The Research Council of Norway

Evaluation of Mathematics, ICT and Technology 2023-2024

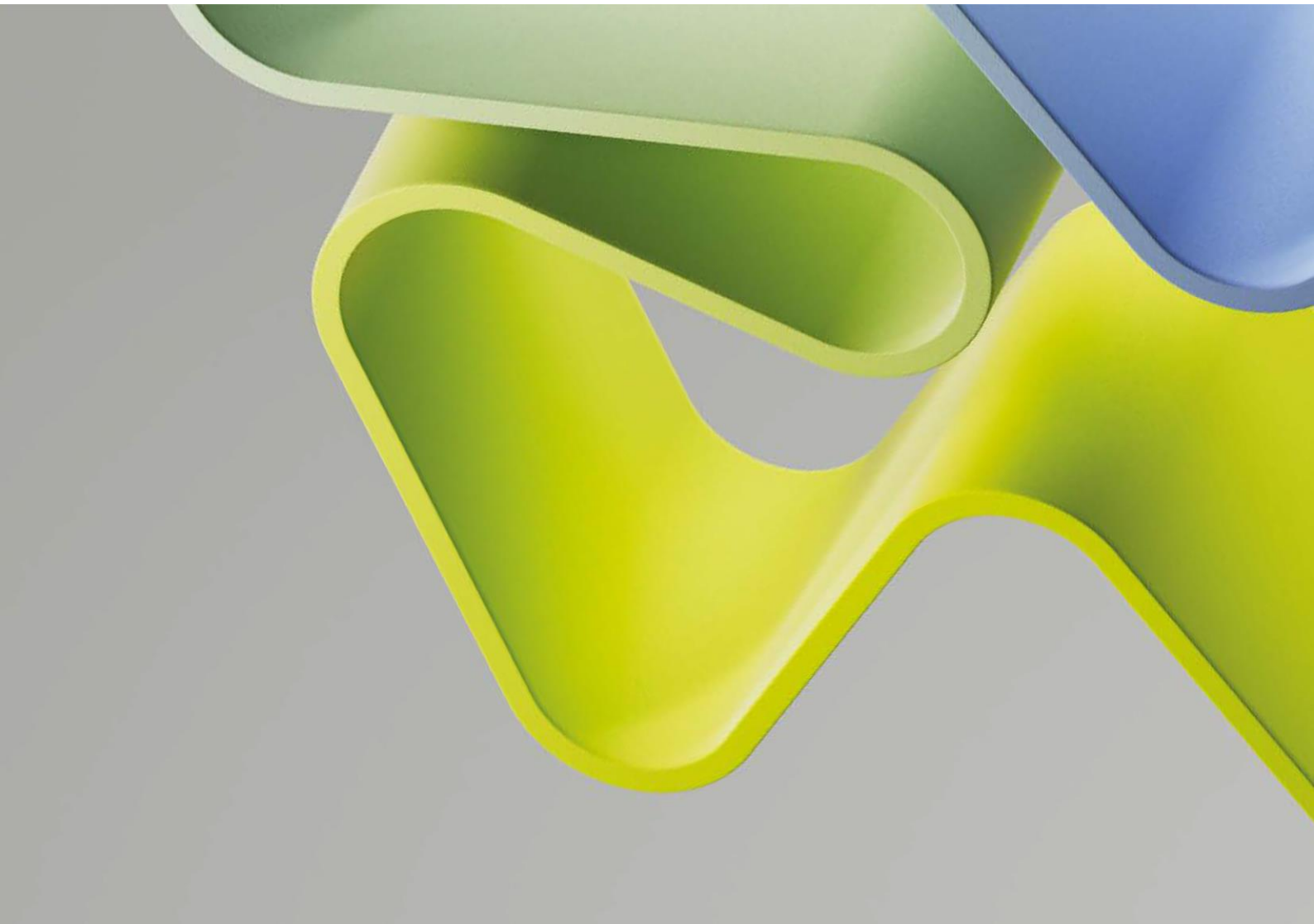
Evaluation Report for Administrative Unit

Administrative Unit: **Department of Manufacturing and Civil Engineering (IVB)**

Institution: **Norwegian University of Science and Technology (NTNU)**

Evaluation Committee Higher Education Institutions 4

December 2024



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The members of this Evaluation Committee have evaluated the following administrative units at the higher education institutions/research institutes within Mathematics, ICT and Technology 2023-2024 and has submitted a report for each administrative unit:

- Department of Building, Energy and Material Technology, UiT the Arctic University of Norway
- Department of Architecture and Technology (IAT), Norwegian University of Science and Technology (NTNU)
- Department of Civil and Environmental Engineering (DCEE), Norwegian University of Science and Technology (NTNU)
- Department of Geoscience (IGV), Norwegian University of Science and Technology (NTNU)
- Department of Structural Engineering (KT), Norwegian University of Science and Technology (NTNU)
- Department of Manufacturing and Civil Engineering (IVB), Norwegian University of Science and Technology (NTNU)
- Department of Energy and Process Engineering (EPT), Norwegian University of Science and Technology (NTNU)
- Department of Built Environment (BE), Oslo Metropolitan University (OsloMet)
- Department of Energy and Petroleum Engineering (IEP), University of Stavanger (UiS)
- Department of Mechanical and Structural Engineering and Material Science (IMBM), University of Stavanger (UiS)
- Department of Process, Energy and Environmental Technology (PEM), University of South-Eastern Norway (USN)

The conclusions and recommendations in this report are based on information from the administrative units (self-assessment), digital meetings with representatives from the administrative units, bibliometric analysis and personnel statistics from the Nordic Institute for Studies of Innovation, Research, and Education (NIFU) and Statistics Norway (SSB), and selected data from the National survey for academic staff in Norwegian higher education and the National student survey (NOKUT). The digital interviews took place in the autumn 2024.

The members of the Evaluation Committee are in collective agreement with the assessments, conclusions and recommendations presented in this report. None of the committee members has declared any conflict of interest.

The Evaluation Committee has consisted of the following members:

Professor Claudio Mazzotti, University of Bologna (Chair)

Professor David Baglee, University of Sunderland

Professor Elsa de Sá Caetano, University of Porto

Professor Sebastian Geiger, TU Delft

Professor Per Heiselberg, Aalborg Universitet

Professor Mohamed Pourkashanian, University of Sheffield

Description of the Administrative Unit

The Department of Manufacturing and Civil Engineering (IVB) at the Norwegian University of Science and Technology (NTNU) (as of November 2024) has 64 employees in academic and research positions, of which 23,5% are female. There are 11 professors, 16 associate professors, 13 lecturers, 2 researchers, 19 PhD fellows, and 3 postdocs. The Deputy Heads of Research and Education oversee all research and educational activities, with day-to-day responsibilities delegated to the Heads of the two research groups. The leadership team consists of the Department Leader, Head of Administration, Deputy Head of Research, Deputy Head of Education, and the Leaders of the two research groups. Research projects and teaching activities are organised within these groups. Additionally, the department organises annual research and education seminar as well as innovation camp for the entire department.

- The research is organised in the following research groups:
- Civil Engineering and Geomatics Group
- Manufacturing Materials and Energy

The department aspires to be Norway's leading academic institution in its disciplines and aims for international leadership in areas like advanced and sustainable composites, smart manufacturing systems, smart energy systems, and sustainable buildings and environments. It has a substantial portfolio of Horizon Europe and Research Council of Norway (RCN) projects and collaborates strategically with SMEs at Raufoss Industrial Park and the regional county council. The department prioritises strategic research areas by announcing new opportunities and uses established recruitment platforms and networks to attract employees. The department's research impacts regional innovation through collaboration with Raufoss Industrial Park, national innovation through participation in Centres for Research-Based Innovation (SFI) and national research infrastructures like MANULAB, and international research through active participation in international projects. Currently, it holds a large portfolio of Horizon Europe and RCN projects with international collaborations

The department fosters national and international collaborations in its main research areas, balancing applied research with industry and basic research with universities and research organisations. Key national partnerships include SFI, the Norwegian Manufacturing Research Centre, the Green Platform, and the Norwegian Wood Cluster. Proximity to Raufoss Industrial Park enhances industry collaboration, and the department also works with the county council on specific projects, such as the wood/timber industry. Internationally, the department collaborates through RCN and Horizon Europe projects. These collaborations are vital for research development, and the department aims to strengthen these partnerships and attract new collaborators by leveraging its interdisciplinary expertise.

Overall Assessment

The unit's ToR asked to specifically address the fact that the unit has been established only in 2016, due to a university merger. The merger included a shift in orientation from education more toward a research and research infrastructure profile. The research groups are still working towards consolidating their main research directions. The evaluation thus is requested to provide a qualitative assessment of IVB as a whole in relation to its strategic targets. This is done in the following assessment.

The department is the result of a merger in 2016 between NTNU and Gjøvik University College (HiG). The department has two research groups which are aligned to (1) “smart technologies” including composites, manufacturing and energy and (2) sustainable building and environments which includes building information modelling, digital twin, sustainability assessment and wood-based solutions. The department has formed strong partnerships with local industry via the Raufoss Industrial Park and participates with national research centres. The department is active in several European projects and aims to introduce new research themes including Industry 4/5, artificial intelligence and big data. Cross disciplinary research is promoted, which seems to be driven by industry demand and the fact they are a small department and require support from other departments. The faculty has five strategic areas, of which three are aligned to the department research themes namely: ‘competitive and Sustainable Manufacturing’, ‘Sustainable and Reliable Energy’ and 'Green shift in the built environment'.

The department has a good track record in research outputs and a good record in Q1 publications by staff who have an international reputation in research and development of innovative solutions. The ratio of professors, to associate professor to lecturers is above the national average. However, the ratio between male professors and female professors is approximately 22% female, 78% male, which is lower than the national average. The head of department is aware of the need to attract female staff, although this is a problem in many countries, and where possible, the strategy is to prioritise female appointments, in addition, the Faculty / University has a new committee for Equality, diversity and inclusion, and new initiates such as annual events to encourage female appointments. The department is managed by a head of department, supported by a deputy head of research, a deputy head of education and two research group leaders. Currently the department does not have a recruitment policy available to share, although they do recognise the importance of such a strategy as this makes them vulnerable to recruiting key staff.

Professors, supported by early career researchers, lead the research projects. The department, at the time of the review, had 26 PhD students. They are supported by a good mobility scheme and have access to a wide range of training programmes to enhance the “softer skills” such as networking and proposal writing. In terms of a benchmark, it is not clear if the professors and associate professors are given targets as to the number of PhD students per professor, or in fact the number of publications in Q1, income generation and external esteem factors. The department attracts funding from several funding agencies although approximately 50% is from single source. The department does not formally record the number of proposals under development at a faculty level. The department has developed a plan to reinvest a percentage of the income, approximately 20%, in staff and facilities to help develop long term goals for new areas of research and new industrial collaborations. Having 50% funding from one source can influence the research agenda and therefore limit the scope for expansion. In addition, without a broader portfolio of research income from other funders, decisions from one “major” source of income can be biased against new ideas, gender, ideology, and geography. For example, the large distance

between centres seems could be problematic and influence funding bodies regarding a risk of access to dedicated labs, due to distance.

The Oil and Gas industry is very important to the region and the university, a large amount of funding is from this sector. However, the job market is moving away from oil and gas toward sustainable projects and academic programmes to suit. The department is aware that new themes need to be developed such as Industry 5. The unit has shown it needs to adapt continuously by examining new approaches to innovation for academic, industrial and society requirements, the new research and engineering paradigm is Industry 5. A strength of the department is having the foresight to have traditional engineering programmes but allow the transition to more renewable and sustainable programmes to suit the economic, societal and job market issues in the region and beyond.

The University has developed several tools and techniques to ensure the Act relating to equality and a prohibition against discrimination (Equality and Anti-Discrimination Act)" is embedded and followed by the departments, The self-assessment report provided several documents, which are available to all staff, which help support the importance of gender diversity, discrimination and equality within the department. This approach seems no different to universities across Norway as "unit specific" plans for equality and diversity are rarely developed in favour of central strategies to create a more inclusive community.

A strong link between undergraduate, postgraduate, PhD programmes and industry is evident. This approach allows the department to attract local students to tailormade programmes. In addition, students can undertake their research work with industry and use the labs for industry specific, work-based problems. The research themes highlighted in the self-assessment include areas such as smart manufacturing, materials, sustainable built environment, and wood mechanics. These areas are developed to allow access to additional Horizon funding, the research Council of Norway (RCN) projects or regional and national funding. The aim is to be innovative with choices of research themes which will have an impact on society, the European green agenda and sustainable development goals suggested by the European commission. This approach should also help to build new relationships with local and national SMEs.

The department has a strong collaboration with the administrative units within NTNU as well as with other national and international academic and industrial partners The self-assessment reported a high level of cooperation between units. While this is not unique, it does contribute to enhancing the student experience. The department is part of the national Centre Research-based Innovation for Manufacturing (https://www.sfimanufacturing.no/), it hosts the national Centre for manufacturing (https://www.ntnu.no/vareproduksjon/nasjonalt-senter-for-forskning-pa-vareproduksjon), and it is part of the Norwegian Wood Cluster (https://www.nwcluster.no/). In addition, the department has strong collaboration with the Raufoss Industrial Park (https://www.raufossindustripark.no/) where it is involved in many industrial research projects.

The department teaching and research are relevant to the needs of society as described via the reports supplied and the impact case studies. Nevertheless, there is a need to better understand the challenges and opportunities faced by their local communities. A strategic approach involves conducting research with local relevance and addressing community-specific (and perhaps not obvious) issues.

The department is successful without the use of a defined "department specific" strategy. This could be divided into several smaller themes with set KPIs or one large strategy which encompasses all strategies related to teaching, reach out, research, EDI, recruitment of staff

and students. It seems the institutional and faculty strategies are more important and followed. The term “we are just a small part of the faculty” should not preclude the department from developing their own short-, medium- and long-term strategy. It was difficult to understand where the department wanted to be in 5-10 years due to a lack of a ‘future strategy’.

The department has a clear vision on how IVB intends to increase research, both fundamental and applied research. The plan, which is divided into two priorities, are (1) increase local and national funding via closer cooperation with industry and research centres, and (2) increase their international footprint via Horizon and other international funding bodies. In order to achieve the department priorities, time must be available for the research team to focus on research, with little or, if possible, no teaching. The department encourages interdisciplinarity and collaboration, between the units to increase staff participation, shared use of labs, and particularly the involvement of early career researchers. The many initiatives available to support early career researchers should allow them to go on to contribute to society in research with impact and to ensure the department has a specific niche in the national and international research ecosystem. It is important for the leadership to identify and share the values of the units and acknowledge that the research staff can, and should, influence the departments direction. The department is very capable of meeting all their objectives, plans, KPIs in the future as they have a plan that includes the development of talented researchers who will become research leaders, a positive research culture, clear goals and resources specific to their research themes.

The Terms of Reference for the administrative unit is attached to the report.

Recommendations

1. The research strategy does not seem to have been updated when the new department as formed in 2016. A research strategy is required which, for example, could include measurable KPIs for publications, income, number of PhD students (including gender balance) and number of students on academic programmes which could potentially become PhD students. A clear direction as to research themes is required, to encompass the need and benefits of the transition to renewable technologies. The strategy could also help to focus on new areas to attract funding from national and international collaborations. While the organisation of the research groups, the staff and the facilities are good, the method(s) by which to monitor success is missing, or not evident in the documentation.
2. A staff recruitment strategy which is specific to the needs of the department is required to ensure the department attracts selects and retains the specific staff required to grow and shape teaching and research. This also needs to include gender specific programmes to attract women at all stages of their careers.
3. A clear strategy is required for staff development either teaching or research focused to determine management or academic progression, this was not clear in the information supplied, A set of clear objectives is required from senior management. Setting objectives is not an easy process but once in place they provide a useful benchmark from which management can identify development needs and monitor and support performance over a period of time. Clear objectives are also a useful management tool, helping managers to identify what is being done, by whom and when.
4. A well-defined strategy is required to encourage and foster more collaboration with internal departments, other faculties etc. These do already exist, but this could be more by known reputation than be design. Possibly consider a research institute within the department. The research unit could be led by a senior academic leader, professor with an international reputation, with responsibilities for research

development, external engagement, income generation and oversight of all funding proposals and funded projects, also linked to the overarching research strategy (Point 1).

5. To develop a clear and unit specific strategy a further recommendation is to plan the development based upon four key aims. 1) Focus: on excellence with impact and build upon the best performing subject areas, which provide a high profile and high impact research outcomes. 2) Focused investment, on more internally funded support for research, equipment, Postgraduate Research (PGR). Students and targeted investment in research leadership and research-active staff, 3) Selectively refocus the KPI and benchmarks and link staff with strong individual profiles to the best performing research groups. 4) Identify and selectively invest in emerging research areas and groups with clear potential to achieve sustainable research excellence with societal impact including cross-disciplinary collaboration.

1. Strategy, Resources, and Organisation of Research

The department of Manufacturing and Civil Engineering (IVB) has two, relatively young, research groups. Group 1- advanced sustainable composites, smart manufacturing systems, smart energy systems and group 2 - sustainable building and environments. These groups were developed from a merger in 2016 from a small number of groups who focused primarily on education. The two new groups focus, primarily, on research. Administration and management roles are clear. Several events are in place to support staff “outside” of the research groups therefore encouraging academic staff, to engage in both academic teaching and research. The department collaborates with other departments to ‘create synergies’ particularly within research and teaching. Where possible research outputs are fed into the academic programmes.

1.1 Research Strategy

The research strategy is developed by the faculty and “used” by the department although it is unclear where, how or why. Success is measured by the number of externally funded national and international projects, the number of publications in high impact international journals and the number of PhDs and MSc completed on the strategic research topics.

The key research themes are based upon the needs of industry although the unit has shown it can adapt to the needs of society and the career prospects of graduates, especially regarding sustainable and innovate solutions to support national and global problems in a number of areas. The unit is supported by strong links to industry park, Raufoss, which is one of the largest industrial parks in Norway. Despite the use of a dedicated research strategy, the department has a steady income from a mixture of national and international funding sources, including the Norwegian government, European Government, local SMEs and projects supported by their own technical laboratories (approximately 5M NOK). This is one area that could be exploited to increase income and reputation.

The development of a strategy, or a best a detailed plan, will allow the staff to recognise areas of weaknesses, and help highlight which areas need to be strengthened, which staff, require additional investment and help create a supportive environment with the goal to achieve excellence, recognition, and impact. In addition, the strategy would support the aim to promote excellence in research and innovation through the introduction of new ideas and focus on excellence with impact.

A research strategy is pivotal in creating a supportive environment that values research excellence, innovation, integrity, and open collaboration while providing staff, students and industry the opportunity to access the unit’s state of the art facilities and equipment. The

current research environment does encourage collaboration across other units and departments. The close collaboration should help identify career paths for professors and associate professors with equal opportunities.

Recommendations to the administrative unit.

- As stated previously the department does not follow their own research strategy, the direction is set by the faculty. To maintain and further develop successful research proposals, which are aligned to the themes of the unit, it is recommended that a specific research, innovation and knowledge exchange strategy is developed. The strategy needs to clearly articulate the mission of the unit and ensure it is in-line with the priorities set out by the faculty and university. The strategy needs to ensure the unit research themes are current and relevant to industry, academia and will make a positive difference to society. The unit does generate excellent research outputs and has established strong links with industry, but a dedicated strategy with clear, challenging but achievable KPIs would allow the unit to focus on developing their own niche and unique selling point, separate but linked to the faculty and university.
- The SWOT analysis stated that the focus is on education rather than research due to university college legacy, therefore, staff need to be encouraged to undertake research. In addition, being the location a small remote town, attracting staff who may be reluctant to relocate is an issue. The strategy would allow the unit to develop key priorities for staff development including (but not limited to) setting staff targets for income generation, increase PhD applications for female scientists, support staff by incentivising research via individual research and knowledge exchange plans via SMART objectives. Governance and management at a unit level, with representation from the faculty would ensure key priorities and metrics are aligned to the strategic goals of the university.
- It is recommended that a strategy, or a clearly defined plan, which would help measure the success of PhD mobility within local, national and international industries is required. Currently the plan is to invest in PhD students through different funding mechanisms but the level of success or a return on investment is unknown.

1.2 Organisation of Research

The department has a department leader, Deputy head of research, Deputy head of education and leaders for research groups 1 and 2. The deputy head of research organises yearly research seminars and innovation camps for the department. The research groups organise knowledge exchange and outreach activities. The department’s research contributes to MSc and PhD academic programmes, and all encouraged to work with a research professor on one or more research project. Professors are given targets and KPIs for research, teach on several programmes and allowed a certain amount of freedom to explore new areas of research. it is difficult to identify who is responsible for approving the development of research proposals and who has the authority to have the final decision on costs, staff time and the use of external staff. I.e. experts in a required subject. The unit does not seem to have a professoriate, or similar committee / group where strategic decisions regarding the research themes, appropriate staff, costs to develop and income are discussed.

Most of the department's research activities are carried out through research projects led by different professors within the group. Junior (early career) researchers work with the professors on the research projects. The department aims to leverage its multidisciplinary research areas to attract novel and interdisciplinary projects from the RCN and Horizon Europe. As a result, the unit currently has a large portfolio of RCN and Horizon Europe projects.

Master's students can progress to PhD programmes through internal mechanisms however, it is not clear how staff can benefit from this activity, i.e. supervise, or undertake a PhD, or apply for associate or full professor. Mobility from one institution to another or from country to country is funded via RCN yet the KPIs to measure success, value for money, EDI and benefits to the department are not clear. The department is successful with a strong local, national and international reputation for producing innovative research projects. The faculty strategy identifies priority research and innovation areas and identifies the necessary steps for development.

The research groups are structured with a professor supported, mostly, by an early career researcher. The department has a strong reputation for research, shown by publications and a good research income for the size of the department, which has 70 academics. Twenty six percent are female, which seems to be the average across the sector. The department is trying to recruit female research staff. Where possible, research outputs are included in academic programmes at under and post graduate level allowing academic staff to engage in research.

Recommendations to the administrative unit.

- It is recommended that a research unit, or group, specific and comprehensive strategy is developed to ensure the mechanisms to measure success, the goals and key themes are known to all staff, other groups and other departments. The present strategic plan is supplied by the faculty and outlines the faculty aims and vision from 2017-2022. The group/ unit strategy should build upon this strategy by "promoting" their achievements and capabilities while considering the university position, the society's needs, and the global challenges to make a true contribution and impact from research.

1.3 Research Funding

The income from research projects is approximately at the same level in 2022 as in 2018. A small drop is evident due to covid, this was followed by a small but steady rise back to 2018 levels. 50% funding is from one source – NFR; this is a concern, if funds suddenly are withdrawn, what is the strategy for attracting other funds. It is difficult to know if this is a strategic or historic decision.

There is a lack of information on the number of bids written since 2016, and not submitted, bids submitted, and bids submitted and unsuccessful. It is also difficult to understand the process for the development and the staff involved. Are bids approved before development, and by whom and do all professors take part in development working with early careers researchers, who ensures quality assurance and financial fit to the department. Are staff supplied with KPIs for income, publications etc at a formal appraisal.

Recommendations to the administrative unit.

- The department has been successful in attracting external funding, which is very much reliant on one funder. External research funding is a key to ensuring growth and success. The recommendation is to develop a clear plan to increase research income from a range of sources and to encourage and support staff to prepare and apply to appropriate and relevant opportunities. In addition, the links to other departments is clear, but lacks a group / unit plan to promote research collaboration with other Faculties within the University as well as external academic institutions and Industry to develop strong consortia. The capabilities of NTNU of funds raising seems not fully exploited but they should be.

- A formal peer review system is recommended which would ensure funding proposals are appropriate to the unit, Faculty and University. This would help identify and measure success against failure and possibly remove the reliance of over 50% of funds from one source.

1.4 Research Infrastructures

The department participates in MANULAB research infrastructure. This is a national infrastructure for manufacturing research. It is funded by RCN and its partners NTNU, SINTEF. In addition, the department has access to a range of specialist labs including the Advanced and Sustainable Engineered Materials Laboratory, the NTNU Nano lab (clean room) the National Massive MIMO research infrastructure, amongst others. The department do not participate in ESFRI but have been involved with the European Space Agency and CERN. The department has very strong links with Raufoss Industrial Park and the local County Council.

The department provided information on how “FAIR” principles which are embedded within the department. The department has access to the national Dataverse repository and employs Bookit Lab systems to track all lab experiments. The use of identifiers is used to ensure all data can be cross referenced and metadata standards are used prior to publication.

Recommendations to the administrative unit.

- The department is utilising its links and proximity to the Raufoss Industrial Park; however, in order to maintain the links and grow new collaborations with industrial labs in the country and beyond, a plan needs to be developed which helps to create synergies with existing research centres, strengthen the links between research, knowledge transfer activities, innovation, and industry engagement. New areas such as Industry 4 or Industry 5 are embedded within the group and promoted widely within local and national activities beyond, however, there lacks a plan to Invest in equipment related to targeted research. This would help identify other funding providers to secure funding to support lab work, over reliance on one funder could be dangerous. It would be prudent to consider having the labs, included in an EU - Horizon portal which allows universities to showcase their expertise and equipment throughout Europe.
- A research unit / group specific information system, if not available, to help track, analyse, support, and enhance performance would help to maintain high standards of research governance and integrity. For example, it is not clear how the labs are used by students and staff for extra curricula activities such as open days or industry presentations. While the infrastructure is well developed it is not clear how this is manged to allow for growth and sustainability.

1.5 National and international collaboration

The success of the department is testament to the hard work of the staff, and the research quality is clear. The Department has a large portfolio of Horizon Europe and RCN projects with international collaborations. The department has very strong connections within industry and academia and see this as essential to sustain and grow the department. However, it is difficult to know if this is a strategic decision or by natural design. In addition, the lack of information regarding how the unit works with original equipment manufacturers and their dedicated supply chains is missing, is there a strategy to link with an OEM and supply chain and develop specific relationships in one or two key areas, for example the Norwegian Wood Cluster. Based upon this approach, other universities have developed research centres close to an industrial park located away from the University i.e. satellite research centre co-

owned with Uni and Industry partner, is this possible for IVB? As previously mentioned, several mechanisms exist to allow universities to showcase their expertise and or equipment on funder websites i.e. EU Horizon, COST, and others, to attract partners to develop research proposal. According to the data provided, currently the research group

Manufacturing, materials and energy is a partner in 6 international and 6 national research projects and the research group for civil engineering and geomatics is a partner in 9 international and 6 national research projects. It is difficult to know if the international projects are being led by the unit, however, based upon the number of projects and the income, and the fact that the unit was developed as recent as 2016, it is reasonable to assume that their international reputation is strong and respected.

The unit is developing plans to work closer with the Raufoss Industry Park. Although the plans were not provided in the self-assessment the unit has stated that the department aims to ensure a balance of collaborative industry led projects and basic research with other universities. National and international collaborations have been successful, and the unit has plans in place to strengthen the European research portfolio, including the use of interdisciplinary research expertise within the department to attract international partners. The plans also require increased work with the local council, where it is necessary for the unit and or department to define shared priorities, objectives, and programs of work, for example with the Norwegian Wood Cluster, where the shared goal is to address local needs, drive innovation, and create a more inclusive community.

Recommendations to the administrative unit.

- The recommendation is to continue to develop connections with industry and academia to find new partners for research collaboration and possible teaching exchanges to enhance the international reputation. Identify areas to disseminate their skills and expertise using the number of expert registers available in Europe and wider.

1.6 Research staff

Based upon supplied paperwork it is difficult to determine the recruitment policy. Plans to support gender balance, EDI and the promotion of mobility can be found but lack specific detail. The workload model is 40-40-20 which is common amongst Norwegian universities. Sabbaticals for up to one year are available. It is difficult to determine if there is an expectation that each prof, or associate prof, would have several PhD students. At the date of publication, the department had 27 PhD fellows and 27 professors and associate professors, with a ratio of 1 PhD per year per professor. This is an average value among the Units considered in the present exercise.

The department reports 70 employees in academic and research positions, of which 26% are female. IVB has 8 professors, 19 associate professors and 11 lecturers. After merge with NTNU in 2016, all new positions were announced as either professor or associate professors thereby moving the focus from teaching to research.

The department has introduced a number of systems to support career development such as an integrated PhD track to recruit master students into PhD positions. Allowing potential PhD students to work on their PhD before they complete their master’s degree, seems unique to this sector. The department offers a starters kit for newly recruited female researchers. In addition, mentoring programmes and academic fellowship programmes are in place to help attract and retain promising research staff.

In addition, specific RCN mobility projects such as International Partnerships for Excellence in Education, Research and Innovation have been used by the department. Recently, the department has also been developing mobility proposals for the Marie Curie Initial Training Network (ITN) program. Staff mobility is funded by the research projects, although the department has received additional funding for mobility from RCN. Annual talks with permanent staff are documented in which clear guideline on how, for example, a professor manage time, develop funding proposals etc. Staff performance is measured against these guidelines. Six-month reviews are then used to measure performance.

Recommendations to the administrative unit.

- While the research staff are successful in attracting funding and have access to state-of-the-art labs, (in certain areas) a recommendation, as with previous areas, is to develop a strategy which formalised the role and expectations of the staff, if one exists it was not provided. The “role profile” would identify key tasks, i.e. teaching, research, reach out, admin, and clearly define the main purpose and key accountabilities such as funding, management and leadership. The role profile needs to form part of the staff appraisal system and be managed by the member of staff and the line manager. The profile would provide clear roles, responsibilities and metrics while providing the detail to develop a skills matrix, this is helpful when deciding upon cross disciplinary activities.
- Different student numbers were available through university website and data provided, however the split between academic programmes was not provided, based upon the 40-40-20 academic workload, it could be prudent to evaluate the amount of teaching undertaken by active research staff. Could students be taught or supervised in labs by PhD students, freeing up time to develop the research portfolio. PhD could be encouraged to support with the supervision of undergraduate final-year projects and/or MSc projects. This could be considered as part of the normal activities of a PhD student, and potentially a very formative experience.

1.7 Open Science

The department follows the university open access policies and has a system for Gold, green and hybrid publishing models. Funds are available centrally to support open access charges. The NTNU data management plan is based upon the FAIR plan. NTNU is a member of DataverseNO, to allow information open and available under a CC-BY licence. This policy has been used well and seems to be successful.

The NIFU data shows that, from 2013 to 2022, archived data increased from 10.0% to 37.1%, and golden access publications increased from 0% to 36.1%. Therefore, non-open-access publications decreased from 90% to 26.8%. These numbers are in line with the national average for archive, golden access, and non-open access (41.5%, 35.3%, and 23.2%) and evidence a positive effort to increase open access publications.

Recommendations on how to promote open science.

- It is recommended to continue to follow the data management plan (FAIR) with the university policies and procedures for open access and Equality and ensure the policy applies equally to all researchers and across all disciplines.

2. Research production, quality and integrity

The Department’s main research activities are stated as Informatics, Multidisciplinary technology, Chemistry and material sciences, Construction engineering, Multidisciplinary natural science, and Energy. Most of the department’s publications are in Informatics,

followed by Multidisciplinary technology and Chemistry and material sciences. From the merger in 2016, the unit has attracted a number of national and international research projects funded by industry and European funding bodies. Professors in key research themes have been appointed although the number of professors has decreased from 10 in 2013, to 6 in 2021, while associate professors have increased from 5 to 20 at the same time.

2.1 Research quality and integrity

The newly formed (2016) research groups are active in developing applied research solutions for industry. However, it is difficult to obtain detailed individual group research activity as the data seems to be by department and not a specific/ individual group.

When explored in the interview the answers were centred around the ongoing development of a system to record the necessary data at faculty and university level. This may be due to the size of the department.

Publications have grown significantly from 2013-2022 and grown very well since 2019-2022. However, it is difficult to determine if this is due to the newly formed research groups, or a by-product of Covid or a change in the faculty strategy. A significant number of papers are not open access, yet data is not provided as to why.

According to the NIFU data, the number of publications of the group grew from 57 in 2019 to 97 in 2022. This represents a publication rate of 1.3 papers per research member per year, in 2022, and the percentage of all author shares is 1.1%. These numbers put the research unit slightly close by the national average.

These numbers align with the 9.9% participation in the 10% most cited papers and the normalised citation index of 93 in 2023.

Regarding collaborations in publications at the national and international levels, the research unit has a share of 6.2% for the first and 62.9% for the latter. The first number is significantly lower than the national average of 24.3%, and the latter is slightly above the national average of 56.9%. Over the 2019-2022 period, these numbers have been stable. It is difficult to determine which group has published in which ranking score (Q1-Q3)

International researchers bring mix of skills, knowledge and expertise in securing funds and the department has a very strong mix of academic and industrial networks. The department has a good track record of income generation – unclear as to which thematic area or group income is assigned to. Distance between centres seems to be problematic and access to dedicated labs is difficult due to distance – possible opportunity for competition to increase their market share. A SWOT analyses was provided but this was generic for the department and not the research groups.

The recommendation is to at least maintain the quality and quantity of the research outputs and create a strategy to ensure the quality is not lost due to quantity.

Research group Manufacturing, materials and energy. Overall assessment.

This research group has a broad research portfolio which fall under the sub-headings of advanced sustainable composites, smart manufacturing systems, smart energy systems. Areas include Industry 4.0. Process monitoring, machine learning and machine vision, Sustainable manufacturing, Manufacturing Systems modelling, Additive Manufacturing, Wireless sensor systems and wireless industrial communication. Product design, quality engineering and measurement systems. This new group was formed in 2016 and since then has attracted professors with an international reputation, a number of national and international research projects.

The group has very good links with local industry partners based in the Raufoss industry park and works closely with Sintef. The group have access to state of the art labs, in Manulab which is a national infrastructure for manufacturing and engineering research. Funded by the Norwegian research council and others, it is managed by the Department of Manufacturing and Civil Engineering.

One issue is the lack of a specific research strategy which will help prioritise the key themes, identify and build upon the strengths to drive innovation and enhance the student experience. The group has shown that they are capable of developing internationally excellent and world-leading research with real-world impact. From the data provided it seems the workload is 40-40-20, while this seems standard across Norway, more time could be diverted to research without compromising teaching responsibilities or affecting the student experience. That being said, the group do have a strong international presence.

Based upon the data provided, it is very difficult to determine how the research funding is shared amongst the groups, as all funding is centralised and provided to the groups. A risk to this group is the number of international universities who operate in this area with regard to teaching and research and it is difficult to see the unique selling point which would make this unit stand above the competition.

Overall, a good research group with a reasonably strong local and national presence and a good international presence, with a high number of research areas but lack a specific research strategy.

NB, it was often difficult to split the two research groups from the data provided especially when reviewing staff profile and recruitment strategy, the split in funding, the publication data and research project management. Both group assessment will be similar.

Research group: Civil engineering and geomatics. Overall assessment.

As with the previous group, this research group has a wide portfolio and includes sustainable building and the built environment. Built environment and Geomatics. This is divided into 5 subheadings, geomatics, Life cycle sustainability assessment, optimisation and decision support, sustainable and resilient built environment development, Digital Twin for sustainable built environment. The group have access to a number of labs, including a Geomatics lab, a Building Information Modelling - BIM, Virtual and Augmented Reality VR/AR and the Norwegian Research Laboratory for Universal Design. The group is also part of the Norwegian Wood Cluster.

This group has good industrial collaboration, a good mix of publications and a reasonably clear focus on which themes are society shaping. As with the previous group, while group management is clear, it is difficult to understand how funding is divided, what is the split between research and teaching and what is the strategy to grow and sustain the large number of research areas. A formal strategy is required to bring together the different plans for growth and to identify the unique selling point. It is difficult to know which staff work in which research group from the information supplied and the website.

Overall, a good research group which could formalise activities with a defined and specific strategy and require a unique selling point.

3. Diversity and equality

The department has a range of plans, policies and procedures to address gender balance. 8.2% of professors 28% of associate professor and 16% of research fellows are female. This is typical across the sector. The department has a strong "marketing campaign" to increase the number of females across the disciplines. The department follows the university action plan on gender equality and diversity which is aligned with *"NTNU's mission and vision of "Knowledge for a better world". Knowledge for a better world is best created in an organisation with equal opportunity, diversity and gender balance".* The unit follows the action plans, strategies and measures to ensure gender equality and diversity are followed. Documents were provided which clearly outline the different development plans firmly embedded within the university to address issues such as gender, diversity and sexual harassment.

4. Relevance to institutional and sectorial purposes

Research within the department is used to develop research informed academic programmes. There exists a strong link between the MSc programmes and the PhD student programmes of research. Students within the department can work on a PhD and or industrial projects while studying for their MSc.

The list of collaborative partnerships provided are impressive and show the breadth and quality of the partnership outputs, as stated by the department, more can be done to explore and expand the partnerships to help expand reputation and diversify income streams. The different research themes discussed in the collaborative partnerships show a broad range of themes and good international networks supported by modern labs, with state-of-the-art equipment. However, it has been stated that the lack of synergy between the themes can be problematic when trying to create a strong relationship with other departments. This could impact external relationships with local SMEs who requires quick and easy access to a solution which requires more than one department. In addition, access to the labs, can be often time consuming and expensive.

It is not clear how the department directly contributes to policy development for intelligent manufacturing systems or sustainable composites. However, via several good publications and the impact case studies, the contribution to the knowledge base is evident.

<u>Recommendations</u>

- It is recommended that the department continues to allow MSc student to engage in PhD studies, this seems unique across the sector. The research at the department is implemented in the different subjects, although it was difficult to see this. To ensure research led or informed teaching the group should continue to allow professors and associate professors to teach in a range of subjects. A clear plan is required to show how new programmes are developed based upon society needs and the changing academic landscape.

5. Relevance to society

The department teaching and research are relevant to the needs of society as described via the reports supplied and the impact case studies. One study described the development of a cost-effective wireless sensor for monitoring bolted sections. The study involved the development of a system that would operate in harsh conditions and monitor several crucial factors such as heat, humid and pressure. The project was led by a senior research professor and, at the time, two PhD students. However, information provided in the details of

the impact section explains the company and its achievements and not the impact of the new bolt system to the company. Web links are provided to company websites in which the bolt is described but all seem to claim, “in the future” and “trials are ongoing. It was difficult to determine if the system was built and tested and if impact had been recorded for the company, the university and society.

The recommendation is to understand the challenges and opportunities faced by their local communities. A strategic approach involves conducting research with local relevance and addressing community-specific (and perhaps not obvious) issues.

Comments to impact case 1: Title: Geographical Island Flexibility (GIFT)

The GIFT case study is centred around energy sustainability on inhabited EU island, who are dependent upon fossil fuels. The aim is to develop a virtual power system utilising an energy management system with advanced data visualisation. This was linked to renewable energy, greenhouse gas emissions and international green energy mandates. This is a complex and multi-faceted project combining several different systems including predictive modelling, digital twins and a virtual power management system.

The research team, at the time, consisted of two professors, two associate professors, one lecturer and three PhD students. The underpinning research was very good. A detailed table was provided outlining the research methodology and the planned outputs. Three references to internal journal publications were cited to support the research.

This was a very good case study with multiple outputs which influence policy and procedures. Weblinks' are provided which show the progress and potential outputs of the project.

Methods and limitations

Methods

The evaluation is based on documentary evidence and online interviews with the representatives of Administrative Unit.

The documentary inputs to the evaluation were:

- Evaluation Protocol that guided the process
- Terms of Reference
- Administrative Unit's self-assessment report
- Administrative Unit's impact cases
- Administrative Unit's research groups evaluation reports
- Bibliometric data
- Personnel and funding data
- Data from Norwegian student and teacher surveys (only for HEI's)

After the documentary review, the Committee held a meeting and discussed an initial assessment against the assessment criteria and defined questions for the interview with the Administrative Unit. The Committee shared the interview questions with the Administrative Unit three weeks before the interview.

Following the documentary review, the Committee interviewed the Administrative Unit in an hour-long virtual meeting to fact-check the Committee's understanding and refine perceptions. The Administrative Unit presented answers to the Committee's questions and addressed other follow-up questions.

After the online interview, the Committee attended the final meeting to review the initial assessment in light of the interview and make any final adjustments.

A one-page summary of the Administrative Unit was developed based on the information from the self-assessment, the research group assessment, and the interview. The Administrative Unit had the opportunity to fact-check this summary. The Administrative Unit approved the summary with minor adjustments.

Limitations

The Committee judged that the Administrative Unit's self-assessment report was insufficient to assess all evaluation criteria fully, and some information gaps remained after the interview with the Administrative Unit.

List of administrative unit's research groups

Institution	Administrative Unit	Research Groups
Norwegian University of Science and Technology (NTNU)	Department of Manufacturing and Civil Engineering (IVB)	Manufacturing Materials and Energy
		Civil engineering and geomatics group

Terms of Reference (ToR) for the administrative unit

The board of the Faculty of Engineering, Norwegian University of Science and Technology (NTNU) mandates the evaluation committee appointed by the Research Council of Norway (RCN) to assess department of Manufacturing and Civil Engineering (IVB) based on the following Terms of Reference.

Assessment

You are asked to assess the organisation, quality and diversity of research conducted by IVB as well as its relevance to institutional and sectoral purposes, and to society at large. You should do so by judging the unit's performance based on the following five assessment criteria (a. to e.). Be sure to take current international trends and developments in science and society into account in your analysis.

a) Strategy, resources and organisation

b) Research production, quality and integrity

c) Diversity and equality

d) Relevance to institutional and sectoral purposes

e) Relevance to society

For a description of these criteria, see Chapter 2 of the mathematics, ICT and technology evaluation protocol. Please provide a written assessment for each of the five criteria. Please also provide recommendations for improvement. We ask you to pay special attention to the following 5 aspects in your assessment:

1. As a department under NTNU's Faculty of Engineering, IVB follows common strategic goals and priorities from both a faculty level and centrally at NTNU, as well as on a departmental level. Relevant strategic documentation from NTNU has been listed under "Documentation". Note that the Faculty of Engineering's Research Strategy for 2018-2022 is still valid.
2. IVB is responsible for 2 research groups. The first group focuses on manufacturing, sustainable materials, energy, and ICT. The other group focuses on sustainable and digital built environment, such as building information modelling, digital twin, sustainability assessment, circularity, and timber-based solutions.
3. IVB is a relatively new administrative unit, established in 2016, after the merger of Gjøvik University College (HiG) with NTNU. It is relatively young department that is still being built up. The two research groups mentioned above (formerly part of HiG) make up the new department at NTNU Gjøvik.
4. Before the merger with NTNU, as part of the University College, the focus of both groups was on education. After the merger, IVB has an increasing focus on research and the research infrastructure has been (and continues to be) significantly upgraded. The research groups are still working towards consolidating their main research directions.
5. The research areas of IVB may not be fully covered by the various panels (areas such as composite materials and life cycle assessment of materials and processes). We have asked the RCN to expand the panels to cover as much of the IVB's research areas as possible.

In addition, we would like your report to provide a qualitative assessment of IVB as a whole in relation to its strategic targets. The committee assesses the strategy that the

administrative unit intends to pursue in the years ahead and the extent to which it will be capable of meeting its targets for research and society during this period based on available resources and competence. The committee is also invited to make recommendations concerning these two subjects.

Documentation

The necessary documentation will be made available by the mathematics, ICT and technology secretariat at Technopolis Group.

The documents will include the following:

- • a report on research personnel and publications within mathematics, ICT and technology commissioned by RCN
- • a self-assessment based on a template provided by the mathematics, ICT and technology secretariat
- • strategic plans of relevance from NTNU and its Faculty of Engineering, (hyperlinks to NTNU-sites included):
    - NTNUs main strategy 2018-2025 (e)
    - NTNUs development agreement with the ministry 2023-2025 (n)
    - NTNUs wider contribution to innovation, (n)
    - NTNUs international development plan 2023-2025 (e)
    - NTNUs development plan for open science 2023-2025 (e)
    - NTNUs development plan for gender equality and diversity 2023-2025 (e)
    - Faculty of engineering main strategy 2018-2025 (n)
    - Faculty of engineering research strategy 2018-2022 (e)

Interviews with representatives from the evaluated units

Interviews with the IVB will be organised by the evaluation secretariat. Such interviews can be organised as a site visit, in another specified location in Norway or as a video conference.

Statement on impartiality and confidence

The assessment should be carried out in accordance with the *Regulations on Impartiality and Confidence in the Research Council of Norway*. A statement on the impartiality of the committee members has been recorded by the RCN as a part of the appointment process. The impartiality and confidence of committee and panel members should be confirmed when evaluation data from IVB are made available to the committee and the panels, and before any assessments are made based on these data. The RCN should be notified if questions concerning impartiality and confidence are raised by committee members during the evaluation process.

Assessment report

We ask you to report your findings in an assessment report drawn up in accordance with a format specified by the mathematics, ICT and technology secretariat. The committee may suggest adjustments to this format at its first meeting. A draft report should be sent to the IVB and RCN. IVB should be allowed to check the report for factual inaccuracies; if such inaccuracies are found, they should be reported to the mathematics, ICT and technology secretariat within the deadline given by the secretariat. After the committee has made the amendments judged necessary, a corrected version of the assessment report should be sent to the Faculty of Engineering, NTNU and the RCN no later than two weeks after all feedback on inaccuracies has been received from IVB.

Appendices

1. Description of the evaluation of EVALMIT
2. Invitation letter to the administrative unit including address list
3. Evaluation protocol
4. Template of self-assessment for administrative unit (short-version)

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