Board of the Division for Science for final approval.

The principal evaluation committee will consist of the leader and one member from each sub-panel.

Tasks of the evaluation sub-panels

The panels are requested to

- Evaluate research activities with respect to scientific quality, national and international collaboration. The evaluation shall focus on research that are/can be published in peer-reviewed publications and conferences. Contract research with restricted public access to the results is not included in this evaluation.
- Evaluate the relevance and impact of the evaluated research activities.
- Evaluate how the research is organized and managed.
- Submit a report with specific recommendations for the future development of research within engineering science, including means of improvement when required.

Aspects to be addressed in the sub-panel reports:

1. National aspects

- Strengths and weaknesses of Norwegian Engineering Science research in an international context
- Impact and relevance of the evaluated research with regard to the future needs of national and international business- and public sectors
- The impact of national excellence centres (SFF, SFI, FME, NCE, ..) on scientific quality and societal impact and relevance.

- Research cooperation nationally and internationally
- General resource situation regarding funding and infrastructure
- Training, recruitment, gender balance and mobility
- Any other important aspects for consideration

2. Institutions/departments

- Does the institution/department have an overall research strategy which feeds into the individual research group strategy?
- Is research leadership being exercised in an appropriate way?
- Is there sufficient collaboration between research groups within the institution/department?
- Are there satisfactory policies in place guiding the recruitment and handling of employees?
- Are the efforts to increase gender balance in scientific positions satisfactory?
- In which way have the previous evaluation (2004), national research policies and White Papers been used by the institution/department in its own strategic planning?

3. Research groups

Strategy, organization and research cooperation

- Has the research group developed a satisfactory strategy with plans for its research, and is it implemented?
- Is the size and organization of the research group reasonable?
- Is recruitment, including measures to address gender balance, handled satisfactory?
- Is there sufficient contact and co-operation with other research groups nationally, both within universities, university colleges and research institutes?
- Do the research group take active part in interdisciplinary/multidisciplinary research activities?
- 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?
- Do they take active part in internationally funded projects, international professional committees, work on standardization and other professional 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?

Scientific quality and productivity: To be rated on a scale 1 - 5

- 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: To be rated on a scale A - E

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

Tasks of the principal evaluation committee (Joint Committee)

The committee is requested to compile a summary report based on the assessments and recommendations from the three sub-panels. This report should offer an overall assessment of the state of the research involved. The report should also offer a set of overall recommendations concerning the future development of this research.

The committee is requested to:

- Summarize the overall scientific quality and relevance of the research within engineering science. Identify which research areas have a particularly strong scientific position in Norway, in a national and international context, and which are particularly weak?
- Summarize general assessments related to structural issues
- Summarize how the research institutions have followed up former evaluations
- Are there any other important aspects of research within engineering science that ought to be given special consideration on a national or international level?

The committee's conclusions should lead to a set of recommendations for the future development of research in engineering sciences in Norway.

Tentative outline of the joint report

- Executive summary
- Research areas – major general findings
    - Scientific quality
    - Impact and relevance
- Structural issues
- Follow up of former evaluations
- Other aspects of importance
- Recommendations

5.2. Assessment Criteria

Assessment of Research Groups

Three main areas of performance is highlighted for the research groups in the mandate for Evaluation of Engineering Science, and the mandate describes what is covered for each of these areas:

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

For two of these criteria an assessment should be made using a five point scale.

Scientific quality and productivity:
5 – excellent
4 - very good
3 – good
2 – fair
1 – weak

Relevance and impact:
A – very high relevance and impact
B – high relevance and impact
C– good relevance and impact
D – low relevance and impact
E – very low relevance and impact

Scientific quality and productivity

For "scientific quality and productivity" the following three points appear in the mandate:

- 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?

For this item the following should be used as a basis for the rating. The rating **3 = good** means that the group performs to the standard normally to be expected from a research group in its field.

Excellent

International front position, undertaking original research and publishing in the best international journals and presenting research at recognised international conferences with peer review. High productivity. Very positive overall impression of the research group.

Very good
High degree of originality, a publication profile with a high degree of international publications in good journals and at recognised international conferences. High productivity and very relevant to the field internationally. Very positive overall impression of the research group.

Good
Contribute to international and national research with good quality research of relevance to international research development. Acceptable productivity. Positive overall impression of research group. The group performs to the standard normally to be expected from a group in its field.

Fair
The quality of research is acceptable, but international profile is modest. Much routine work. Relevance and productivity of research is modest. No original contributions to the field of research. Overall impression is positive but with a distinct degree of scepticism from the evaluators.

Weak
Research quality is below good standards and the publication profile is meagre. Only occasional international publication or presentations. No original research and little relevance to problem solving. Not an overall positive impression by evaluators.

Relevance and impact

For “relevance and impact” the following five points appear in the mandate:

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

The panel should give a rating of the research group based on how they evaluate the performance of the group related to these points. The rating **C = good relevance and impact** means that the group performs to the standard normally to be expected from a research group in its field.

A = very high and **B= high** means that the group is above standards and **D = low** and **E = very low** the group is below the standard to be expected for a group in its field.

6. Research groups included in the evaluation

Institution	Faculty/ Business area	Institute/ Department	Project group to be evaluated	Panel 1	Panel 2	Panel 3
NTNU	Faculty of Engineering Science and Technology (IVT)	Energy and Process Engineering	Thermal Energy	x		
			Industrial Process Technology	x		
			Fluids Engineering	x		
			Energy and Indoor Environment	x		
			Industrial Ecology		x	
		Civil and Transport Engineering	Building and Construction			x
			Geotechnics			x
			Marine Civil Engineering			x
			Road, Transport and Geomatics			x
		Structural Engineering	Concrete			x
			SIMLab			x
			Structural Mechanics			x
			Biomechanics			x
		Marine Technology	Marine Technology			x
			Marine Systems		x	
		Engineering Design and Materials	Materials			x
			Design, Analysis and Manufacturing		x	
		Production and Quality Engineering	Production Systems		x	
			Production Management		x	
			Project and Quality Management		x	
			Reliability, Availability, Maintainability and Safety (RAMS)		x	
		Hydraulic and Environmental Engineering	Water and Wastewater Engineering			x
			Hydraulic Engineering			x
		Petroleum Engineering and Applied Geophysics	Petroleum Technology and Applied Geophysics	x		
		Product Design	Product Design		x	

	Faculty of Natural Sciences and Technology (NT)	Materials Science and Engineering	Physical Metallurgy	x		
			Process Metallurgy	x		
	Faculty of Information Technology, Mathematics and Electrical Engineering (IME)	Electric Power Engineering	Electric Energy Conversion	x		
			Electric Power Technology	x		
			Electric Power Systems	x		
NMBU	Faculty of Environ-mental Sciences and Technology	Mathematical sciences and Technology	Water and Environmental Technology			x
UiA	Faculty of Engineering and Science	Engineering Sciences	Mechatronics		x	
			Renewable Energy		x	
			Civil engineering and offshore Construction			x
UiB	Faculty of Mathematics and Natural Sciences	Physics and Technology	Petroleum and Process Technology	x		
			Measurement Science and Instrumentation		x	
UiS	Faculty of Science and Technology	Department of Petroleum Engineering	Drilling and Well Technology	x		
			Natural Gas Technology			
			Reservoir Technology			
		Department of Mechanical and Structural Engineering and Materials Science	Mechanical Engineering and Materials Science			x
			Offshore-technology			
			Civil Structural Engineering			
UiT	Faculty of Science and Technology	Engineering and Safety	Engineering and Safety		x	
Telemark University College	Faculty of Technology		Process, Energy and Automation Engineering	x		
Østfold University College	Faculty of Engineering		Engineering Sciences			x
Gjøvik University College	Faculty of Technology, Economy and Management		Sustainable Manufacturing		x	
IFE		Energy and Environmental Technology	Solar energy		x	
NGI		Offshore energy	Computational Geomechanics			x
		Natural Hazards	Geosurveys			x
		Environmental Engineering	Water and Resources			x

IRIS		IRIS Energy	Drilling and Well modelling	x		
			Enhanced Oil Recovery	x		
			Reservoir	x		
MARINTEK		Offshore Hydrodynamics	Hydrodynamic Modelling			x
			Structural Engineering			x
		Ship Technology	Seakeeping and Control			x
		Maritime Transport Systems	Logistics and operations research		x	
		Energy systems and Technical Operation	Energy Systems		x	
SINTEF Building and infrastructure			Building physics Group			x
			Concrete Group			x
SINTEF Materials and Chemistry		Materials and Nanotechnology	Material- and Structural Mechanics			x
SINTEF Energy Research			Bioenergy	x		
			Combustion	x		
			Power conversion and transmission	x		
			Flow phenomena	x		
SINTEF Fisheries and Aquaculture			Fishing gear technology		x	
			Process Technology		x	
			Marine ICT		x	

7. Schedule for panel meetings

PANEL 3						
Date	start time	end time	time	Activity	Group no	Location / Group name
	Sunday 16. nov					Trondhjem, Rica Nidelven Hotel
Sunday	18:00	20:00	02:00	Introductory panel meeting		
	Monday 17. nov					
Monday	09:00	10:00	01:00	Preparatory panel meeting		
	10:00	10:15	00:15	Interview department	P3-5	NTNU IVT Hydraulic and Environmental Engineering
	10:15	10:45	00:30	Interview group	P3-5a	Water and Wastewater Engineering
	10:45	11:00	00:15	Panel discussion		
	11:00	11:30	00:30	Interview group	P3-5b	Hydraulic Engineering
	11:30	11:45	00:15	Panel discussion		
	11:45	12:00	00:15	Break		
	12:00	12:15	00:15	Interview department	P3-13	SINTEF Materials and Chemistry
	12:15	12:45	00:30	Interview group	P3-13a	Material andStructural Mechanics
	12:45	13:00	00:15	Panel discussion		
	13:00	14:00	01:00	Lunch		
	14:00	14:15	00:15	Interview department	P3-11	MARINTEK
	14:15	14:45	00:30	Interview group	P3-11a	Hydrodynamic Modelling
	14:45	15:00	00:15	Panel discussion		
	15:00	15:30	00:30	Interview group	P3-11b	Structural Engineering
	15:30	15:45	00:15	Panel discussion		
	15:45	16:00	00:15	Break		
	16:00	16:30	00:30	Interview group	P3-11c	Seakeeping and Control
	16:30	18:00	01:30	Panel discussion - drafting of report		
	Tuesday 18 nov					Trondhjem, Rica Nidelven Hotel
Tuesday	09:00	09:30	00:30	Preparatory panel meeting		
	09:30	09:45	00:15	Interview department	P3-2	NTNU IVT Structural Engineering
	09:45	10:15	00:30	Interview group	P3-2a	Concrete
	10:15	10:30	00:15	Panel discussion		
	10:30	11:00	00:30	Interview group	P3-2b	SIMLab
	11:00	11:15	00:15	Panel discussion		
	11:15	11:30	00:15	Break		
	11:30	12:00	00:30	Interview group	P3-2c	Structural Mechanics
	12:00	12:15	00:15	Panel discussion		
	12:15	12:45	00:30	Interview group	P3-2d	Biomechanics
	12:45	13:00	00:15	Panel discussion		
	13:00	14:00	01:00	Lunch		
	14:00	14:15	00:15	Interview department	P3-12	SINTEF Building and Infrastructure
	14:15	14:45	00:30	Interview group	P3-12a	Building Physics Group
	14:45	15:00	00:15	Panel dicussion		
	15:00	15:30	00:30	Interview group	P3-12b	Concrete
	15:30	15:45	00:15	Panel discussion		
	15:45	16:00	00:15	Break		
	16:00	16:15	00:15	Interview department	P3-3	NTNU IVT Marine Technology
	16:15	16:45	00:30	Interview group	P3-3a	Marine Technology
	16:45	18:15	01:30	Panel discussion - drafting of report		

	Wednesday 19. nov					Trondhjem, Rica Nidelven Hotel
Wednes	09:00	09:30	00:30	Preparatory panel meeting		
	09:30	09:45	00:15	Interview department	P3-1	NTNU IVT Civil and Transport Engineering
	09:45	10:15	00:30	Interview group	P3-1a	Building and Construction
	10:15	10:30	00:15	Panel discussion		
	10:30	11:00	00:30	Interview group	P3-1b	Geotechnics
	11:00	11:15	00:15	Panel discussion		
	11:15	11:30	00:15	Break		
	11:30	12:00	00:30	Interview group	P3-1c	Marine Civil Engineering
	12:00	12:15	00:15	Panel discussion		
	12:15	12:45	00:30	Interview group	P3-1d	Road, Transport and Geomatics
	12:45	13:00	00:15	Panel discussion		
	13:00	14:00	01:00	Lunch		
	14:00	14:15	00:15	Interview department	P3-4	NTNU IVT Engineering Design and Materials
	14:15	14:45	00:30	Interview group	P3-4a	Materials
	14:45	16:45	02:00	Panel discussion - drafting of report		
	17:00			Departure from hotel		
	18:20			Travel to Oslo		Gardermoen, Park Inn Hotel
	Thursday 20. nov					Gardermoen, Park Inn Hotel
Thursda	09:00	09:30	00:30	Preparatory panel meeting		
	09:30	09:45	00:15	Interview department	P3-6	Norwegian University of Life Sciences (NMBU)
	09:45	10:15	00:30	Interview group	P3-6a	Water and Enivironmental Technology
	10:15	10:30	00:15	Panel discussion		
	10:30	10:45	00:15	Interview department	P3-7	University of Agder
	10:45	11:15	00:30	Interview group	P3-7a	Civil Engineering and Offshore Construction
	11:15	11:30	00:15	Panel discussion		
	11:30	11:45	00:15	Break		
	11:45	12:00	00:15	Interview department	P3-8	University of Stavanger
	12:00	12:30	00:30	Interview group	P3-8a	Mechanical and Structural Engineering and Materials Sciences
	12:30	13:00	00:30	Panel discussion		
	13:00	14:00	01:00	Lunch		
	14:00	14:15	00:15	Interview department	P3-9	Østfold University College
	14:15	14:45	00:30	Interview group	P3-9a	Engineering
	14:45	15:00	00:15	Panel discussion		
	15:00	15:15	00:15	Interview department	P3-10	Norwegial Geotechnical Institute (NGI)
	15:15	15:45	00:30	Interview group	P3-10a	Computational Geomechanics
	15:45	16:00	00:15	Panel discussion		
	16:00	16:15	00:15	Break		
	16:15	16:45	00:30	Interview group	P3-10b	Geosurveys
	16:45	17:00	00:15	Panel discussion		
	17:00	17:30	00:30	Interview group	P3-10c	Water and Resources
	17:30	18:30	01:00	Panel discussion - drafting of report		
	Friday 21. nov					Gardermoen, Park Inn Hotel
Friday	09:00	13:00	04:00	Panel discussion - drafting of report		
	13:00	14:00	01:00	Lunch		
	14:00	15:00	01:00	Panel discussion - drafting of report		
	15:00	16:00	01:00	Summary panel meeting		

8. Curriculum vitae for the Panel members

Professor Wolfgang Rauch

Wolfgang Rauch studied Civil Engineering at the Technical University of Graz, Austria and at ETH, the Swiss Federal Institute of Technology, where he also graduated in 1985. In 1991 he achieved his PhD at the Institute of Environmental Engineering, University Innsbruck. Until 2002 he had positions at the University Innsbruck, the Technical University of Denmark and at EAWAG, Swiss Federal Institute for Environmental Science and Technology. In 1997 he obtained an advanced degree (Habilitation) in environmental engineering from the University Innsbruck. In 2002 he has been appointed full professor for sanitary engineering at the University Innsbruck. Since 2005 he is head of the Institute of Infrastructure Engineering.

Wolfgang Rauch has published app. 100 papers in peer-reviewed journals, among others in Science (345/6198). He holds an h-factor of 22 (SCI). He is well known in the international community due to his activity in international organisations. Among others he served as a member of the IWA task group on river water quality modelling and chaired the Joint Committee of IAHR and IWA on Urban Drainage in the period 2002 to 2005. Since 2013 he is the Chair of the IWA Program Committee. He serves as editor of one of the most important journals in the field that is *Water Research* and additionally as Editor in Chief for the journal *Water Science and Technology*.

Professor Michael Havbro Faber

Michael Havbro Faber took up his present position as head of department and professor of risk and safety at the department of civil engineering at Technical University of Denmark on January 1, 2011. Before that he held a position as professor in the field of risk and safety at ETH in Zürich, Switzerland. A position he had for 10 years.

Michael Havbro Faber is born in 1961 and graduated as a civil engineer specializing in offshore engineering at the Department of Building Technology and Structural Engineering at Aalborg University in 1985, where in 1989 he also defended his PhD thesis in the field of structural reliability theory. In addition to ETH, his academic career includes research positions at the Technical University of Munich in Germany and at the University of Newcastle in Australia, while his industrial experience mostly comes from COWI in Lyngby, Det Norske Veritas in Oslo, and on-going consultancy work for the international and national construction, energy and transport sector.

During his career Michael H. Faber has been actively involved and taken leadership in several international committees, including: The Joint Committee on Structural Safety (JCSS); acting vice-president, the International Forum on Engineering Decision Making (IFED); founding and acting president, the ISO 2394 Principles of Reliability of Structures; convener, the international Civil Engineering Reliability and Risk Association (CERRA); president, The

World Economic Forum, member of Global Agenda Council on Catastrophic Risks, the OECD High Level Risk Forum and the Danish Academy of Technical Sciences.

Professor Emeritus, Dr. h.c. Preben Terndrup Pedersen

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, USA and in 1973 visiting researcher at Det Norske Veritas, Norway. Professor of Strength of Marine Structures at Department of Naval Architecture and Offshore Engineering at DTU from 1973 to 2010. He was Vice-president of the Danish Academy of Technical Sciences 1998-2002. During 1992 – 2007 he was Head of Department of Mechanical Engineering.

He is foreign member of the Chinese Academy of Engineering, Norwegian Academy of Technical Sciences, Fellow of Royal Institute of Naval Architects, Fellow of Society of Naval Architects and Marine Engineers, US, and foreign member of The Norwegian Society of Sciences and Letters. He is a member of the editorial board of 5 international journals. In 2010 he was awarded the Doctor Honoris Causa degree from NTNU.

He has been advisor to A. P. Møller – Mærsk and strongly involved in the design of the then largest containership Emma Mærsk, advisor on risk management of large bridge structures in Denmark and he is member of some boards of industrial companies. He has authored or co-authored 13 books and more than 100 papers in refereed journals and other major publications on structural strength, dynamics and risk analyses of marine structures and has been the principal advisor for more than 30 Ph.Ds.

Professor Geert De Schutter

Geert DE SCHUTTER is full professor at Ghent University, Belgium. He is doing research in the field of concrete technology, at the Magnel Laboratory for Concrete Research, Department of Structural Engineering. He is laureate of several national and international awards, among which the Vreedenburgh Award in 1998, the RILEM Robert L'Hermite Medal in 2001, and the ACI Anderson Medal in 2014. In 2002 he was invited professor at Oita University, Japan. Since 2008, he is invited professor at the University of Cergy-Pontoise, near Paris, France. In 2012, he was awarded the Francqui Chair at the University of Liège, Belgium. From 2014 to 2017, G. De Schutter is also invited professor at Tongji University, Shanghai, China. From February 2009 to February 2014, Prof. G. De Schutter was also Director of Development of RILEM. At present, he is still member of RILEM Bureau, and RILEM Development Advisory Committee (DAC), and is RILEM Regional Convener for East-Asia.

Professor Jan G. Rots

Jan Rots graduated from Civil Engineering at TU Delft in 1982. Subsequently, he continued his research into the mechanics of concrete structures in a combined position at TNO Building and Construction Research and TU Delft. He passed his PhD in 1988. Next, he was awarded a KNAW Research Fellowship (academy researcher), followed by a NWO/STW Pioneer Fellowship in computational modelling of structures. He 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 and the DIANA Foundation. In 1999 he was appointed as full professor in Structural Mechanics at the Faculty of Architecture at TU Delft. In 2006 he moved as full professor to Civil Engineering, while keeping a part-time position at Architecture. His research interests widened to nonlinear analysis of brick/block masonry, glass, free-form structures, underground structures, induced seismicity. Since 2002 he served as head of the Department of Building Technology at Architecture, twice as dean of Architecture and since 2009 he is head of the Department Structural Engineering at the faculty of Civil Engineering & Geosciences. He has been a member of numerous technical, advisory and evaluation committees and took up multiple organizational tasks that bridge design, engineering and science.

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