

# NTNU Materials Evaluation Report

by

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## Principal Conclusions

### Materials Area

- The Materials Area has made excellent progress and has added significant value relative to the limited funds expended.
- The developments in Nano Science, Solar energy and Impact Engineering are clearly of high international caliber, represent good examples of both internal and external collaboration, and could serve as role models for other areas of materials.
- The number of Materials Area faculty have declined, and even replacement is not assured. (Crises: solar cells, steel technology.)
- Support for basic materials research is very difficult to obtain, but critical for outward looking goals that are essential to achieve NTNU's broader goals.
- The Materials area is diverse, but has a valuable shared vision and coherent strategic plan.
- The Materials Area can catalyze educational initiatives.
- Industrial interaction is very strong but can benefit by being more global.
- A basic thrust in multi-scale modeling should be initiated to support a wide range of more applied projects. Build on strong characterization capabilities.

### Strategic Areas Collectively

- The Strategic Areas (SA's) are well-chosen, well-conceived, and can provide a path to achieve NTNU's new, ambitious goals.
- The new goals require long-term, fundamental changes in university priorities. The principal practical mechanism for achieving these goals is by faculty hiring policy and practice, i.e. long-term financial commitments in priorities established by the SA's.
- The SA's need resources commensurate with the new goals. The resources need to be approximately 10 times the current allocation, and they must be long-term

annual allocations to permit faculty hiring. Such funds will be best used by further leveraging other funds (from normal NTNU budget processes via the Faculties) for the hiring of permanent faculty

- Looking backward in time, the allocation of the recommended funds would have been relatively painless at NTNU. More than 50 new faculty positions in SA priorities would have been created without reductions of non-SA units (representing about 5% of NTNU faculty).
- Leadership of the Rectorate and Directors is essential. Metrics will need to be established with broad consensus. Periodic reviews will be required, both internal and external, against these metrics.
- SA Directors need: technical dedication to the area, no conflicting positions, energy, enthusiasm, persistence, international perspective. A strong current example includes the highly successful Energy Area.
- A shared vision is essential for setting priorities. Conversely, implementation requires a top-down approach, i.e. one carried out by the Rectorate and SA Directors.

### **Summary / Overview – Materials Area**

Before presenting our detailed views on various aspects of the Strategic Area of Materials it may perhaps be useful to provide a few words to summarize our overall impressions, organized into three topics: a) aspects we think are very commendable b) aspects we think would benefit from change and c) specific topics which we feel it would be useful for the members of the materials area to discuss and consider in relation to their future strategic planning.

It should be noted that we are clearly drawing on our experience of a number of institutions both in North America and Europe in terms of perspective. We hope that these listings will help catalyze critical discussion and debate within the group.

#### **Commendable Aspects**

- The Materials area is vital to the future excellence of NTNU and to the Norwegian economy as a whole. The Dean leading the area is well informed and has an excellent knowledge of the people in the group.
- The range of topics is broad but well chosen both for current and future national needs. Many activities in the group are of very high international stature.

- In many areas the quality of equipment and the standard of experimental work is outstanding

### **Aspects Could Benefit From Change**

- The question of leadership is vital in the future – a Dean cannot have the time, energy, and undivided attention needed to lead a Strategic Area. The current Dean has done an excellent job, but the group needs new dynamic leadership with an aggressive approach to raising funds and developing new industrial linkages in a global framework.
- The real level of collaboration within the group is unevenly developed in some departments, i.e. there are insufficient links to areas of mechanics, the energy sector and the use of structural materials. Some area members are unaware of meetings, seminars, visitors, and other activities.
- The Materials area needs a higher profile nationally and a much greater degree of collaboration in the European and global arena. There is an urgent need to develop mechanisms to attract high caliber graduate students and post doctoral researchers if this area is to reach its potential.
- There are serious issues in the development of Faculty Positions particularly in the areas of Solar Materials and structural steels.
- The area shows little evidence of new educational initiatives or even the use of an attractive and exciting seminar program which links the various activities of the group.
- In order to reach its potential the group needs to take ownership of the area, develop more resources internally and externally, hire in priority areas, and construct a coherent and cohesive structure.

### **Aspects for Discussion**

- The existing summer schools appear to work well – perhaps they can be expanded into other topics to improve the visibility and international collaboration in the Materials area.
- There is a real need to develop graduate programs which are taught entirely in English (and advertised as such). The goals are to gain recognition as an international university, to attract promising and diverse students, and to enable rich international options for the students to develop similar to those developed at INPG Grenoble. In order to get the most visibility and impact, this should be a university-wide decision that would be promoted strongly.

- In many cases the Materials Area is isolated from the major currents which develop links to manufacturing and to design. These changes are vital to the future of Norway's manufacturing sector. Perhaps the approach to funding is too complacent in the materials area –the area of impact mechanics is an excellent example of innovation and the development of a global approach and should be considered by other areas

## Evaluation Findings, By Topic

### Strategic Area Concept and Process

The Materials Area is from an administrative viewpoint complex as it involves 3 faculties and 8 departments. Thus it is an ideal vehicle for fostering interdisciplinary actions. There are already excellent examples in both Nanomaterials and SIM lab which deserve encouragement and future support.

One effective way to develop a more interdisciplinary approach would be to use joint appointments in areas of strategic interest. Another would be to use a supervisory committee system for graduate students rather than individual professors –this is a very flexible vehicle as it can be used not only between department but between institutions and this is used often in institutions such as INPG Grenoble and LLN Belgium and in many North American universities.

The area could help rationalize and improve course offering in areas such as mechanics, metal forming ,failure analysis and fracture mechanics which could be of benefit to a number of departments In Marine Technology, Mechanics, Design and Materials.

There has been a disconnection between the current concept of the Strategic Areas, and the central support necessary to make substantial long-term changes. Only by addressing this key issue can the NTNU goals be achieved via the Strategic Area approach.

The concept of the Strategic Areas is correct, and can achieve the one current “profiling” overarching goal and make progress toward the others, but not unless resources are allocated with an assured path to contribute to those areas.

We have no opinion on the optimal number of strategic areas that can be supported NTNU. However, we note that the current areas represent two philosophies, which we find positive. In essence, three of them are chosen with a national view of strengths and economic impact (Materials, Energy, Marine). The others reflect either emerging trends or areas of strength at NTNU. We believe this mix is a good one.

## NTNU Goals

Two “profile” goals (Top 10 European university, Top 1% World university) are unattainable except in a dream scenario. (We concluded this by considering two aspects. 1. Is there an agreement with the Norwegian government and Education Ministry with the NTNU goals? If so, will they commit the required funds to make it happen? 2. On some lists, the University of Lausanne is Number 10 in Europe. The funding per student is apparently several times that at NTNU. This kind of disparity is unlikely to be overcome without a national commitment.)

The unrealistic nature of these two university-wide goals causes the faculty members to ignore them, or even worse, to be discouraged about such unrealistic expectations. (The same can happen as the expectations of the Strategic Areas are dramatically increased without providing the means to make them possible.)

The third “profiling” goal (“become best in a few strategic areas”) *is* attainable with the right investments and support, and can assist in moving NTNU upward in both the other rankings. The Strategic Areas are the right approach and concept, but the required funding and carry-through must be made commensurate with the new mission for these Areas. (We understand that the history of the current Strategic Areas did not include the newly-defined overarching goals, so we look forward to how the Strategic Areas can be harnessed to carry out the new goals.) NTNU’s Strategic Areas cannot be effective if the institutional investments are diffuse, i.e. spreading money and positions around by a process which does not follow Strategic Area goals. As stated elsewhere, it appears that this is precisely what has happened since the Strategic Areas were first identified.

It should be noted that attainment of the “best in a few strategic areas” goal can help move *toward* the other, stretch-type goals.

## Materials Area Strategic Plan

The strategic area plan for 2007 –2012 developed in the Materials strategic area is an excellent example of responding to both current opportunities and future developments. The area of Sensors and electronics and the current work in Nanomaterials clearly has great future potential but in some cases lacks direct industrial support.

The development of Consortia of SME’s to interact with these areas may be of value in developing industrial partners and increased visibility for these topics.

In the area of light metals there is clear evidence of collaboration over a long period of time but the changes in the AI industry in Norway may require new approaches and projects in this area. Researchers in this area may consider additional partners such as the automotive producers as used by SIM lab and by a number of North American universities.

In a large strategic area such as a Materials a much more global portfolio of industrial contacts is appropriate to foster networking and improving both visibility and social impact.

The area of materials for Oil and Gas technology clearly overlaps with Energy and Marine Technology and highlights the urgent need to develop a comprehensive and clearly visible activity in modern steels and steel selection and life prediction.

The area which focuses on Materials for Energy Technology focuses on Solar Cell materials and really defines the serious disconnects which can develop between the well documented needs of the strategic area and its close collaboration with SINTEF and the priorities of the Institution.

It is clear that at least one faculty appointment must be made in the area related to the eventual retirement of Professor Lohne. However no steps have been taken in this direction *despite* the strong industrial interaction and clear societal needs. This is an area in which the Administration needs to act very quickly.

We were impressed by the development of the area of Nanomaterials in terms of its scope, innovation, laboratory facilities, leadership, and new educational initiatives. It is a tribute to Thomas Tybell and Tor Grandeand and represents an excellent example of the changes that can be achieved by wise investment and targeted positions. It also illustrates that the future success of the strategic areas depend on well thought out hiring practices and a committed administrative structure.

### **Strategic Areas – Education Aspects**

Any strategic area depends on being able to recruit and fund high caliber graduate students and in the context of the goals of NTNU the number available is not sufficient. Thus NTNU should look seriously at the models of a number of other European universities or even METU in Turkey. These universities teach a number of senior level courses and all graduate courses in English and arrange to have reciprocal agreements with other Universities for exchange of courses in order to make programs more flexible and more attractive to students a good example is in the Nano/micro materials program introduced by Grenoble, Barcelona and other universities.

We found the course offerings at NTNU quite rigid in format. Members of the strategic area could collaborate much more to develop new offerings in the curriculum to facilitate horizontal collaboration for offering topics such as Materials Selection and Design, Process Selection, Modern Structural Steels, Joining Technologies, etc. which would be accessible to students in Materials, Marine Technology, Mechanics and Design.

It should be emphasized that this approach of developing a more flexible portfolio of course offerings needs to be undertaken by NTNU as a whole and needs to be linked to incentives to reward instructors who undertake these actions and to an overall reduction

in teaching load to allow more flexible and exciting educational vehicles to be developed. A useful resource for this type of development might be Professor M.F Ashby at the University of Cambridge

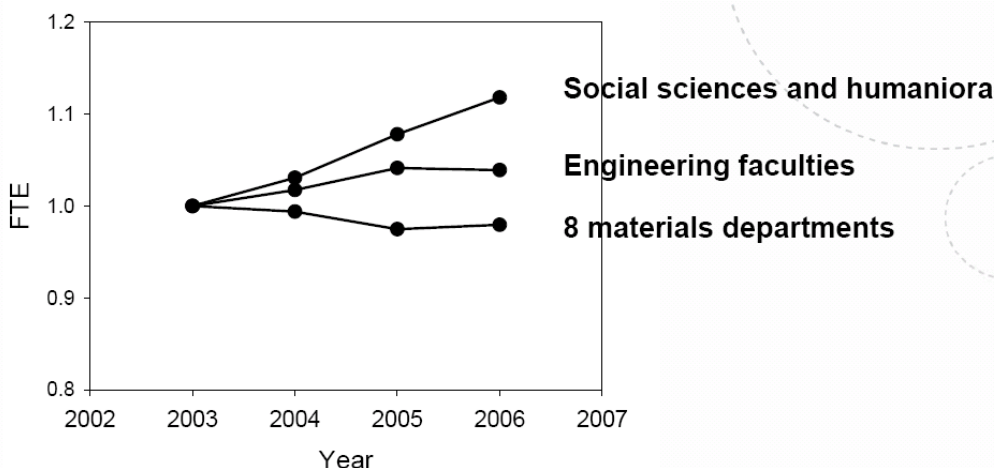
### Strategic Areas – Implementation

Nearly all of our concerns and recommendations for improvement of the Strategic Areas are related to implementation. As stated above, we believe that the Strategic Area approach can be effective, and can accomplish institution goals, but not without better support and implementation.

First, the identification of Strategic Areas has not translated into hiring priorities yet. (Note: We believe that nearly the only way to change an academic institution in a major way, in the long-term, is by faculty hiring practice. This is particularly true at NTNU where unions are important and where tenure is granted immediately.)

In the Materials Area, we found that the available faculty members to carry out the new responsibilities have decreased during a time of growth of NTNU (and during a time during which the Materials Area was supposedly a priority). Figure 1 shows the FTE faculty positions in the 8 departments that contribute most to the Materials Area. The number of faculty has decreased from 2003-2006. During that same period, the number of FTE faculty in Social Sciences and Humaniora (which have little connection to most of the Strategic Areas) grew by more than 10%

### Full Time Equivalents, Relative to 2003



Source: DBH. Filter: Førstest=ja. Category: Undervisnings- og forskerstillinger

The Evaluators were informed by the Rectorate that budget constraints limited the ability at NTNU to invest in Strategic Areas. That does not appear to be the case, see Table 1. Over the period from 2002 to 2006 the number of faculty members at NTNU increased from 873 to 970. (This is the net change, and does not include replacements, which also



offer opportunities for strategic prioritization.) Thus, almost 100 faculty positions could have been allocated (via budget or other means) to the Strategic Areas *without a decrease in budget or positions to any other units*. Unfortunately, such a policy was apparently not followed (refer to Figure 1 again.). It is also apparent from Table 1 that staff positions have been added disproportionately to faculty positions in recent years.

**Table1: NTNU Staff Trends, 2002-2006**

	2002	2003	2004	2005	2006
FTE Admin	698	735	791	824	856
FTE Faculty	873	897	924	952	970

Similar numbers for the Faculty of Natural Sciences and Technology over the same time period are presented in Table 2. This Faculty is the principal one responsible for the Materials Area. In fact, the Dean of Natural Sciences and Technology is also the Director of the Materials Area. (This seems to contradict the idea that having a dean as the director of a Strategic Area guarantees more resources.) The number of FTE faculty in the Faculty has decreased over the period, while the number of faculty of NTNU has increased significantly.

**Table 2: Natural Science and Technology Faculty Staff Trends, 2002-2006**

	2002	2003	2004	2005	2006
FTE Admin	45	49	51	57	58
FTE Faculty	146	147	144	146	142

Strategic Area directors require resources to steer hiring and recruitment decisions in order to carry out long-term changes support the area. As noted above, this authority has not been available in the current mode of operation.

There is a disconnection between naming Strategic Areas as priorities and the institutional prioritization of resources. In some cases, such as the Materials Area, the area has apparently been penalized by being a Strategic Area. If it is accepted that hiring is the major way to change direction at a university, this kind of disconnect makes it difficult, if not impossible, to achieve the desired goals of the Strategic Areas.

### **Strategic Leadership and Vision**

“Leadership” implies many things in this context. First, the goals and aspirations of an institution must be a shared vision of faculty, administration, and major partners (funding

agencies, Ministry of Education). The choice Strategic Areas seem to have undergone a broad process. We detected no major objection to the current choice.

The second of aspect of leadership lies with the Rectorate. It is the responsibility of the Rectorate to allocate resources across university groups in order to carry out the shared vision. In the case of the Strategic Area, these allocations were quite small – they are not consistent with the current goals and aspirations. (But, they were perhaps sufficient in view of the original goals of obtaining Centers of Excellence. Three were awarded.) In terms of the current organization, the Strategic Areas are not of high priority. We were surprised to learn that the Rectorate meets with the Directors of the Strategic Areas for a total of 8 hours per year.

The third aspect of leadership lies inside the Strategic Area itself. The management of the Strategic Areas varies in quality widely. We find the Energy Area to be a model for effective, persistent stewardship of a diverse area. The leader there has been a consistent advocate for the area, and has effectively represented the area in Brussels, in Oslo, with industry, and around the world. This success has two key ingredients: 1) sufficient funding (partly because of the national importance of energy and industrial sources), and 2) a dedicated, long-term, persistent leader who is not distracted by other administrative duties.

In the Materials Area, we find that it is not possible for a dean to commit the level of time and energy to the administration and growth of a Strategic Area. There are an insufficient number of common meetings, for example, that would help include researchers from other departments keep informed. There is also an inherent conflict of interest (and time, and commitment) between Faculty duties and Area duties. Finally, the dean's own technical work, physical chemistry, is not central to the thrust of the area. We do not accept the institutional argument (presented in documents before the evaluation meeting) that a dean has the budget authority to push an area more effectively. Note that the Faculty of Natural Sciences has decreased in faculty numbers, and that the decrease in the Materials Area is even more significant.

### **Strategic Areas - Resources Needed**

There is a huge disconnection between the *current* broad institutional goals for the Strategic Areas (“raising the level of NTNU in world opinion”), which are indeed grand, and the minor amount of funding provided (about NOK 2 million per area). A SINTEF representative that we spoke with stated that most of the problems with implementation of the Strategic Areas could be addressed by simply multiplying the allocation by 10, to NOK 20 million per year, area.

This should not be taken as a criticism. The current goals were formulated after the Strategic Areas were established for a different purpose. However, we believe that the Strategic Areas can accomplish the new goals with sufficient resources and resolve. Here is a list of what we believe is required:

1. Appointment (in consultation with the current Strategic Area faculty) of Directors who do not have other administrative duties, who are central to the technical thrust of the Area, and who have the time, initiative, skills, commitment and persistence to accomplish the objectives in the long term.
2. Provision of resources (money and/or faculty positions) commensurate with the goals and objectives. As a reasonable guideline, we recommend that half of new faculty positions (and correlated funding) be allocated to the Strategic Areas, through the Director. By leveraging these resources in negotiation with Faculties and Partners, this should provide an impact of double. (To put the commitment in perspective, over the past four years such a policy would have re-allocated 50 faculty positions at NTNU in Strategic Area hiring, without any reduction in other uses. To put it in another perspective, this investment would represent more than 5% of the NTNU budget, as opposed to the current ratio of approximately 0.5% allocated to Strategic Area purposes. Surprisingly, this is very close to the SINTEF estimate of ten times more resources needed!)
3. Setting of objective measurable, concrete goals by the Rectorate for Strategic Areas (publications, external support, and so on) and careful monitoring of such metrics. Similarly, such goals should be set inside of each Strategic Area in view of a Strategic Plan for the next 5-10 years. We note that the Materials Area has such a plan, one that we judge to be useful and carefully constructed.
4. Closer connections and responsibility of Strategic Areas to the Rectorate, not to the Faculties. (However, all hiring must be agreed with Faculties and Departments, who presumably will provide some of their resources to match the Strategic Area resources.) Frequent meetings between the Rectorate and Directors, some of which should be one-on-one.
5. Periodic external reviews of Strategic Area performance informed by metric data in addition to self evaluation. (Similar to the current exercise upon which this report is based.) Perhaps such evaluations should occur every 2 or 3 years? A similar but internal evaluation would be performed annually.