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Case Study Review of Interdisciplinary Research in Norway

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Executive summary

Interdisciplinary research (IDR) is gaining a lot of attention both in Norway and globally because the emphasis on tackling complex real-world problems and conducting frontier research means that traditional monodisciplinary approaches are no longer appropriate. This has resulted in a range of approaches being adopted by funders, researchers and institutions to stimulate and support IDR. In this study, we consider the cases of 5 research institutions in Norway that take a variety of approaches to support IDR. The sample includes a range of institution types and considers different approaches, geographical locations and disciplinary spread.

Individual case studies were compared and contrasted to identify commonalities and differences among approaches adopted to support IDR in Norway and see how these approaches compare with approaches used by English Higher Education Institutions (HEIs).¹ This analysis forms the basis of this report.

Drivers for supporting IDR

Current research priorities for Norway and the Nordic region, as articulated in the Norwegian government's long-term plan for research and education² and research themes for education and research in the Nordic region³ are reflected in the research strategies of most Norwegian universities. These priorities concern interdisciplinary topics like climate change, enabling technologies and oceans, thus increasing the emphasis on IDR in Norway. From the English context, we know that a focus on IDR in institutional strategies can help to embed interdisciplinarity in an institution even though it is not essential for supporting IDR. In Norway, a strategic focus on IDR seems to have stimulated researchers to adopt interdisciplinary ways of working.

Overall, the following drivers for supporting IDR emerged from this study

- To undertake research that addresses major societal challenges in line with Norwegian and international research policies
- To fulfil the purpose of the institution and the institutional strategy
- To access more diverse or larger funding streams

These reasons mirror those that emerged from our previous case study review of English HEIs⁴ where the two main drivers for institutional support for IDR were to undertake research that addresses practical issues or societal challenges, and to access a wider variety of or larger external funding sources. Both drivers were also identified independently in the Landscape Review of the UK's IDR.⁴

Approaches for organising and supporting IDR

Norwegian research institutions undertake various approaches to organise and support IDR. The approaches outlined below were commonly employed across our sample.

¹ <http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/Independentresearch/2016/Two,reports,on,interdisciplinary,research/Technopolis-Case%20study%20of%20interdisciplinary%20research%20in%20HEIs%20in%20England.pdf>

² <https://www.regjeringen.no/en/topics/research/innsiktsartikler/langtidsplan-for-forskning-og-hogare-utdanning/mal-og-prioriteringar/id235351/>

³ <http://www.norden.org/en/theme/education-and-research-in-the-nordic-region>

⁴ <http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/Independentresearch/2016/Two,reports,on,interdisciplinary,research/Landscape%20review%20of%20UK%20interdisciplinary%20research.pdf>

Ways of organising IDR

The institutions in our sample frequently combined the following two approaches

- Co-location of different disciplines in a single location such as a centre, institute or department with ‘virtual networks’ of external collaborators
- Top-down strategic approaches combined with bottom-up investigator-led approaches

Co-location approaches usually involve the creation of cross-faculty research centres like the Arctic Centre for Sustainable Energy, Centre for the Science of Learning & Technology (SLATE) and Centre for Scalable Data Access in the Oil and Gas Industry (SIRIUS) at the Universities of Tromsø, Bergen and Oslo respectively or thematic research centres within institutes and university departments such as the Centre of Precision Agriculture and Norwegian Genetic Resource Centre at Norwegian Institute of Bioeconomy Research (NIBIO) and the Centre for Technology and Society and Centre for Gender Studies within the Department of Interdisciplinary Studies of Culture at Norwegian University of Science and Technology (NTNU). Co-location of different types of expertise in centres is complemented by external partnership networks or ‘virtual networks’ in other organisations including universities, companies, public sector organisations, etc. and other departments or faculties. These partners are an integral part of the centre’s IDR teams and these teams regularly communicate with each other, often through online means, hence our use of the term ‘virtual network’.

Top-down strategic approaches take the form of research priority areas or themes of strategic importance to an institution. These encourage researchers to adopt interdisciplinary ways of working. On the other hand, the research projects themselves originate in a bottom-up manner with researchers choosing their own research questions, project teams and level of interdisciplinarity. A mix of top-down and bottom-up approaches was the norm among the cases selected for this study.

Co-location, virtual network, top-down and bottom-up approaches are also used within English HEIs, however they are not always combined with each other. Nevertheless, flexible systems that accommodate both researcher- and institution-led approaches seem to work well in the English context as well.

Ways of stimulating and growing IDR

The institutions in our sample commonly use the following mechanisms to grow, support and embed IDR

- **Networking**, both formally through seminars, conferences and workshops or informally through lunch meetings and coffee mornings

Institutions try and create opportunities for people with different disciplinary backgrounds and expertise to interact and exchange ideas. Networking outside the institution can be used to develop external networks that can help to fill gaps in in-house competences and expertise. While ‘virtual networking’ can also work, face-to-face interactions are also important.

- **Training students** to be interdisciplinary through dedicated master’s and PhD courses to grow the IDR skills base and thus the capacity for IDR

With the exception of NIBIO, which is a specialist research institute, each of the university-based institutions selected for this review train both master’s and PhD students. In addition, SIRIUS runs a mentoring programme where post-doctoral researchers and PhD students are mentored for 9-12 months by industrial partners.

- **Recruitment** to build research capacity and plug gaps in technical expertise

Especially when senior staff are recruited, they can help consolidate new themes of research and provide access to additional researcher networks. For instance, by recruiting a researcher from the

Geosciences Department, SIRIUS not only added more value to its research, but also gained access to the researcher's departmental knowledge.

- **Acquiring external funding** to expand the resources available for IDR beyond the core funding available

External funding can enable institutions to recruit more staff and thus increase IDR activity or to sustain IDR activity when core funding is no longer available. Interviewees from the Department of Interdisciplinary Studies of Culture at NTNU believe that they have been particularly successful in acquiring a large volume of external funding because of their experience of applying for external funding and their interdisciplinary competences which help to frame grant proposals in a manner that appeals to funding agencies.

In English HEIs, acquiring external funding is the second step on the 'funding ladder' which moves from small amounts of seed funding (over the short term) to securing an external project grant (medium term) and culminating in the establishment of a research centre (long term). A similar strategy was not explicitly visible among the Norwegian cases.

- **Creating a supportive environment**

It is important to have a research environment that is open and welcoming to researchers from different disciplines and encourages them to talk to and work with each other. Institutions do this by investing in infrastructure such as centres and providing administrative support, thus establishing a supportive organisational culture, providing platforms for interdisciplinary discussion and removing barriers to IDR.

Awarding seed funding for IDR projects is also a valuable way to legitimise and support IDR activity as we observed in the English HEIs. In England, small pots of core institutional funding were awarded for pump-priming activities such as proof-of-principle research projects and developing bids for external funding. In Norway, internal funding awarded for IDR is usually more substantial and over a longer term (years compared to months) than the seed funding grants in English HEIs. For example, NIBIO's Strategic Institute Initiatives fund internal projects, typically for 5 years.

- **Approaches that cut across existing institutional structures**

Initiatives such as cross-faculty themes and clusters help to overcome disciplinary boundaries that result from having disciplinary faculties and faculty-based administrative and financial systems.

'What works' and lessons learned

The following lessons were articulated as being of importance for undertaking IDR, and as such, should be kept in mind.

- **Developing and nurturing IDR is demanding, requiring the investment of time and effort**

IDR can take longer to bear results owing to the necessity of coordinating a team, communicating regularly, learning about another discipline and keeping abreast of developments in more than one field.⁵ The success of IDR collaborations can be improved by facilitating factors such as a supportive research environment and openness, curiosity, respect, good communication, effective leadership and a shared vision within the project team. On the other hand, barriers to successful IDR include lack of shared understanding of aims and concepts within a team; the disciplinary nature of many Norwegian degree programmes which results in a lack of interdisciplinary skills; disciplinary differences in conceptual understanding, norms and methodological requirements; disciplinary organisation of universities (e.g. faculties) and related administrative and financial systems; difficulty of publishing IDR in top-rated journals and strong economic disincentives for interdisciplinary publishing because of the current structure of the National Science Index (NVI).

⁵ Burggren, W., Chapman, K., Keller, B., Monticino, M. and Torday, J., 2010. Biological sciences. In: Frodeman, R., Klein, J.T. and Mitcham, C. ed. *The Oxford Handbook of Interdisciplinarity*. Oxford: Oxford University Press, pp.119–132.

- **A balance between top-down and bottom-up approaches is important**

Top-down approaches help to provide a structure for IDR, while bottom-up approaches are important for getting researcher buy-in. While researchers formulate the research ideas and suggest collaboration partners, they also adapt to the requirements and orientation of funding sources and calls. Thus, a balance between bottom-up and top-down approaches is crucial.

UiT provides a good example of this balance. Inclusion of five research priority areas (technology; energy, climate, society and environment; sustainable use of resources; community development and democratisation; health, welfare and quality of life) in the university's strategy for 2014-2020 and annual funding calls for interdisciplinary projects involving at least three faculties can be considered the top-down approaches. Conversely, bottom-up approaches include faculty-level initiatives which have led to the founding of centres like the Arctic Centre for Sustainable Energy and project-level collaborations including those funded through the annual IDR calls.

- **Thematic initiatives can help build a culture of IDR**

Research themes concerning societal challenges can provide a focus for IDR by moving attention away from disciplines to problem solving, thus acting as an incentive for people with different types of expertise to team up. For example, most of the IDR at NIBIO occurs in thematic research centres and units such as those focused on precision agriculture, international development, Norway's genetic resources and climate. The Universities of Oslo and Bergen as well as UiT and NTNU have named key strategic research areas, most of which require an interdisciplinary approach.

While thematic initiatives were common among the English HEIs as well, two of the cases studied – the Royal College of Art and the White Rose University Consortium – did not adopt a thematic approach. Instead they focused on fostering high-quality research regardless of whether it was inter- or mono-disciplinary. This approach does not seem to affect the capacity of these institutions to instigate and support high-quality IDR.

- **Collaborations are smoother when they stem from existing research networks or previous collaborations**

Teams established through interdisciplinary networks or from previous experience of working together will have established structures and trust meaning there will be less lag time in starting a project and fewer hurdles to overcome in conducting the research. Therefore, research teams with previous experience of working together often have a greater chance of securing external funding and delivering high-quality outputs. SIRIUS is a case in point in that it has overcome the usual challenges experienced in the establishment of large consortia mainly because its structure (including partners) and industrial advisory board are based on the groundwork laid in the EU Framework Programme project, *Optique (Scalable End-user Access to Big Data)*⁶.

While the advantages of having teams that have worked together previously is echoed in the literature,⁷ it has also been shown that new collaborations can sometimes be more innovative in terms of mixes of expertise, approaches and ideas.⁸ In English HEIs, this contradiction has been circumvented on occasion through the use of small seed funding or pump-priming grants which allow researchers to form new IDR teams while also gaining experience of working together.

- **Researchers can maintain a variety of disciplinary and interdisciplinary identities**

Combining a disciplinary identity with one or more interdisciplinary identities facilitates IDR and strengthens its quality since it helps scholars keep up with a wider set of theoretical and methodological advances. For some, keeping a disciplinary identity is important and constitutes a way to approach and participate in IDR. One remains a 'political scientist' or 'historian', and contributes to IDR from this perspective. For others, a new, more interdisciplinary identity such as

⁶ <http://optique-project.eu>

⁷ http://www.nap.Edu/download.php?record_id=11153

⁸ Cummings, J.N. and Kiesler, S., 2008. Who collaborates successfully? Prior experience reduces collaboration barriers in distributed interdisciplinary research. *Proceedings of the 2008 ACM conference on Computer supported cooperative work*, 437-446.

a gender studies researcher has grown. However, a new identity may take time to develop and may not follow a standard template, bringing together different disciplines in varying degrees.

Policy considerations

The study highlights the following points which decision makers should consider when developing a strategy for supporting and encouraging IDR

- A collaborative and supportive research environment where IDR is accepted as a legitimate and valuable activity is very important for fostering IDR
- Priority research themes can provide a focus for IDR and galvanise research activity towards addressing research problems in that area
- Co-location of different disciplines in one place is not a prerequisite for IDR. However, a space, either physical or virtual, for the collision of ideas is necessary
- Researchers' previous experience of working together makes collaborations smoother and might increase the chances of securing funding and delivering high-quality outputs
- Both top-down and bottom-up approaches can be used to grow and support IDR. However, a top-down approach will need buy-in from academics while bottom-up approaches will need institutional support to remain successful in the long run
- Involvement of key staff, for example, strategic leaders as 'champions of IDR' within and outside research institutions can help to increase the visibility of the institution's IDR internally as well as externally and to embed it in institutional structures and culture
- A formal evaluation of IDR activity within institutions will provide useful intelligence regarding factors affecting the success and failure of interdisciplinary collaborations. Similarly, an evaluation of peer review processes for awarding research funding will help to allay concerns regarding bias against interdisciplinary proposals and the capability of reviewers and expert panels to review them

1 Introduction and literature review

1.1 Spotlight on interdisciplinary research (IDR)

Interdisciplinary approaches to research are gaining a lot of attention both in Norway⁹ and globally because of the emphasis on tackling complex real-world problems.¹⁰ As scientific knowledge production continues to shift towards problem-oriented research, traditional monodisciplinary approaches are no longer appropriate;¹¹ indeed, they may actually hinder the development of fitting solutions. In fact, problem-solving as conceptualised by Gibbons et al¹² can be accomplished using one of two modes of knowledge production, where Mode 1 knowledge production is disciplinary and Mode 2 is interdisciplinary. Mode 2 includes not only the practice of applied science in universities and other research institutions but also the generation of research-based knowledge elsewhere in society. Mode 2 work is transient, and forms and re-forms around applications problems. It typically brings together the analytical and/or methodological strengths of two or more disciplines to search for or to create new knowledge, operations or art,¹³ as exemplified by several fields of productive study, such as biochemistry, biophysics, social psychology, geophysics and informatics.¹⁴

The increased focus on ‘frontier research’, which aims at creating new knowledge irrespective of established disciplinary boundaries or traditional distinctions between applied and basic research, is also an additional driver.¹⁵ Since 2000, many European programmes such as New and Emerging Science and Technology (NEST) and the European Research Council have had an explicit focus on frontier research.

1.2 Defining IDR

The notion of interdisciplinarity can be vague,¹⁶ and when further coupled with additional terms such as multidisciplinary, pluridisciplinarity, crossdisciplinarity and transdisciplinarity, can result in much confusion.¹³ Besides, these terms are often used interchangeably in practice, which further exacerbates the problem. The fact that interdisciplinarity is complex, heterogeneous, dynamic and context-specific in nature also makes it difficult to define.¹¹ Moreover, the contentious issue of what counts as a discipline is inherent in any discussion of interdisciplinarity.

Choi and Pak (2006) have attempted to tease out the differences between some of the terms used to describe interdisciplinarity and recommend the following definitions:

“Multidisciplinary draws on knowledge from different disciplines but stays within the boundaries of those fields.

Interdisciplinarity analyses, synthesises and harmonises links between disciplines into a coordinated and coherent whole.

⁹ https://www.regjeringen.no/en/dokumenter/meld.-st.-7-2014-2015/id2005541/sec1?q=long-term%20plan%20for%20research#match_0

¹⁰ Pohl, C., van Kerkhoff, L., Hersch Hadorn, G. and Bammer, G., 2008. Integration. In: Hoffmann-Riem, H., Biber-Klemm, S., Grossenbacher-Mansuy, W., Joye, D., Pohl, C., Wiesmann, U., and Zemp, E. ed. *Handbook of transdisciplinary research*. Zurich: Springer, pp.411-424.

¹¹ Schmidt, J.C., 2008. Towards a philosophy of interdisciplinarity: An attempt to provide a classification and clarification. *Poiesis & Praxis: International Journal of Technology Assessment and Ethics of Science*, 5, 53–69.

¹² Gibbons, M., Limoges, C., Nowotny, H., Schwartzman, S., Scott P. and Trow, M., 1994, *The New Production of Knowledge*, London: Sage; and Nowotny, H., Scott, P., and Gibbons, M., 2001, *Re-thinking Science: Knowledge and the public in an age of uncertainty*, Polity, London

¹³ Nissani, N., 1997. Ten cheers for interdisciplinarity: The case for interdisciplinary knowledge and research. *The Social Science Journal*, 34, 201-216.

¹⁴ Aboelela, S.W., Larson, E., Bakken, S., Carrasquillo, O., Formicola, A., Glied, S.A., Haas, J. and Gebbie, K.M., 2007. Defining Interdisciplinary Research: Conclusions from a Critical Review of the Literature. *Health Services Research*, 42, 329–346.

¹⁵ https://ec.europa.eu/research/future/pdf/hleg_fullreport_frontier_research_april2005.pdf

¹⁶ Siedlok, F., and Hibbert, P., 2014. The organization of interdisciplinary research: modes, drivers and barriers. *International Journal of Management Reviews*, 16(2), 194-210.

Transdisciplinarity integrates the natural, social and health sciences in a humanities context, and in doing so transcends each of their traditional boundaries.”

Multi-, inter- and transdisciplinarity represent a continuum where multidisciplinary has the lowest degree of synthesis and collaboration between disciplines, and transdisciplinarity has the highest.¹⁷ For example, disciplinary boundaries are maintained in multidisciplinary research, necessitating little, if any, interaction between disciplines. Usually, there is no improved understanding of the problem as a whole, and the disciplinary hierarchies, structures and functions remain unchanged; moreover, the researchers’ worldviews remain unchanged.¹⁸

In contrast, powerful disciplinary interests are often challenged by interdisciplinarity, which can be messy, bottom-up and embodied within small teams or individuals.¹⁹ Herein, participants often collaborate on a common research problem; they develop and use a common language, while retaining their own disciplinary methods and conceptual frameworks.¹⁷ Synergistic outcomes, which are more than the sum of the parts, are obtained.¹⁸ Such research can yield unexpected insights and potentially transformative solutions, but are also vulnerable to competition from multidisciplinary approaches, which are more conventional.¹⁹

Transdisciplinarity, on the other hand, transgresses and transcends disciplinary boundaries.²⁰ It integrates different perspectives and methods, not only from academia but also from societal stakeholders such as governmental organisations, charities and industry, in the process creating common frameworks and languages.²¹ Such an approach can provide a distinctive focus for intellectual endeavour that is not bound by a traditional disciplinary structure.²¹

Among the less popular terms for interdisciplinarity, ‘pluridisciplinarity’ is used as a synonym for multidisciplinary, while ‘crossdisciplinarity’ has not been defined explicitly and can represent a myriad of discipline-crossing activities.²² For the purpose of this report, the term ‘interdisciplinarity’ or ‘IDR’ is used as an ‘umbrella’ term to encompass all modes of interdisciplinary activity.

1.3 Evaluating IDR

Political and public demands for accountability and transparency in the use of taxpayers’ money for research necessitates the development of robust and reliable mechanisms for evaluating all types of research including IDR. However, the complex, heterogeneous nature of IDR and disparate value systems of disciplines create problems for conceptualising acceptable indicators of the quality and extent of IDR.

Among several ways to evaluate IDR,²³ one is to conceptualise IDR as a combination of multiple disciplines. In this case, the individual components of the project are assessed according to the norms and criteria of the discipline that they fall under. Novelty and knowledge creation from the point of view of the parent discipline are desired, but may not be possible to achieve for each and every discipline involved. Basically, this approach provides fragmented rather than holistic evaluation of a research project. The second way emphasises integration and synergy between disciplines. The idea is to create a new ‘model of excellence’ that is comprehensive i.e. measures all the activities of the research group. The

¹⁷ Aboelela, S.W., Larson, E., Bakken, S., Carrasquillo, O., Formicola, A., Glied, S.A., Haas, J. and Gebbie, K.M., 2007. Defining Interdisciplinary Research: Conclusions from a Critical Review of the Literature. *Health Services Research*, 42, 329–346.

¹⁸ Lyall, C., Bruce, A., Tait, J. and Meagher, L., 2011. *Interdisciplinary research journeys: Practical strategies for capturing creativity*. London: Bloomsbury Publishing.

¹⁹ <http://www.theguardian.com/science/political-science/2014/jun/11/science-policy-research-silos-interdisciplinarity>

²⁰ Bruce, A., Lyall, C., Tait, J. and Williams, R., 2004. Interdisciplinary integration in Europe: the case of the Fifth Framework programme. *Futures*, 36(4), 457-470.

²¹ Nowotny, H. and Gibbons, M., 2001. The potential of transdisciplinarity. In: Klein, J.T., Grossenbacher-Mansuy, W., Häberli, R., Bill, A., Scholz, R.W. and Welti, M. ed. *Transdisciplinarity: Joint problem solving among science, technology, and society*. Basel: Birkhäuser, pp.67-80.

²² Klein, J.T., 1990. *Interdisciplinarity: History, theory and practice*. Wayne State University Press, pp.11

²³ Huutoniemi, K., 2010. Evaluating interdisciplinary research. In: Frodeman, R., Klein, J.T. and Mitcham, C. ed. *The Oxford Handbook of Interdisciplinarity*. Oxford: Oxford University Press, pp.309–320.

most radical alternative is to devise an assessment system that dispenses completely with any influence of disciplinarity. For instance, societal values could be used to evaluate research rather than disciplinary standards.

Typically, bibliometric and citation-based methods are used to evaluate IDR.²⁴ However, this can result in a disciplinary bias since research outputs differ across disciplines. For example, monographs and book chapters are prized in disciplines within the arts and humanities, conference contributions are valued in computer science and engineering, and journal articles are the main output in the sciences.²⁵ Another source of concern is the amount of literature covered by bibliometric databases such as Scopus and Web of Science, which can be biased in favour of English language publications and have different coverage of journals.²⁴ Citations also underlie journal impact factors, which are prone to ‘gaming’ by the academic community and are erroneously seen as a measure of quality rather than readership.²⁵ Thus, bibliometric or citation-based indicators can be biased for/against certain disciplines and as such may not be ideal metrics for evaluating IDR.

Furthermore, citation impact also differs by degree of interdisciplinarity. Research with a moderate degree of interdisciplinarity is more likely to have a higher citation impact than research with very high or very low degrees of interdisciplinarity.²⁶ Similarly, the highest citation impact in scientific subjects (Science, Technology, Engineering, Mathematics and Medicine) was shown to come from papers that include a small percentage of very highly atypical references (i.e. from journals not often co-cited in literature of the host field) with a substantive number of conventional references (i.e. from similar journals).²⁷ However, one study found that IDR articles gain more citations than disciplinary research articles 13 years after publication, while they receive a lower number of citations in the early years.²⁸ Other studies have provided evidence of a linear positive relationship between IDR and citations.²⁹

Faced with a large range of direct outputs from IDR such as publications, patents, software, art and artefacts as well as indirect outputs such as networks, skills and enhanced reputation of individuals and institutions (NAS, 2010),³⁰ the use of impact has been proposed as a viable alternative. To that end, narrative impact studies and alternative metrics or ‘altmetrics’ that measure the attention received by research outputs in the social media could potentially be useful tools to measure the level of public engagement and impact associated with interdisciplinary projects.³¹ For example, a majority of the research underpinning societal impact in the impact case studies submitted to the 2014 UK Research Excellence Framework (REF) was multidisciplinary.³² On the other hand, there appear to be no altmetrics yet available that are sufficiently well defined and robust for use in assessing research quality.

²⁴ Wagner, C.S., Roessner, J.D., Bobb, K., Klein, J.T., Boyack, K.W., Keyton, J., Rafols, I. and Börner, K., 2011. Approaches to understanding and measuring interdisciplinary scientific research (IDR): A review of the literature. *Journal of Informetrics*, 5(1), 14-26.

²⁵ Wilsdon, J., Allen, L., Belfiore, E., Campbell, P., Curry, S., Hill, S., Jones, R., Kain, R., Kerridge, S., Thelwall, M., Tinkler, J., Viney, I., Wouters, P., Hill, J. and Johnson, B., 2015. *The metric tide: report of the independent review of the role of metrics in research assessment and management*.

²⁶ Yegros-Yegros, A., Rafols, I., & D’Este, P., 2015. Does interdisciplinary research lead to higher citation impact? the different effect of proximal and distal interdisciplinarity. *PLoS ONE*, 10(8), e0135095.

²⁷ Uzzi, B., Mukherjee, S., Stringer, M., & Jones, B., 2013. Atypical Combinations and Scientific Impact. *Science*, 342(6157), 468–472.

²⁸ Wang, J., Thijs, B., & Glänzel, W. 2015. Interdisciplinarity and impact: Distinct effects of variety, balance, and disparity. *PLoS ONE*, 10(5).ref

²⁹ Chen, S., Arsenault, C., & Larivière, V., 2015. Are top-cited papers more interdisciplinary? *Journal of Informetrics*, 9(4), 1034–1046.

³⁰ http://www.nap.edu/download.php?record_id=11153

³¹ Wilsdon, J., Allen, L., Belfiore, E., Campbell, P., Curry, S., Hill, S., Jones, R., Kain, R., Kerridge, S., Thelwall, M., Tinkler, J., Viney, I., Wouters, P., Hill, J. and Johnson, B., 2015. *The metric tide: report of the independent review of the role of metrics in research assessment and management*. London, UK.

³² King’s College London & Digital Science, 2015. *The nature, scale and beneficiaries of research impact*. London, UK.

1.4 Managing and Supporting IDR

Despite increased impetus for IDR, the dynamics of interdisciplinary collaborations remain poorly understood.³³ The complexity and uncertainty of interdisciplinary endeavours makes it difficult to define 'best practice.' Nevertheless, a better understanding of how successful IDR is organised and managed is essential for making informed and effective decisions about funding, institutional structures and collaborations.

The management of IDR is both a cognitive and organisational task.³⁴ Several roles and functions need to be reconciled. Managers need to play an active role in facilitating communication and cooperation between researchers from different institutions and working environments.³⁴ They need to act as mediators who ensure consensus in teams and effective flows of mutual learning in order to accomplish shared goals. IDR managers should have good social and cognitive skills in order to build fruitful relationships among stakeholders and stimulate knowledge exchange. Indeed, a key feature of IDR is knowledge integration in the context of a defined project, resulting in the production of a glossary or common language, transfer of concepts, bridging concepts, qualitative or quantitative models, scenarios, regulations, devices, etc.³⁵

Successful IDR teams are characterised by equality, mutual acceptance, trust and openness among the team members.^{34,36,37} It is also important to recruit the right mix of disciplines, expertise and personalities to the team and to create structures for team working and evaluation.³⁸ Moreover, strong project leaders with a clear vision and good interpersonal and team building skills are essential for the success of interdisciplinary projects.^{39,40}

The success of interdisciplinary collaborations is dependent on several other factors including proximity of research, closeness of disciplines and prior experience.^{38,39,41} For example, greater geographical distance between collaborators may reduce the chances of success because coordination becomes more expensive and time-consuming, and more efforts are required to maintain contact with partners.^{38,41} Moreover, collaborations where collaborators have prior experience of working together are more likely to succeed.⁴¹ On the other hand, new collaborations are more likely to involve new mixes of expertise, approaches and ideas; thus, newcomers sometimes prove to be more innovative than 'tried and tested' teams.⁴¹

³³ Siedlok, F., and Hibbert, P., 2014. The organization of interdisciplinary research: modes, drivers and barriers. *International Journal of Management Reviews*, 16(2), 194-210.

³⁴ Hollaender, K., Loibl, M.C. and Wilts, A., 2008. Management. In: Hoffmann-Riem, H., Biber-Klemm, S., Grossenbacher-Mansuy, W., Joye, D., Pohl, C., Wiesmann, U., and Zemp, E. ed. *Handbook of transdisciplinary research*. Zurich: Springer, pp.385-397.

³⁵ Pohl, C., van Kerkhoff, L., Hersch Hadorn, G. and Bammer, G., 2008. Integration. In: Hoffmann-Riem, H., Biber-Klemm, S., Grossenbacher-Mansuy, W., Joye, D., Pohl, C., Wiesmann, U., and Zemp, E. ed. *Handbook of transdisciplinary research*. Zurich: Springer, pp.411-424.

³⁶ König, B., Diehl, K., Tscherning, K. and Helming, K., 2013. A framework for structuring interdisciplinary research management. *Research Policy*, 42(1), 261-272.

³⁷ McLeish, T. and Strang, V., 2014. *Leading interdisciplinary research: transforming the academic landscape*. London: The Leadership Foundation for Higher Education.

³⁸ Choi, B.C.K. and Pak, A.W.P., 2007. Multidisciplinarity, interdisciplinarity and transdisciplinarity in health research, services, education and policy: 2. Promoters, barriers, and strategies of enhancement. *Clinical and Investigative Medicine*, 30(6), 224-232.

³⁹ http://www.nap.edu/download.php?record_id=11153

⁴⁰ Porter, A.L., Roessner, J.D., Cohen, A.S. and Perreault, M., 2006. Interdisciplinary research: meaning, metrics and nurture. *Research Evaluation*, 15(3), 87-195.

⁴¹ Cummings, J.N. and Kiesler, S., 2008. Who collaborates successfully? Prior experience reduces collaboration barriers in distributed interdisciplinary research. *Proceedings of the 2008 ACM conference on Computer supported cooperative work*, 437-446.

Importantly, good relationships and frequent communication allows better coordination, problem solving and project management.^{42,43,44} Academic institutions can further facilitate interdisciplinarity by providing opportunities for communication between disciplines, establishing a supportive organisational culture, removing barriers and recruiting people with different backgrounds and disciplinary expertise.^{45,46}

Strategic funding decisions can act as a driver for IDR and nurture new areas of research.⁴⁶ Good design and management of IDR funding schemes can have a positive effect on the success of IDR by encouraging productive collaborations and helping to realise outcomes. This benefits from continuity of expertise over the long-term within funding agencies.⁴⁷ Internationally, many funding agencies build programmes around themes that lend themselves to interdisciplinary approaches, thus adopting a top-down approach to encourage IDR.⁴⁸ In addition, strategic initiatives such as joint PhDs between different disciplines and discipline-hopping fellowships can contribute greatly to the development of IDR skills.⁴⁹

1.5 Challenges in Conducting IDR

Disciplinary ‘silos’ and disciplinary cultures are the main barriers to interdisciplinarity.⁵⁰ The disciplinary nature of research institutions is also believed to hinder interdisciplinarity.⁴⁴ Moreover, the current education system remains geared towards specialisation in a single discipline and consequently reinforces disciplinary institutions.^{44,50} Researchers can form ‘tribal’ affiliations with their disciplines and find it difficult to abandon deeply held disciplinary perspectives that are built on experience.⁵¹ Furthermore, disciplinary norms, jargon, concepts and methodological conventions can obstruct knowledge exchange between disciplines and hinder communication between team members, making it difficult to develop a common language.^{43,44,52}

There is also evidence that certain evaluation mechanisms may disfavour IDR. There are lingering doubts about whether the peer review process is fair to IDR because of concerns that reviewers may not have the breadth of expertise to judge the quality of proposals that combine methods and concepts from different subject areas.⁵³ Sometimes, evaluators are asked to review the section of an interdisciplinary proposal or publication that falls within their own specialist area. Consequently, proposals or publications are rejected because they do not conform to the standards of individual disciplines, a

⁴² Cummings, J.N. and Kiesler, S., 2008. Who collaborates successfully? Prior experience reduces collaboration barriers in distributed interdisciplinary research. *Proceedings of the 2008 ACM conference on Computer supported cooperative work*, 437-446.

⁴³ Choi, B.C.K. and Pak, A.W.P., 2007. Multidisciplinarity, interdisciplinarity and transdisciplinarity in health research, services, education and policy: 2. Promotors, barriers, and strategies of enhancement. *Clinical and Investigative Medicine*, 30(6), 224-232.

⁴⁴ Broto, V.C., Gislason, M. and Ehlers, M.H., 2009. Practising interdisciplinarity in the interplay between disciplines: experiences of established researchers. *Environmental Science and Policy*, 12(7), 922-933.

⁴⁵ http://www.nap.edu/download.php?record_id=11153

⁴⁶ Porter, A.L., Roessner, J.D., Cohen, A.S. and Perreault, M., 2006. Interdisciplinary research: meaning, metrics and nurture. *Research Evaluation*, 15(3), 87-195.

⁴⁷ Lyall, C., Bruce, A., Marsden, W., & Meagher, L. (2013). The role of funding agencies in creating interdisciplinary knowledge. *Science and Public Policy*, 40(1), 62-71.

⁴⁸ Gleed, A., & Marchant, D. (2016). *Interdisciplinarity – Survey report for the Global Research Council 2016*. Stockport, UK: DJS Research.

⁴⁹ McLeish, T. and Strang, V., 2014. *Leading interdisciplinary research: transforming the academic landscape*. London: The Leadership Foundation for Higher Education.

⁵⁰ Heberlein, T.A., 1988. Improving interdisciplinary research: integrating the social and natural sciences. *Society & natural resources*, 1(1), 5-16.

⁵¹ Siedlok, F., and Hibbert, P., 2014. The organization of interdisciplinary research: modes, drivers and barriers. *International Journal of Management Reviews*, 16(2), 194-210.

⁵² Burggren, W., Chapman, K., Keller, B., Monticino, M. and Torday, J., 2010. Biological sciences. In: Frodeman, R., Klein, J.T. and Mitcham, C. ed. *The Oxford Handbook of Interdisciplinarity*. Oxford: Oxford University Press, pp.119-132.

⁵³ Bruce, A., Lyall, C., Tait, J. and Williams, R., 2004. Interdisciplinary integration in Europe: the case of the Fifth Framework programme. *Futures*, 36(4), 457-470.

situation, often termed ‘double jeopardy’.⁵⁴ Lack of experience or expertise among reviewers or review panels to assess all parts of interdisciplinary proposals and the relative ease of matching proposals with a narrower focus to reviewer expertise was reported as a potential cause of lower funding success rates for interdisciplinary proposals within the Australian Research Council’s Discovery Programme.⁵⁵ In this study, interdisciplinarity had the largest negative impact on funding success in the environmental sciences, physical sciences, economics, mathematical sciences, and history and archaeology, and a slight positive impact in agricultural and veterinary sciences, earth sciences, law and legal studies, and built environment and design.

Publishing can also be a problem, as IDR may not fit in nicely with what editors see as their journal’s remit. In addition, such research may fall foul of the disciplinary norms of what counts as a legitimate output and how quality is assessed.⁵⁶ For example, collaboration between a statistician and a biologist is unlikely to result in a theoretical advance in statistics and thus will not be viewed favourably by a traditional statistics department. Since promotions and other rewards are based on productivity, conducting IDR can be detrimental to career progression if the university/institutional committees place more value on journal articles and impact factors than other types of outputs and impacts.⁵⁷

Moreover, funders and universities value evidence of ‘leadership’ and ‘independence’ for career progression, which may be hard to prove in collaborative modes of working.⁵⁸ Besides, practices regarding authorship may also be very different among disciplines and, therefore, it may be difficult to evaluate a team member’s performance in another discipline without familiarity with the norms and evaluation criteria of that discipline.⁵⁹

Venturing outside the comfort zone of one’s own discipline requires time, effort and commitment. Consequently, IDR can take longer to bear results owing to the necessity of coordinating a team, holding regular meetings, educating oneself in another discipline and keeping abreast of developments in more than one field.⁶⁰ This can be a major disincentive for early career researchers who are trying to build careers. This may also be because IDR may expose researchers to career and professional risks because of leaving known disciplinary communities and established innovative research trajectories.^{60,61,62} In HE systems ‘research excellence’ is often rewarded based on disciplinary norms, which, in turn, appear to disadvantage IDR.⁶³

Since IDR is a collaborative exercise, differing expectations of team members about the research can be a hindrance.⁵⁷ If these issues are not resolved at the outset, the resultant conflicts can be detrimental to interdisciplinary activity.

Collaboration barriers are even more influential in transdisciplinary research, where academics and societal stakeholders such as governmental agencies, non-governmental organisations, or industry usually collaborate. Among transdisciplinary collaborations with industry, two barriers can be

⁵⁴ Huutoniemi, K., 2010. Evaluating interdisciplinary research. In: Frodeman, R., Klein, J.T. and Mitcham, C. ed. *The Oxford Handbook of Interdisciplinarity*. Oxford: Oxford University Press, pp.309–320.

⁵⁵ Bromham, L., Dinnage, R., & Hua, X. (2016). Interdisciplinary research has consistently lower funding success. *Nature*, 534, 685–687.

⁵⁶ Burggren, W., Chapman, K., Keller, B., Monticino, M. and Torday, J., 2010. Biological sciences. In: Frodeman, R., Klein, J.T. and Mitcham, C. ed. *The Oxford Handbook of Interdisciplinarity*. Oxford: Oxford University Press, pp.119–132.

⁵⁷ Choi, B.C.K. and Pak, A.W.P., 2007. Multidisciplinarity, interdisciplinarity and transdisciplinarity in health research, services, education and policy: 2. Promoters, barriers, and strategies of enhancement. *Clinical and Investigative Medicine*, 30(6), 224–232.

⁵⁸ <http://www.acmedsci.ac.uk/policy/policy-projects/team-science/>

⁵⁹ Kahn, J. (2011). The two (institutional) cultures: a consideration of structural barriers to interdisciplinarity. *Perspectives in Biology and Medicine*, 54(3), 399–408.

⁶⁰ Jacobs, J. A., & Frickel, S. (2009). Interdisciplinarity: A critical assessment. *Annual Review of Sociology*, 35(1), 43–65.

⁶¹ Reif, F., & Strauss, A. (1965). The Impact of Rapid Discovery upon the Scientist’s Career. *Social Problems*, 12(3), 297–311.

⁶² Rhoten, D., & Parker, A. (2006). Risks and rewards of interdisciplinary research path. *Science*, 306.

⁶³ Laudel, G., & Origgi, G. (2006). Introduction to a Special Issue on the Assessment of Interdisciplinary Research. *Research Evaluation*, 15(1), 2–4.

identified: orientation barriers and transactional barriers.⁶⁴ Orientation barriers refer to the clash between norms regarding open dissemination and autonomy, and industry norms of disclosure restriction. Transactional barriers refer to the cost in time and effort for the legal formalities of establishing a collaboration between an academic organisation and a company. Factors such as professional experience in industry, previous collaborative experience, and trust among university-industry partners support the success of such mixed collaborations. Similar barriers may affect transdisciplinary research in fields such as sustainability or climate change, where collaborations include not only industry, but also other types of stakeholders such as policy-makers and civil society organisations.

The success of IDR depends on the lowering or removal of barriers. This may require incentivising IDR as well as changes in research cultures, processes and organisations. For example, expectations and publishing hierarchy should be established at the outset, peer review committees should involve a breadth of expertise and experience, and collaborative efforts should be adequately rewarded.⁶⁵ Ultimately, there should be a level playing field for good quality research, be it disciplinary or interdisciplinary. Crucially, it is important to differentiate fact from perception in these debates. Nevertheless, the perception of a barrier has the same effect as a real barrier and demands attention.

⁶⁴ Tartari, V., Perkmann, M., & Salter, A. (2014). In good company: The influence of peers on industry engagement by academic scientists. *Research Policy*, 43(7), 1189–1203.

⁶⁵ Campbell, L.M., 2005. Overcoming obstacles to interdisciplinary research. *Conservation Biology*, 19(2), 574-577.

2 Approach

2.1 Scope

For the purpose of this study, any research activity involving more than one discipline (as identified by ‘A review of the UK’s interdisciplinary research using a citation-based approach’⁶⁶) including interdisciplinary, multidisciplinary, transdisciplinary and cross-disciplinary research was included in the umbrella term ‘IDR’.

This study covers research institutions in Norway from the applied research institute and university sectors and the departments/centres therein and focusses primarily on institutional approaches rather than individual projects.

2.2 Sample

The research sample consisted of five Norwegian research institutions. Cases were selected to ensure coverage of various institution types, models, disciplines and geographical locations (see Table 1).

Table 1 Case study institutions and their IDR models

Institution	Model for organising IDR	Disciplinary mix
The Arctic University of Norway (UiT), Tromsø	Combination of top-down and bottom-up approaches	All disciplines
Centre for the Science of Learning & Technology (SLATE), University of Bergen	University-based IDR centre	cognitive psychology, pedagogy, information/computer science, statistics, sociology, design, development psychology, and neuroscience
Department of Interdisciplinary Studies of Culture, Norwegian University of Science and Technology (NTNU), Trondheim	University department	Humanities, social sciences, medicine, science and technology
Norwegian Institute of Bioeconomy Research (NIBIO), Ås	Project-driven specialist research institute	Botany, food science, agricultural science, environmental science, economics
Centre for scalable data access in the oil & gas industry (SIRIUS), University of Oslo	University-based IDR centre	IT, management

Source: The authors

2.3 Method

We used case study methodology because it allows exploration of an issue or problem using a case as a specific illustration⁶⁷. This qualitative approach can be adopted for one or more ‘real-life, contemporary bounded systems’ and hence was eminently useful for the purposes of this study.

Each of the 5 case studies involved:

- Desk research to outline the wider context of the case study (e.g. type of institution, organisational structure, funding sources, historical context, etc.)

⁶⁶ <http://www.hefce.ac.uk/pubs/rereports/Year/2015/interdisc/Title,104883,en.html>

⁶⁷ Creswell, J.W., 2013. *Qualitative inquiry and research design: Choosing among five approaches*. Sage publications.

- Interviews with 2-8 strategic leaders (e.g. research support manager, pro Vice-Chancellor of Research, Centre Director/s, Departmental Heads) and/or researchers (e.g. Theme Leaders, IDR project participants) (for a list see each individual case study)
- Collection of relevant and illustrative data regarding the outcome of a support mechanism/approach where available

The semi-structured interviews were conducted in person during a site visit in all cases except NIBIO where telephone interviews were conducted. The semi-structured approach enabled systematic enquiry into each case, whilst still allowing interviewees to raise issues and make relevant points not captured by the interview template (see Appendix A).

After completion, individual studies (see Chapter 5) were compared and contrasted to identify commonalities and differences among approaches adopted to support IDR in Norway and see how these approaches compare with approaches used by English Higher Education Institutions (HEIs).⁶⁸ This analysis forms the basis of this report wherein we emphasise lessons learned and caveats regarding the adoption of particular approaches.

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<http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/Independentresearch/2016/Two,reports,on,interdisciplinary,research/Technopolis-Case%20study%20of%20interdisciplinary%20research%20in%20HEIs%20in%20England.pdf>

3 Analysis and ‘what works’

3.1 Why do institutions support IDR?

Three main reasons for supporting IDR emerged from this study. The first is to undertake research that addresses major societal challenges in line with Norwegian and international research policies. The second is to fulfil the purpose of the institution and the institutional strategy. For instance, SLATE and SIRIUS, which are cross-faculty research centres and the Department of Interdisciplinary Studies of Culture at NTNU have been created expressly for undertaking IDR. Finally, the third reason is to access wider funding sources for research. This could be considered the reason for setting up both SLATE and SIRIUS which have allowed the Universities of Bergen and Oslo respectively to leverage funding from the Norwegian Ministry of Education and Research and the Research Council of Norway’s (RCN’s) Centres for Research-based Innovation (SFI) scheme respectively.

These reasons mirror those that emerged from our previous case study review of English Higher Education Institutions (HEIs)⁶⁹ where the two main drivers for institutional support for IDR were to undertake research that addresses practical issues or societal challenges, and to access a wider variety of or larger external funding sources. Both drivers were also identified independently in the Landscape Review of the UK’s IDR.⁷⁰

Importantly, an emphasis on IDR is visible in the current research strategy of many Norwegian universities (including Bergen, Oslo, NTNU and UiT) in the form of strategic research themes such as climate change, energy, oceans, health, life sciences, sustainability, enabling technologies and global challenges.^{71,72,73,74} These research themes, which involve IDR, are a reflection of current research priorities for Norway and the Nordic region, as articulated in the Norwegian government’s long-term plan for research and education⁷⁵ and research themes for education and research in the Nordic region.⁷⁶ From the English context, we know that while a specific focus on IDR in institutional strategies is not essential for supporting IDR, it can help to embed interdisciplinarity in the institution, provided that it is communicated effectively and backed up by explicit actions. In Norway, a strategic focus on IDR seems to have stimulated researchers to adopt interdisciplinary ways of working.

3.2 Approaches

As in our previous study covering English HEIs,⁶⁹ this case study review also revealed a variety of approaches to organise and support IDR. In each of our cases, specific interventions were used depending on the specific circumstances and requirements of the institution in question. Nonetheless, there was an underlying model for organising IDR that provided the framework within which specific interventions were used. We discuss these models and interventions in the next subsections.

3.2.1 Models for organising interdisciplinary research

Although the models for organising and supporting IDR are diverse, the institutions in our sample frequently combined the following two approaches.

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<http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/Independentresearch/2016/Two,reports,on,interdisciplinary,research/Technopolis-Case%20study%20of%20interdisciplinary%20research%20in%20HEIs%20in%20England.pdf>

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<http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/Independentresearch/2016/Two,reports,on,interdisciplinary,research/Landscape%20review%20of%20UK%20interdisciplinary%20research.pdf>

⁷¹ https://en.uit.no/om/art?p_document_id=377752&dim=179033

⁷² <http://www.uio.no/english/research/strategic-research-areas/>

⁷³ <https://www.ntnu.edu/research/strategicareas>

⁷⁴ <http://www.uib.no/en/strategy#>

⁷⁵ <https://www.regjeringen.no/en/topics/research/innsiktsartikler/langtidsplan-for-forsking-og-hogare-utdanning/mal-og-prioriteringar/id2353511/>

⁷⁶ <http://www.norden.org/en/theme/education-and-research-in-the-nordic-region>

- Co-location of different disciplines in a single location such as a centre, institute or department with ‘virtual networks’ of external collaborators
- Top-down strategic approaches combined with bottom-up investigator-led approaches

In practice, this means that universities, university departments and independent institutes create research centres around specific research themes. These can be cross-faculty research centres like the Arctic Centre for Sustainable Energy (ARC), SLATE and SIRIUS at the Universities of Tromsø, Bergen and Oslo respectively as well as thematic research centres within institutes and university departments such as the Centre of Precision Agriculture and Norwegian Genetic Resource Centre at NIBIO and the Centre for Technology and Society and Centre for Gender Studies within the Department of Interdisciplinary Studies of Culture at NTNU. However, not all of the institution’s research is conducted in the centres themselves. There are temporary as well as long-standing collaborations with partners and adjunct staff based outside the institution e.g. in other organisations (including universities, companies, public sector organisations, etc.) and other departments or faculties. These partners are an integral part of the research and regularly stay in touch through online means, hence our use of the term ‘virtual network’.

Top-down strategic approaches usually manifest themselves as research priority areas or themes around which the different disciplines within an institution galvanise. On the other hand, the research projects themselves originate in a bottom-up manner with researchers choosing their own research questions, project teams and level of interdisciplinarity. A mix of top-down and bottom-up approaches was the norm among the cases selected for this study.

These models have some similarities with the models we encountered in the ‘Case Study Review of Interdisciplinary Research in England’, although the approaches discussed above are not always combined.⁷⁷ In that study, we discovered that flexible systems that accommodate both researcher- and institution-led approaches work well. While IDR that was structured around researchers’ research interests was seen to work best, specific ‘top-down’ institutional initiatives were used to encourage researchers to adopt interdisciplinary ways of working. However, it was universally acknowledged that ‘forced’ initiatives fail. Furthermore, while co-location offered opportunities to mix formally and informally with experts from different disciplines, this was not necessary for successful IDR, and ‘virtual’ or ‘nomadic’ networks also enabled interdisciplinary collaborations. The voluntary nature of membership of these networks made it easy for researchers to join or leave, and hence only motivated researchers were retained. Added benefits were low overhead costs and the flexibility to adapt or abandon the structure e.g. centre if necessary.

3.2.2 *Interventions to stimulate and grow interdisciplinary research*

The following approaches were consistently employed to encourage and grow IDR in our Norwegian case studies.

3.2.2.1 *Networking*

As communication between disciplines is considered key to stimulating IDR, most institutions in this review make efforts to create more opportunities for knowledge exchange and discussion between people from different disciplinary backgrounds. Such networking often leads to long-term partnerships between individual researchers, departments or centres, and even entire organisations. External networks also help to recruit people with competences that are unavailable in-house.

In Norway as in England,⁷⁷ interdisciplinary interactions are pursued through formal networking events such as seminars, conferences and workshops or informal events such as lunch meetings or coffee mornings. Examples we came across in Norway include seminars by external speakers and “First Friday” presentations of ongoing projects by post-doctoral researchers and students at SLATE and the NIBIO conference – a major trade conference on agriculture and food production – which acts as a central

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<http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/Independentresearch/2016/Two,reports,on,interdisciplinary,research/Technopolis-Case%20study%20of%20interdisciplinary%20research%20in%20HEIs%20in%20England.pdf>

meeting place for professionals in business, government management, politics, counselling and research. While virtual methods of networking and communication can work, face-to-face interactions are also considered important. NIBIO interviewees cited positive experiences from having internal seminars within the divisions where staff members can present their projects. This has resulted in staff having a better overview of research in the institute, which in turn has stimulated IDR. The meetings have also proven very valuable for building a culture of IDR.

3.2.2.2 Training students

Training interdisciplinary researchers through dedicated master's courses and interdisciplinary PhD projects is important for growing the IDR skills base and preparing the ground for future IDR. It is believed that teaching students to be interdisciplinary early on prepares them for an interdisciplinary career in the future, thus increasing the capacity for IDR. To that end, institutions in both Norway and England⁷⁸ develop taught master's courses or doctoral programmes that impart the technical and transferable skills that are relevant to IDR. With the exception of NIBIO, which is a specialist research institute, each of the university-based institutions selected for this review train both master's and PhD students.

Since 2016, SIRIUS has trained mentors in its partner companies to help run a mentoring programme where post-doctoral researchers and PhD students are mentored for 9-12 months by the industrial partners. The scheme has been received very positively by the industrial partners, and feedback from mentees has also been positive.

3.2.2.3 Recruitment

Recruitment can be used to build research capacity and plug gaps in technical expertise (both disciplinary and interdisciplinary) within an institution. When experienced staff are recruited, particularly to senior roles, they can help consolidate new themes of research and provide access to additional researcher networks. For instance, by recruiting a researcher from the Geosciences Department to work with them, SIRIUS not only added further value to its research, but also gained access to the researcher's departmental knowledge.

3.2.2.4 External funding

Across our sample, external funding was a way to expand the resources available for IDR beyond the core funding available. The Department of Interdisciplinary Studies of Culture at NTNU has been particularly successful in acquiring a large volume of external funding compared to other departments in the Faculty of Humanities because of its longstanding experience in applying for external funding as well as its interdisciplinary competences which help to frame grant proposals in a manner that funding agencies find relevant.

Moreover, where core funding is only available for a limited time, capturing external funding is a proposed mechanism for sustaining IDR activity. At present, none of the institutions covered in this review depend on external funding for their survival. However, this may change if SIRIUS and SLATE do not receive core funding after the initial 5 years.

In English HEIs⁷⁸, acquiring external funding is the second step on the 'funding ladder' which moves from small amounts of seed funding (over the short term) to securing an external project grant (medium term) and culminating in the establishment of a research centre (long term). A similar strategy was not explicitly visible among the Norwegian cases.

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<http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/Independentresearch/2016/Two,reports,on,interdisciplinary,research/Technopolis-Case%20study%20of%20interdisciplinary%20research%20in%20HEIs%20in%20England.pdf>

3.2.2.5 Creating a supportive environment

The value of an environment that is open and welcoming to researchers from different disciplines and encourages them to talk to and work with each other has long been highlighted as key to successful interdisciplinary collaborations. Academic institutions create a supportive environment by providing platforms for communication between disciplines, establishing a supportive organisational culture, removing barriers and recruiting people with different backgrounds and disciplinary expertise.^{79,80} Across the cases in this review, it was evident that institutions are making efforts to create such spaces, for example, by investing in infrastructure such as centres and providing administrative support. For instance, UiT provides support both at the institutional and faculty level to help researchers write applications for external funding. Embedding a research culture that encourages interdisciplinary ways of working is also vital. For instance, although there is no explicit reward system for IDR at NIBIO, it is encouraged and receives positive feedback from the institute, which motivates researchers to be interdisciplinary.

Awarding seed funding for IDR projects is also a valuable way to legitimise and support IDR activity as we observed in the English HEIs. Here, small pots of core institutional funding were awarded for pump-priming activities such as proof-of-principle research projects and developing bids for external funding.⁸¹ In Norway, internal funding awarded for IDR is usually more substantial and over a longer term (years compared to months) than the seed funding grants in English HEIs. For example, NIBIO has established Strategic Institute Initiatives through which core funding is allocated to internal projects, typically for 5 years, with the aim of enhancing research networks across subject areas and departments.

3.2.2.6 Approaches that cut across institutional structures

Initiatives that facilitate IDR with external partners and across existing institutional structures like departments and faculties are particularly useful for stimulating IDR. These can include cross-faculty themes and clusters, which have been successful in England⁸¹ as well as in Norway. For example, to stimulate IDR, UiT funds projects in five strategic research areas and requires project teams to be drawn from at least three faculties. Similarly, SLATE has a research cluster related to future research and innovation that focuses on forming interdisciplinary groups across the university and building on new strands of research that emerge from these collaborations.

All of the approaches discussed not only serve to create the right conditions for successful IDR collaborations, but also to embed interdisciplinary culture within the institution in question. Concomitantly, by building research capacity, appropriate support structures and infrastructures such as interdisciplinary departments, institutes and centres, they also establish a foundation for sustaining IDR in the future. Again, these approaches are almost identical to those adopted in English HEIs to stimulate, sustain and embed IDR.⁸¹

3.3 'What works' and lessons learned

The following lessons emerged as being consistently useful for supporting IDR within Norwegian research institutions.

3.3.1 *Developing and nurturing IDR is demanding*

Time and effort are required for interdisciplinarity to mature and to build understanding and sharing learning within teams. IDR can take longer to bear results owing to the necessity of coordinating a team, communicating regularly, learning about another discipline and keeping abreast of developments in

⁷⁹ http://www.nap.edu/download.php?record_id=11153

⁸⁰ Porter, A.L., Roessner, J.D., Cohen, A.S. and Perreault, M., 2006. Interdisciplinary research: meaning, metrics and nurture. *Research Evaluation*, 15(3), 87–195.

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<http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/Independentresearch/2016/Two,reports,on,interdisciplinary,research/Technopolis-Case%20study%20of%20interdisciplinary%20research%20in%20HEIs%20in%20England.pdf>

more than one field.⁸² Other barriers can also affect the success of IDR including disciplinary barriers, collaboration barriers, transactional barriers, career-related barriers and publishing barriers as have been discussed in depth in the literature review (see Section 1.5). Many of the same points were reiterated in the Landscape Review of the UK's IDR.⁸¹ In this study, a survey of researchers, funders and strategic leaders in HEIs across the UK showed that the following barriers can impede successful IDR.

- Collaboration-related barriers such as identification of appropriate partners, establishing shared priorities and a shared language, and communication within an IDR team
- Disciplinary barriers including disciplinary norms and expectations such as different methodological requirements and contrasting interpretations of evidence and rigour as well as discipline-oriented structures such as university departments
- Career-related barriers that adversely impact on the recruitment and promotion of interdisciplinary researchers because IDR-based careers may be seen as risky, interdisciplinary career paths may be less traditional and recruitment and promotion criteria may be more easily evidenced through monodisciplinary research
- Publishing barriers because publishing IDR in what are regarded within disciplines as the 'top-tier' academic journals is more challenging
- Monodisciplinary perspectives of reviewers and lack of reviewers with appropriate expertise and knowledge to assess IDR proposals adversely affects the funding of IDR

In contrast, the study also identified some facilitators of IDR.

- Researchers with strong expertise in one discipline with the capability to collaborate with other disciplines
- Good leaders and 'interdisciplinary champions' who can facilitate and encourage IDR at project, departmental and/or institutional levels through things like helping to establish a supportive research culture and creating coherence within interdisciplinary teams
- Institutional support in the form of a nurturing research environment and specific support measures such as seed funding grants, training grants, new infrastructure and networking opportunities

The last two aspects were also highlighted as being important for successful IDR in Norway. Overall, the main facilitators were

- A research environment where IDR is actively supported
- Personal qualities of researchers, especially openness, curiosity and respect towards other perspectives
- Effective leadership, including for example, gathering the right competences for conducting the research, operating effectively within administrative frameworks, finding ways around barriers and obstacles, and most importantly, prioritising what needs to be done. Leaders can also act as champions for their centres/departments, helping to develop external relationships (e.g. with industry in SIRIUS) and present research in external fora (e.g. at SLATE)
- Good communication and a common language – Face-to-face discussions were cited as important by interviewees from NIBIO
- A shared vision which will prevent different members of a research team from going in different directions

In contrast, the following barriers continue to impede interdisciplinary collaborations in Norway.

- Lack of shared understanding of aims and concepts within the team

This is the biggest challenge where partners from different sectors and with different priorities have to be aligned under a shared vision. For example, SIRIUS does many projects with industrial partners, but

⁸² Burggren, W., Chapman, K., Keller, B., Monticino, M. and Torday, J., 2010. Biological sciences. In: Frodeman, R., Klein, J.T. and Mitcham, C. ed. *The Oxford Handbook of Interdisciplinarity*. Oxford: Oxford University Press, pp.119–132.

needs to ensure that academic standards are maintained. Furthermore, this requires academics who also have significant industrial experience, a combination which is difficult to find in Norway where inter-sectoral mobility is uncommon.

- Disciplinary barriers such as disciplinary training, research cultures, and institutional and administrative structures

The disciplinary nature of many Norwegian degree programmes and incentives for research can be a barrier to IDR. For instance, the present organisation of the National Science Index (NVI) in Norway systematically favours publications in disciplinary journals and provides strong economic disincentives for interdisciplinary publishing. Moreover, different disciplines may have different understandings of the same concept and different criteria for methodological rigour. IDR is often rated lower than monodisciplinary research within individual disciplines, deterring some early career academics from pursuing IDR. Administrative systems organised around disciplinary faculties and rules restricting the number of research groups academics can belong to also act as a barrier to collaboration and creativity, as can finance systems and friction around sharing of costs between faculties.

- Lack of a physical space for an interdisciplinary project where researchers continue to remain siloed in the university departments can be a barrier to more intense interaction within the project team
- Publishing IDR in top journals is more difficult, and interdisciplinary researchers often split their research into constituent disciplines or reorient it slightly to publish in these journals

Writing papers that address a sufficiently wide scholarly audience to get them accepted in well-established scientific journals is particularly a challenge. While writing books and book chapters that have a wider audience than just academics may be a solution, it may be less acceptable in the natural sciences where publishing in peer-reviewed journals is the badge of research quality.

These barriers are not insurmountable, but overcoming them also requires time and effort.

3.3.2 *A balance between top-down and bottom-up approaches is important*

Top-down approaches are important to build a structure and provide incentives for conducting IDR. Top-down approaches signal the importance of IDR at an institution. Conversely, bottom-up approaches are important for getting researcher buy-in because fundamentally projects need to be of interest to researchers. While researchers formulate the research ideas and suggest collaboration partners, they also adapt to the requirements and orientation of funding sources and calls. Thus, a balance between bottom-up and top-down approaches is crucial, and probably unavoidable.

UiT provides a good example of this combined approach. Its top-down approaches are naming five key research areas (technology; energy, climate, society and environment; sustainable use of resources; community development and democratisation; health, welfare and quality of life) within its strategy from 2014 to 2020 and running annual funding calls for interdisciplinary projects that involve at least three faculties. In turn, bottom-up structures emerge from researcher- and faculty-level initiatives. These include centres like the Arctic Centre for Sustainable Energy and cross-faculty projects including those funded through the aforementioned annual calls. However, there are also some challenges in implementing these approaches. For example, the annual cross-faculty calls received very few applications from the humanities and social sciences faculties. This may result from lack of interest from researchers or greater difficulties in formulating projects involving three faculties where humanities and social sciences are concerned.

3.3.3 *Thematic initiatives can help build a culture of IDR*

Themes like societal challenges can provide a focus for IDR. A thematic focus moves attention away from disciplines to problem solving, thus helping to avoid the usual discipline-based conflicts by providing a level playing field. Most research problems that concern societal challenges require an interdisciplinary approach and can thus act as an incentive for people with different types of expertise and backgrounds to team up.

At NIBIO, most of the IDR occurs within its thematic centres such as the Centre for Precision Agriculture, NIBIO International Department, Norwegian Genetic Resource Centre and NIBIO Climate Forum. At UiT, the thematic initiatives (five priority areas) have created an awareness of the possibilities of building collaborations. This might also have stimulated the larger IDR initiatives (i.e. centres) that have emerged bottom-up. Similarly, NTNU has also established four strategic research areas for 2014–2023: energy, health, oceans and sustainability.⁸³

Conversely, SLATE had originally organised itself around three themes, partly based on the nature of existing projects. However, as the centre is still in its early stages, it was difficult to assign projects to these themes as many projects fit into more than one theme. Now the projects are classified in terms of their purpose e.g. policy-related, data architectures-related or assessment-related. Discussions are ongoing as to whether this is the best way to cluster projects. Interestingly, SIRIUS combines the thematic and purpose-based classifications. Its activities are organised around six work packages based on tasks such exploration, operation, supporting technologies, etc. as well as seven topic-based activities (e.g. databases, natural language, scalable computing, etc.) that cut across the work packages (See Figure 1).

Among the English HEIs, we again found that strategic themes can act as instruments to foster IDR by providing a focus for interdisciplinary endeavour and helping to build research capacity in new areas.⁸⁴ While a thematic approach may somewhat restrict the types of IDR undertaken, in combination with institutional support it can help to create hubs of activity, which can be built upon. For instance, sustained activity and growth of strategic thematic groups has led to the creation of research centres at the University of Southampton. However, some institutions like the Royal College of Art and the White Rose University Consortium do not adopt a thematic approach, instead they focus on fostering high-quality research, regardless of whether it is IDR. This does not seem to affect their capacity to do high-quality IDR.

3.3.4 *Collaborations are smoother when they stem from existing research networks or previous collaboration*

In the English case studies, we found that alliances established through interdisciplinary networks or previous experience of working together in a team can offer a competitive advantage over ad-hoc interdisciplinary teams when applying for funding because collaborators who have already worked together or know each other will have established structures and trust within the team meaning there will be less lag time in starting a project and fewer hurdles to overcome in conducting the research.⁸⁴ Therefore, research teams with previous experience of working together often have a greater chance of securing external funding and delivering high-quality outputs compared to those that have not. This point is also echoed in the literature.⁸⁵ However, it has also been shown that new collaborations are more likely to involve new mixes of expertise, approaches and ideas; thus, newcomers sometimes prove to be more innovative than ‘tried and tested’ teams.⁸⁶ In English HEIs, this contradiction is reconciled through the use of small seed funding or pump-priming grants which allow researchers to form new IDR collaborations and also gain experience of working together.⁸⁴

The benefit of building on previous collaborations is demonstrated in the Norwegian context by the Framework Programme project, Optique (Scalable End-user Access to Big Data),⁸⁷ which was the basis for the creation of SIRIUS and enabled the centre to overcome the usual challenges that accompany the establishment of large consortia. The team’s work and achievements in Optique gave it the necessary

⁸³ <https://www.ntnu.no/om>

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<http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/Independentresearch/2016/Two,reports,on,interdisciplinary,research/Technopolis-Case%20study%20of%20interdisciplinary%20research%20in%20HEIs%20in%20England.pdf>

⁸⁵ http://www.nap.Edu/download.php?record_id=11153

⁸⁶ Cummings, J.N. and Kiesler, S., 2008. Who collaborates successfully? Prior experience reduces collaboration barriers in distributed interdisciplinary research. *Proceedings of the 2008 ACM conference on Computer supported cooperative work*, 437-446.

⁸⁷ <http://optique-project.eu>

track and visibility to obtain the commitment and support of the University of Oslo management for submitting a funding application to the RCN.

3.3.5 Researchers can maintain a variety of disciplinary and interdisciplinary identities

Combining a disciplinary identity with one or more interdisciplinary identities facilitates IDR and strengthens its quality since it helps scholars keep up with a wider set of theoretical and methodological advances. For some, keeping a disciplinary identity is important and constitutes a way to approach and participate in IDR. One remains a 'political scientist' or 'historian', and contributes to IDR from that perspective. For others, a new, more interdisciplinary identity such as a gender studies researcher has grown. However, a new identity may take time to develop and may not follow a standard template, bringing together different disciplines in varying degrees.

4 Conclusions and policy considerations

During this case study review, we encountered differing approaches and models to organise IDR, some of which are long established and embedded, while others are currently being introduced. However, none of the models and approaches have been formally evaluated, so it is difficult to make judgements about their success in terms of their effectiveness to deliver the expected outcomes. Formal evaluations are planned for many of the institutions between now and 2021.

Current research policies in Norway⁸⁸ and the Nordic region⁸⁹ have been instrumental in galvanising research institutions to pursue IDR. Universities are giving strategic importance to IDR and building structures and facilities to support more interdisciplinary activity. Whether IDR will still receive this level of attention if national and regional priorities change, remains to be seen.

Among the models used for organising IDR in Norway, the most common model involved top-down strategic approaches, typically in the form of defined strategic thematic priorities, in combination with bottom-up investigator-led approaches, usually manifested as project-level research collaborations organised by individual researchers. In addition, co-location of researchers from different disciplines in a single thematic centre was seen in universities, their departments and independent institutes. However, research institutions ranging from individual centres and institutes to faculties and universities also rely on external collaborators through ‘virtual’ networks for certain expertise. Compared to the English case studies, we saw less variety among the types of models used perhaps owing to the smaller number of case studies included in this review (five in Norway versus 10 in England) as well as universities in Norway.

On the other hand, we found major parallels between the interventions used to stimulate and grow IDR as well as facilitators and barriers described in the literature and in our previous case study review of English HEIs.⁹⁰ The institutional interventions common to both the English and Norwegian contexts were to provide cross-disciplinary networking opportunities, train students and teach them to be interdisciplinary, secure external funding, create a supportive research environment and culture and establish initiatives that cut across disciplinary institutional structures such as departments and faculties. Facilitators of IDR highlighted by Norwegian researchers were a supportive research environment, personal traits of researchers such as openness, good leadership and communication, while barriers were related to collaborating within teams, disciplinary ways of working and publishing IDR. Thus, we did not identify any facilitators or barriers specific to the Norwegian context, only those that stem from the nature of interdisciplinary activity itself.

Based on our observations, we recommend that the following points be considered when developing policy or interventions to promote IDR activity in Norway.

- A collaborative and supportive research environment where IDR is accepted as a legitimate and valuable activity is very important for fostering IDR in an institution
- Priority research themes can provide a focus for IDR and galvanise research activity towards addressing research problems in the specified areas
- Co-location of different disciplines in one physical space is not a prerequisite for IDR. Nevertheless, a space, either physical or virtual, for the collision of ideas is necessary. Opportunities to contact and talk to people from other disciplines is vital, and doing so face-to-face can sometimes be easier

⁸⁸ <https://www.regjeringen.no/en/topics/research/innsiktsartikler/langtidsplan-for-forskning-og-hogare-utdanning/mal-og-prioriteringar/id2353511/>

⁸⁹ <http://www.norden.org/en/theme/education-and-research-in-the-nordic-region>

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<http://www.hefce.ac.uk/media/HEFCE,2014/Content/Pubs/Independentresearch/2016/Two,reports,on,interdisciplinary,research/Technopolis-Case%20study%20of%20interdisciplinary%20research%20in%20HEIs%20in%20England.pdf>

- Researchers' previous experience of working together makes collaborations smoother and might increase the chances of securing funding and delivering high-quality outputs
 - Both top-down and bottom-up approaches can be used to grow and support IDR. However, a top-down approach will need buy-in from academics while bottom-up approaches will need institutional support to remain successful in the long run
 - Involvement of key staff such as strategic leaders as 'champions of IDR' within and outside research institutions can help to increase the visibility of the institution's IDR internally as well as externally and to embed it in institutional structures and culture
 - A follow-up evaluation of IDR projects and funding mechanisms will provide useful intelligence regarding factors affecting the success and failure of interdisciplinary collaborations. In particular, the effectiveness of peer review needs to be evaluated as there are still some concerns as to whether reviewers and expert panels are sufficiently equipped to review IDR proposals and whether mono- and interdisciplinary proposals are treated equally
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5 Case studies

5.1 Centre for the Science of Learning & Technology, University of Bergen

5.1.1 *The institution*

In 2016, the Norwegian Ministry of Education and Research awarded NOK25m funding (over a period of 5 years) to the University of Bergen (UiB) for the establishment of an interdisciplinary Centre for the Science of Learning & Technology (SLATE), a national competence and research centre for international research and national competence development on the use of data and data approaches in education and lifetime learning.^{91,92} The funding was awarded through a national competition and UiB's proposal was rated the best among a total of 3.⁹² As of now, SLATE has been established as a cross-faculty research centre with matched funding from UiB. Physically, it is located within the Faculty of Psychology, but it draws together researchers from various disciplines (computer science, pedagogy, information science, cultural science, etc.) to conduct IDR that will advance the frontiers of the sciences of learning, as well as inform education practice and policy.

SLATE's mandate⁹¹ from the Ministry of Education and Research is to

- Carry out research of high quality on learning analysis, which is the study of the role of data and data analytics for understanding and improving learning, teaching, and education, and covers, among others, the research fields of Learning Analytics and Knowledge, Educational Data Mining, and Big Data in Education
- Be an R&D unit that contributes to national competence and knowledge development within learning analytics
- Map and be a central resource for the possibilities and challenges related to the use and research on learning analytics in Norway
- Be internationally oriented and seek relevant international collaboration within learning analytics
- Develop and disseminate knowledge to the relevant actors in the Educational sector through its R&D activity
- Influence competence development within the learning analytics discipline in other milieu in the Higher Education sector through seeking collaboration

The long-term ambition is for SLATE to develop into a broader national centre for the learning sciences by drawing together even more diverse disciplines such as cognitive psychology, pedagogy, information/computer science, statistics, sociology, design, development psychology, and neuroscience.⁹³

5.1.2 *Model for organising IDR*

As a cross-faculty research centre and because of its research focus, SLATE is inherently interdisciplinary both in terms of its research and researchers. Interdisciplinarity is a core value of the centre along with integrity, excellence and globality.⁹³ Research projects involve both local and international research partners and span from research overviews and systematic reviews to infrastructures for educational data and projects using learning analytics to better understand learning and learning processes.⁹³

SLATE is based in renovated office space (financed by UiB) within the Faculty of Psychology. This is aimed at creating an environment that will stimulate IDR and innovation and attract researchers and stakeholders from the rest of the university as well as other institutions/organisations. The location is interesting for SLATE as the faculty has researchers with expertise in pedagogy, psychology (health-

⁹¹ <https://www.slate.uib.no/mandate>

⁹² Interview

⁹³ SLATE Annual report 2016. Available at: https://docs.wixstatic.com/ugd/c32697_695d2b5a8be442f48059927d9cae74b5.pdf

oriented psychology to developmental and cognitive psychology), neuroscience, and education. The faculty (and the university) also provides administrative and contract-related support.

SLATE funds have predominantly been used to employ PhD and postdoctoral researchers, and to ‘buy out’ academics from their respective faculties. For instance, the Centre Director, Professor Barbara Wasson, belongs to the Faculty of Social Sciences but is based full-time at SLATE. In some cases, faculties allocate a proportion of staff time towards SLATE, which counts towards UiB’s funding contribution.

In addition to UiB-based staff, SLATE works with affiliated and associated faculty based in national and international institutions such the Universities of Oxford (UK), Hong Kong, Maastricht, Webster and OsloMet, some of whom are paid an additional salary of 20% for the adjunct position by SLATE. These individuals communicate regularly with Bergen-based staff through a combination of online and face-to-face meetings. Thus, the centre operates both on a ‘virtual network’ basis as well as on a ‘co-location’ basis, with IDR teams operating from SLATE premises.

Initially, the Centre was organised into three themes, partly based on the nature of existing projects: innovating assessment, big and small data and education, and innovative research futures. However, it quickly became apparent that it was difficult to assign projects to these themes in this early developmental stage of the centre as many projects went across the themes. Now, projects are classified in terms of their focus such as policy-related, data architectures-related or assessment-related. Discussions are ongoing as to whether this is the best way to cluster projects.

SLATE is overseen by an Executive Board⁹⁴ and a Scientific Advisory Committee⁹⁵. Both boards are interdisciplinary in terms of their composition, further reinforcing and embedding interdisciplinarity at the heart of the centre. The Executive Board includes the Deans of the Faculties of Psychology and Social Sciences, the Vice-rector of Education and a student representative from UiB as well as the Research Director of Uni Research Health (a department of Uni Research), the Director of Kulturtanken (a cultural organisation) and the Rector of Amalie Skram Upper Secondary School in Bergen. On the other hand, the Scientific Advisory Committee consists of leading international researchers and consultants from Norway, the UK, the US, Canada and Hong Kong.

Crucially, SLATE aligns with UiB’s wider strategy for the period 2016-2022. The university wishes to develop a “multidisciplinary profile to meet the challenges facing society” and to that end is looking to create interdisciplinary knowledge clusters, build appropriate infrastructure and recruit the right people.⁹⁶ SLATE fulfils all these attributes.

5.1.3 *Interventions to stimulate and grow IDR, their implementation and results*

From the outset, the centre has established its core values, strategic approach and strategic goals for the first 5 years.⁹⁷ The strategic approach involves

- Engaging in research on learning and the learner
- Communicating with stakeholders including the Ministry of Education and Research, education community, teachers, schools, students, parents, and the public
- Inspiring the next generation of researchers in this field
- Expanding partnerships with national, international, intergovernmental, academic, industrial and entrepreneurial communities

As SLATE is still in its foundational stage, interventions have involved establishing the organisational structure of the centre, developing IDR projects, establishing core research capacity through recruitment, and doing outreach to make the centre more widely known. One of the demanding

⁹⁴ <https://www.slate.uib.no/executive-board>

⁹⁵ <https://www.slate.uib.no/scientific-advisory-board>

⁹⁶ <http://ekstern.filer.uib.no/ledelse/strategy.pdf>

⁹⁷ SLATE Annual report 2016. Available at: https://docs.wixstatic.com/ugd/c32697_695d2b5a8be442f48059927d9cae74b5.pdf

challenges at present is to recruit more senior researchers to SLATE to improve the research capacity of the centre and consolidate new themes of research. Even though one appointment has recently been made, recruitment of senior faculty has otherwise proven difficult because the university has not provided funding for professor or associate professor posts.

The centre has established a variety of strategic partnerships from the outset. It collaborates very closely with a big data centre owned by Uni Research, one of the largest research companies in Norway. It also has joint projects with other faculties at UiB and with other universities. For example, a new interdisciplinary group on learning from visualisations has recently been initiated, bringing together seven top professors from different faculties at UiB.⁹⁸ Such joint projects are also a way to bring senior research expertise into SLATE. SLATE has also applied for or been a partner in applications applying for research funding from external funders such as the RCN, Norgesuniversitetet and Erasmus+ to grow its research activity.

Even in its first year, SLATE has drawn a lot of attention from national and international academic organisations and businesses, with requests for meetings, presentations, and collaboration on research proposals.⁹⁹ Demand for collaborations (including from businesses and the public sector) in particular has exceeded capacity. In 2016 and 2017, SLATE staff attended 110 meetings with a cross-section of stakeholders & target groups, gave 67 invited presentations, collaborated on 12 research proposals, published 34 academic works and held 3 international workshops.^{99,100} External presentations and attendance in national and international workshops and conferences has helped to make the centre better known, build contacts and networks, and develop skills and knowledge.

Another approach for building networks and research capacity, promoting knowledge exchange between different fields and stimulating IDR is to invite external speakers (national and international as well as from other faculties) to deliver seminars. These goals are also pursued through hosting guest professors, having affiliated/associated researchers and training students. In 2016, SLATE hosted 6 guest lectures by international speakers, one intern, and one guest professor.⁹⁹ In the same period, SLATE had 4 master's and 2 PhD students, increasing this to 5 new master's students in 2017 and 5 PhD students in 2017.¹⁰⁰ Master's students from any UiB faculty whose research projects are related to topics that fall under SLATE's mandate may apply to be a SLATE master's student.¹⁰¹

SLATE employees (including PhD students) are also encouraged to undertake training for internal competence development. For instance, several SLATE staff completed a 2-month online course on Learning Analytics for Classroom Teachers offered by Curtin University, Australia.⁹⁹ In addition, individuals attend summer schools and internal or external university courses to develop competences in new areas.

Ultimately, the Centre wishes to create a milieu where people can talk and exchange ideas. Approaches to do this are morning coffee meetings to discuss research plans, project leader meetings, research groups on different topics, and 'First Friday' sessions. 'First Friday' is a bottom-up initiative from SLATE researchers where researchers including students and postdocs present their research on the first Friday of every month. Invitations are sent to all faculties. Though very recent, this initiative has already been very successful in attracting people from different faculties at UiB, from professors to master's students.

The centre has also undertaken strategy workshops with a facilitator to keep sight of the strategic aims of the centre and how they should evolve as time progresses.⁹⁸

5.1.4 *Lessons learned and 'what works'*

SLATE seems to have succeeded in creating an inclusive and creative environment in which people from different disciplines enjoy to work together. This has been achieved by building a culture which is team-

⁹⁸ Interview

⁹⁹ SLATE Annual report 2016. Available at: https://docs.wixstatic.com/ugd/c32697_695d2b5a8be442f48059927d9cae74b5.pdf

¹⁰⁰ Information provided by centre

¹⁰¹ <https://www.slate.uib.no/masters>

oriented and open-minded, and by providing a place to exchange ideas. As such, SLATE provides a platform for researchers from different disciplines to meet, set up new projects and produce joint publications.

The researchers interviewed stressed that the personal qualities of interdisciplinary researchers are as important as the research environment. Attributes such as curiosity, openness to different perspectives and approaches, respect and humility are very important. Diversity within the team is not sufficient for creativity and innovation, it needs to be combined with open discourse, challenging the current knowledge base and relational skills for collaboration.¹⁰²

The disciplinary nature of many Norwegian degree programmes and incentives for research (e.g. publishing points) can be a barrier to IDR. Different disciplines may have different understandings of the same concept and different criteria for methodological rigour. IDR is often rated lower than monodisciplinary research within individual disciplines, deterring some early career academics from pursuing IDR. Administrative systems organised around disciplinary faculties and rules restricting the number of research groups academics can belong to also act as a barrier to collaboration and creativity.

According to the award letter from the Ministry, the UiB's proposal included a broader perspective and better plan for the future of the centre compared to the other proposals, and research leaders with competence and extensive experience in learning analytics.¹⁰³ From previous experience of leading another centre, the Director, Professor Barbara Wasson, was mindful of the fact that to be truly successful, the centre would need to expand and broaden over time. Therefore, an expansion strategy had to be in place from the start, especially because the funding awarded only covers the core functions of the centre. In the case of SLATE, this strategy was to include a research cluster related to future research and innovation which would focus on forming interdisciplinary groups across the university and building on new strands of research that emerge from these collaborations.¹⁰³

In conclusion, it seems that SLATE has managed to gather motivated, curious, and knowledgeable people, and initiated some interesting projects. This has been enabled by good leadership within the centre as well as support from strategic leaders (Faculty Deans and Vice-rectors) at the university. Effective leadership involves gathering the right competences (knowledge-wise as well as personality-wise) for the team, understanding how to operate within administrative frameworks, finding ways around barriers and obstacles, and most importantly, prioritising what the centre needs to do.

5.1.5 Future strategy for IDR

Even at this early stage, the Centre is facing some complex questions about its role, especially in relation to the growing Norwegian EdTech community. For example, will SLATE provide a quality stamp for learning analytics products? Moreover, the learning analytics field is growing rapidly and the centre could pursue research in many directions. This has made the centre leadership reflect on what SLATE should focus on, mainly because it currently does not have the resources or mandate to do all these things. Moreover, as learning analytics is a relatively new field in Norway, research is required in the first instance to answer the complex questions that interested stakeholders such as institutions, organisations, and municipalities need to answer. As a result, it has been decided that the centre should first concentrate on building competence and gaining experience in order to be able to provide solid and reliable advice.¹⁰⁴ Therefore, the plan is to hire the right people to build a team that can carry out research, participate in competence development across stakeholders (including researchers), and can provide help and advice to the educational sector. The centre's leadership is mindful of the fact that this will require time, especially because the research entails interdisciplinarity, which itself will take time to mature.

In terms of research areas, SLATE wants to expand its work in the neuroscience, educational psychometry, process data and pedagogy domains through new recruitments and joint research

¹⁰² Ness, I. J., & Riese, H. (2015). Openness, curiosity and respect: Underlying conditions for developing innovative knowledge and ideas between disciplines. *Learning, Culture and Social Interaction*, 6, 29-39.

¹⁰³ Interview

¹⁰⁴ SLATE Annual report 2016. Available at: https://docs.wixstatic.com/ugd/c32697_695d2b5a8be442f48059927d9cae74b5.pdf

projects.¹⁰³ Steps are already being taken in this direction. The centre is also looking to learn how to combine research from these areas to answer the pressing education-related questions in Norway today.

SLATE currently has funding for 5 years from the Norwegian Ministry of Education and Research with the possibility of a 5-year extension pending an evaluation after the first 4.5 years.¹⁰⁵ Hence, it is vital for SLATE to deliver results in line with its mandate. The success of SLATE in the coming years will drive future sustainability, both in terms of acquiring further funding from the Ministry as well as continued UiB support, particularly beyond the initial 10 years.

5.1.6 Interviewees

Professor Barbara Wasson, Centre Director

Ms Jorunn Viken, Centre Manager

Professor Jarle Eid, Department of Psychosocial Science, Former Dean of the Faculty of Psychology,
University of Bergen

Dr Ingunn Ness, Postdoctoral fellow and Cluster leader, SLATE

Researcher Cecilie Hansen, Uni Research Health

Professor Weiqin Chen, Department of Computer Science, Oslo Metropolitan University and Cluster co-leader at SLATE

¹⁰⁵ Interview

5.2 Norwegian Institute of Bioeconomy Research

5.2.1 The institution

The Norwegian Institute of Bioeconomy Research (NIBIO) is a project-driven specialist research institute striving to collect knowledge on how to withdraw value from nature while still taking care of the environment and climate.¹⁰⁶ NIBIO is owned by the Ministry of Agriculture and Food, and is an administrative agency with special authorisation and its own supervisory board. The institute was established in July 2015 following a merger of the Norwegian Institute for Agricultural and Environmental Research (Bioforsk) and the Norwegian Agricultural Economics Research Institute (NILF) with the Norwegian Forest and Landscape Institute (NIBIO). The enlarged NIBIO is now one of the largest government-funded research institutes in Norway, and its organisation and disciplinary mix have changed. The institution employs about 700 people in different parts of Norway.¹⁰⁶

Employees are split into five scientific divisions and one institute management division. The five scientific divisions are

- Division of food production and society
- Division of forestry and forest resources
- Division of biotechnology and plant health
- Division of environment and natural resources
- Division of survey and statistics

NIBIO has an international portfolio with collaborative programmes in many parts of the world. RCN and EU/EEA projects constitute a large amount of NIBIO's research activity. NIBIO also coordinates several large international projects focusing on food security and climate change and participates in research projects in Asia, Africa and Latin America.¹⁰⁶

In 2017, NIBIO's total funding was NOK700m.¹⁰⁷ The Ministry of Agriculture and Food and RCN funding amounted to NOK320m and contract assignments to around NOK80m. Approximately NOK300m was granted in project funding from both national and international sources.

5.2.2 Model for organising IDR

Research at NIBIO is organised into seven subject areas: Forest, Soil, Food, Plant health, Landscape, Environment and Agricultural Economics.¹⁰⁶ The disciplinary mix includes botany, food science, agricultural science, environmental science and economics.

With the exception of contract assignments, IDR is a component in all projects carried out by the institute. Contract assignments are not considered research by the institute, even though they might contain elements of research. Both internal as well as the external cross-division projects involve IDR. In fact, most new external calls for funding, national and international, have explicit requirements for IDR.¹⁰⁸ The majority of IDR is undertaken in thematic centres, which are discussed in more detail in the next section.

In 2017, the total investment in IDR was reportedly NOK300m¹⁰⁷, where

- 10% came from international activities (mostly EU/EEA) – 51 projects
- 10% from Strategic Institute Initiatives – 17 projects
- 40% from RCN (BIONÆR, BIOTEK, etc.) – 100 projects

¹⁰⁶ <https://www.nibio.no/>

¹⁰⁷ Information provided by the institute

¹⁰⁸ Interview

- 40% from other sources (mostly Norwegian universities, public agencies and national research funds) – 274 projects

5.2.3 Interventions to stimulate and grow IDR, their implementation and results

The very nature of the complex real-world problems addressed by the institute calls for an interdisciplinary approach.¹⁰⁹ As already mentioned, most of the projects, with the exception of the contract assignments, are seen to be IDR or contain elements of interdisciplinarity. Thus, excluding some administrative staff (i.e. accounts, HR and estate), all NIBIO employees are involved in IDR.

The institute has adopted a variety of approaches to encourage IDR. Firstly, NIBIO organises a range of conferences to enhance cross-sectoral cooperation among NIBIO employees as well as to network with important actors, cooperation partners and stakeholders. For example, the ‘NIBIO conference’ – a major trade conference on agriculture and food production – acts as a central meeting place for professionals in business, government management, politics, counselling and research.

Secondly, Strategic Institute Initiatives have been established to provide seed funding and support. These are internal projects with the aim of enhancing research networks across subject areas and departments. These projects are typically funded for 5 years. In 2017, there were 17 such projects, with a total spending of NOK33m. Core funding from RCN is allocated to these projects.

Thirdly, centres have been established around different thematic areas. Most of the IDR occurs in these centres, which are the

- Centre for Precision Agriculture – Established in Aug 2016, it is funded from RCN core funding. It received NOK4m for the period 2016/2017¹¹⁰
- NIBIO International Department (NID) – This unit was created in 2016 and coordinates activities in Africa, Latin America, the Caribbean, South and South-East Asia. More specifically, NID undertakes strategic development and coordination, marketing and profiling, relations and networking, project acquisition and reporting, and representation in relation to international markets excluding the EU and USA. NID will monitor Norwegian foreign policy concerning development support, climate and environment, and the work of various national and international organisations such as the Norwegian Agency for Development Cooperation (NORAD), Food and Agriculture Organization of the United Nations (FAO), CGIAR (a global research partnership for food security) and the World Bank as well as other public and private businesses. NID is funded from RCN core funding and has received NOK6.1m so far¹¹¹
- The Norwegian Genetic Resource Centre – This is a unit at NIBIO established and funded by the Ministry of Agriculture and Food. The centre coordinates competence and activities in the conservation and use of national genetic resources and has the task of monitoring and contributing to the efficient management of genetic resources in livestock, crops and forest trees in Norway. It also acts as an advisory body to the Ministry of Agriculture and Food and follows up its work in Nordic and international bodies. Since July 2015, it has received NOK6.3m¹¹²
- NIBIO Climate Forum – The forum coordinates NIBIO’s climate-related work, both internally and externally. In 2017, it received NOK2.5m from RCN core funding¹¹³

There is no explicit reward system for interdisciplinary work, but it is encouraged and receives positive feedback from the institute. However, interviews with employees suggest that the responsibility for pursuing these joint efforts lies with individual researchers.

¹⁰⁹ Interview

¹¹⁰ <https://nibio.no/om-nibio/senter-for-presisjonsjordbruk?locationfilter=true>

¹¹¹ <https://www.nibio.no/en/about-eng/nibio-international-department?locationfilter=true>

¹¹² www.nibio.no/om-nibio/vare-fagdivisjoner/divisjon-for-kart-og-statistikk/norsk-genressurscenter?locationfilter=true

¹¹³ NIBIO Annual report 2016

NIBIO is an independent research institute, but it follows political priorities in the sense that requirements of both national and international funding organisations will impact priorities, for example, bioeconomy versus fossil fuels, food security, clean water or ‘more crop per drop’. Demands for IDR from national research funders might be due to the Norwegian government’s research policy for 2015–2024. The policy is a long-term plan for research and higher education based on a sectoral principle, meaning that ministries are responsible for the development and utilisation of research within their areas of responsibility. As a result, good coordination is necessary to promote effective use of resources and ensure that the research serves society optimally, through adequate focus on the major cross-sectoral research areas.¹¹⁴ The RCN has implemented the policy by introducing thematic research priorities which has created incentives for collaboration across traditional disciplinary boundaries.¹¹⁵

Related to funding is the issue of evaluating funding applications for IDR. The individuals interviewed for this case study stressed that the evaluation of applications for interdisciplinary projects requires good cross-sectoral knowledge and that the quality of NIBIO’s IDR cannot reach its full potential unless extra attention is given to the interdisciplinary elements of research proposals during the evaluation process.

5.2.4 *Lessons learned and ‘what works’*

At NIBIO, IDR seems to occur organically due to the interdisciplinary nature of the areas in focus such as food security and safety, sustainable resource management, innovation and value creation through research, and knowledge production within food, forestry, and other bio-based industries¹¹⁶. However, there are still elements that require more ‘maturing’ with respect to the recent merger. Even though the institute is a unified unit, the previous separate divisions are to a certain degree still operating as individual organisations. The variations in research cultures is somewhat of a barrier to conducting IDR.

NIBIO’s approach to fostering IDR is to have research projects that are fundamentally interdisciplinary or at least include elements of IDR. According to interviews, this will in some cases require different kinds of approaches as to when, where and how projects should be interdisciplinary.

NIBIO has wide-ranging competencies covering several different areas and disciplines. In addition, researchers and research groups can call on other competencies through many external networks that they have developed previously and which make cooperation smooth. Thus, not all the required competencies need to be maintained in-house.

The degree of interdisciplinarity in a project will depend on how different competencies are considered. Applying for project funding and putting together a team of researchers with various backgrounds requires a structure that ensures that the members of the project do not go in different directions. This is an exercise that NIBIO tries to implement daily. The intention is to utilise competencies more widely and thus achieve a more integrated approach.

While there could potentially be some tension between the technical and the social science parts of the institute, this has not been a large problem in reality. This is because the topic of study and research problem at hand determines the composition of the research team. ‘Acknowledging’ the research questions is of key importance – it is the research questions and the problems to be solved that should be in focus. As a result, a culture where others’ disciplinary competences are valued and drawn on follows, and different disciplines and competences support the research and problem solving. At NIBIO, this approach has worked well to establish such a work culture.

It was also noted that it requires some time to make people collaborate. To actively force people to collaborate is risky, but a slight push may still be needed. It is a matter of finding a delicate balance. One way of doing this is to adjust the institute and its work routines and infrastructure, so that it generally supports IDR. Facilitating face-to-face meetings is also important. NIBIO has had positive experiences from organising internal seminars within the divisions where staff members can present their projects.

¹¹⁴<https://www.regjeringen.no/en/topics/research/innsiktsartikler/langtidsplan-for-forskning-og-hogare-utdanning/langtidsplanen-i-politikken/id2353327/>

¹¹⁵ <http://www.forskingsradet.no/>

¹¹⁶ <https://www.nibio.no/>

This has meant that the staff has a better overview of other staff members' projects, which in turn has stimulated IDR. The meetings have also proven very valuable for building a culture of IDR.

5.2.5 Future strategy for IDR

In addition to overcoming barriers between sectors, divisions or disciplines, NIBIO has some organisational challenges due to the merger of the three previously individual institutes. Naturally, each previous institute had developed internal organisations, structures and ways of working. In order to strengthen the IDR activities within the NIBIO, focus will be put on unifying the organisational structure of the institute in 2018.

Currently, NIBIO does not have a published strategy for future IDR activities. However, considering the embeddedness of IDR at the institute, the future strategy might simply be to continue encouraging researchers at the institute to collaborate.¹¹⁷ Given the orientation of the institute, the collaborations will be interdisciplinary in nature.

5.2.6 Interviewees

Per Stålnacke, Director of Research

Bjørn Langerud, Senior Scientific Adviser

Atle Wehn Hegnes, Research Scientist, Economics and Society

¹¹⁷ Interview

5.3 Centre for Scalable Data Access in the Oil and Gas Domain, University of Oslo

5.3.1 The Institution

The Centre for Scalable Data Access in the Oil and Gas Domain (SIRIUS) at the University of Oslo was launched in November 2015 and became operational during the summer of 2016. The centre received funding from the RCN as part of the Centres for Research-based Innovation (SFI)¹¹⁸ scheme. The scheme represents a key strategic instrument in fostering innovation through cooperation between industry and academia in the framework of long-term research collaboration. It provides funding for five plus three years for research activities in strategically important areas for the country. The centre received NOK 96million funding for the 2015-2023 time period from the RCN, which is complemented by contribution from industrial partners and the University of Oslo.

The consortium for the SIRIUS Centre was established based on an existing partnership that formed the basis of a Seventh Framework Programme project entitled Optique, Scalable End-user Access to Big Data.¹¹⁹ The consortium partners are

- Academic and research partners: University of Oslo, Norwegian University of Science and Technology (NTNU), the University of Oxford and Simula Research Laboratories
- Operators: Statoil
- Service companies: Schlumberger and DNV-GL
- IT companies: Computas, Evry, fluid Operations AG, Dolphin Interconnect Solutions, IBM, Kadme, Numascale, SAP (from 2018) and OSISOft

The centre is hosted by the University of Oslo, and is physically located in the Oslo Science Park in the Informatics Building of the University. SIRIUS is the only SFI centre coordinated by the University of Oslo, although the University participates in other SFI centres as well.¹²⁰

The main objective of SIRIUS is to carry out IDR and provide the oil and gas industry with innovative solutions to process and use the significant amount of data generated. The stated high-level objectives of the centre are to¹²¹

- Accelerate the innovation process for data access in the Oil & Gas domain
- Transfer knowledge and expertise via feedback loop in the innovation cycle
- Transform end-user work-practices
- Deliver scalable information systems for accessing disparate data sources
- Deliver scalable, efficient and robust computational environment
- Reinforce mutual understanding and shared vision
- Establish SIRIUS as an internationally recognised Centre of Excellence

5.3.2 Model for organising IDR

SIRIUS is much more than an IDR team at the University of Oslo. It combines the expertise of 15 partners including national and international academic and research institutions and benefits from the contribution of leading industrial partners from the oil and gas industry. Hence, it operates as an intellectual hub with a 'virtual network' where not all projects are delivered from the centre in Oslo.

The activities of the centre are organised around six work packages and seven strands of activities (see below), led by different consortium partners. The activities of SIRIUS are managed and coordinated by

¹¹⁸ Further information at: https://www.forskningradet.no/prognett-sfi/About_the_SFI_scheme/1224067021174

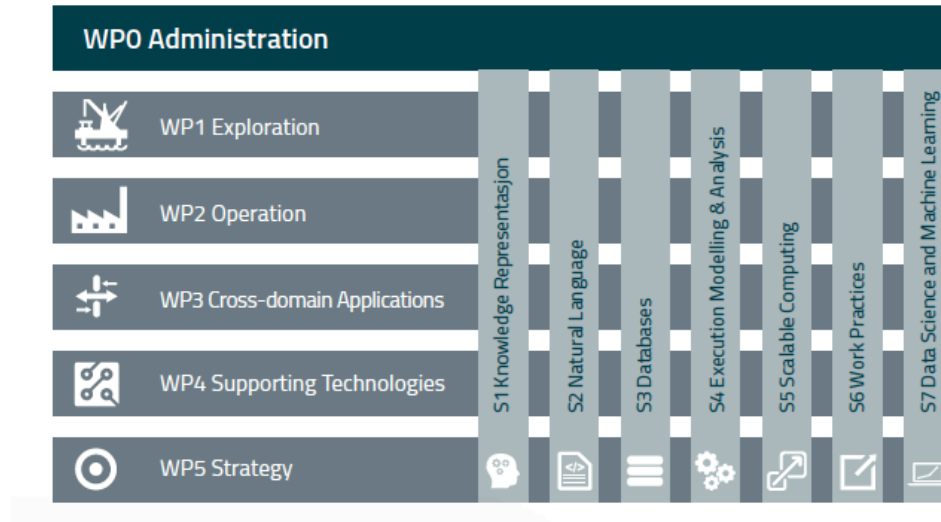
¹¹⁹ <http://optique-project.eu>

¹²⁰ <http://www.uio.no/english/research/centres-for-research-based-innovation/>

¹²¹ Source: SIRIUS, 2015 Annual report

a core team located in the centre. The centre is governed by a Strategy Board, has a General Assembly as main decision-making body, and an Executive Committee, which meets on a monthly basis.

Figure 1 Work packages and main strands of activities



Source: SIRIUS, 2016 Annual report

IDR at the centre potentially also benefits from the University of Oslo’s commitment to fostering research, innovation and interdisciplinarity as the many research centres or the new position of vice-dean for innovation and external relations at the Faculty of Mathematical and Natural Sciences showcase.

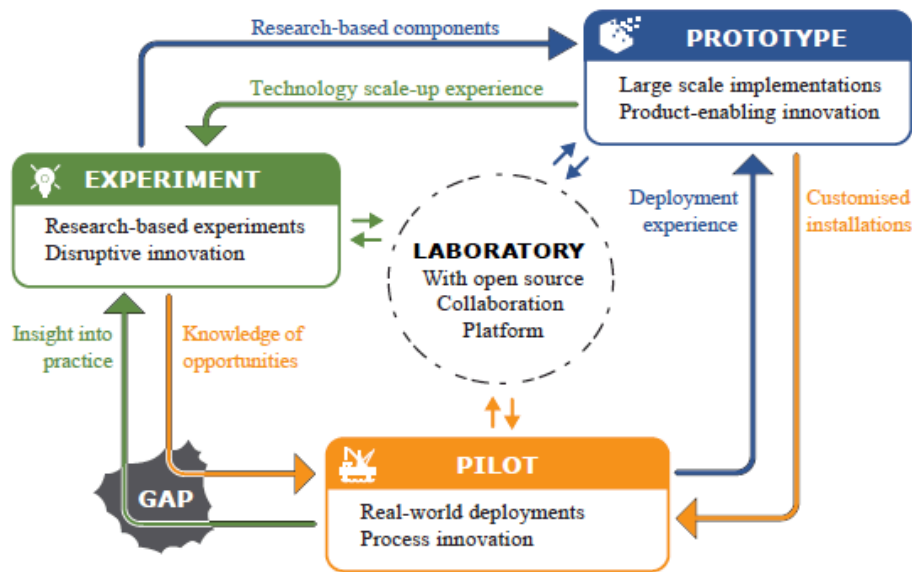
5.3.3 Interventions to stimulate and grow IDR, their implementation and results

Currently the centre’s research is predominantly focused on basic research (80%) with applied research accounting for about 20% of the activities. Over time, however, as the centre matures, the intention is to shift towards more applied research and have a balance of 60:40 of basic vs applied research.

The project portfolios in each SIRIUS work package are designed to combine cutting-edge research with real-world deployment to meet real business problems.¹²² This requires an iterative feedback loop (see Figure 2) between pilots, prototypes and experiments to identify new challenges and gaps in existing solutions that could be filled by targeted research and development.

¹²² SIRIUS Centre, 2016 Annual report

Figure 2 SIRIUS innovation cycle



Source: SIRIUS 2015 annual report

The biggest challenge for the centre is ensuring that the different sectors, timescales and interest of the consortium partners can be aligned under a shared vision, resulting in useful outputs and results. The centre needs to deliver useful results for the industrial partners, while maintaining academic standards. Inter-sectoral mobility is not common in Norway, therefore there are relatively few academics who also have significant industrial experience. Notably, individuals are driving the centre forward, acting as champions in establishing and further developing industrial relations and making the centre work.

The challenge of harmonising the needs and requirements of the partners is not only manifested in the need for balancing the consortium, but in the success criteria and key performance indicators set by the centre. These, listed annually in the centre’s reporting with the targets, feature both publications, awards and conference presentations to showcase the quality of basic research as well as real solutions and pilots developed for the use of the industrial partners.

Managing the generated intellectual property rights is an important aspect of such a consortium. As a basic rule, the results of the laboratory work are regarded as laboratory results (each partner has ownership of their generated results), and as they are funded from the RCN grant, are released as open source licences.

The centre runs formal recruiting processes for any positions available. The positions are appealing, as the ability to attract external funding is often an important recruitment criterion for permanent positions among academics, and the centre with the strong industrial contribution and investment provides a valuable track record for people. Expansion of current staffing figures is mainly limited by the funding available. To engage more academics, the centre needs to attract additional external funding.

The centre is also engaged in different educational activities. A challenge for the centre remains to engage more master’s students in their work. Funds are available to send students for three-month internships to Brazil, but the selection of the students has not taken place yet.

In 2016, SIRIUS selected a supplier for mentoring services through an open tendering process. The main objective was to help train mentors in the partner companies engaged in the centre’s activities as the centre runs a programme for post-doctoral researchers and PhD students, which requires a 9-12 month mentoring period that is delivered by the industrial partners. The idea of the mentoring scheme was regarded very positively by the partners, and even senior management engaged in the mentoring

activities. Student feedback has also been positive. During 2017-2018, ten mentor and mentee pairs were created.¹²³

The centre has plans to expand its operations and apply for additional funding both from national and international sources. It already has a significant international network outside the consortium, which provides the opportunity to engage in research and mobility activities for student and staff. SIRIUS actively seeks funding opportunities to provide IT PhD students with opportunities to engage in a variety of research activities from various subject fields and thereby increase the interdisciplinary applications of the core research activities.

The strategy of the centre was approved by the RCN, as part of the application for the SFI grant, as well as by the University of Oslo and the consortium partners. Need for any revisions, changes in the centre's strategy and priority setting is discussed regularly to ensure that the Centre's activities are aligned with the needs of the partners, there is shared understanding and SIRIUS works towards mutually beneficial goals and objectives.

5.3.4 *Lessons learned and 'what works'*

The former successful collaboration as part of the Framework Programme project, Optique (Scalable End-user Access to Big Data),¹²⁴ its structure and its industrial advisory board created a well-founded basis for the creation of SIRIUS and enabled the Centre to overcome the usual hurdles that accompany the establishment of such large consortia. The achievements and work carried out as part of the Framework Programme project also provided the team at the University of Oslo with the necessary track and visibility internally to gain the commitment and support of the University's management for submitting the application to the Research Council of Norway for the SFI grant. The grant required a long-term commitment from the University of Oslo, and the core team behind the SFI proposal managed to secure a start-up grant from the university.

A key strength of SIRIUS is the large industrial network engaged. The companies involved in the centre's work need solutions for real problems, which require interdisciplinary approaches combining data sciences, semantic technologies and language processing. The unique selling point of the centre's work is, that it is addressing an existing gap, which needs an interdisciplinary approach to provide solutions to real industrial problems.

Although the centre has been operational for less than two years at the time of writing this case study, some institution level effects in terms of increased interdisciplinarity of the work can already be observed. Statoil traditionally works with the Department of Geosciences at the University of Oslo, as a major employer of geologists and physicists educated at the University. Owing to the engagement of Statoil in SIRIUS, and as the company made positions available in the centre, SIRIUS reached out and recruited a researcher in the Geosciences Department to engage in their work. The combination and engagement of the researcher in SIRIUS provides the Centre with access to the departmental knowledge and adds further value to their research. Whether to further expand the centre's activities in this direction or in combination with any other science fields has to be based on joint and strategic decisions.

Communication, establishing a common vocabulary and language, play a crucial role in creating and maintaining efficient working relationships in the consortium. Having a centre coordinator who has both an academic and industrial background and an innovation professional profile plays an important role in the successful management of the task.

As an SFI centre, SIRIUS will undergo a mid-term review, which is due late 2019. The mid-term review will explore its progress to date and highlight recommendations and areas for improvements.

¹²³ SIRIUS Centre, 2016 Annual report

¹²⁴ <http://optique-project.eu>

5.3.5 *Future strategy for IDR*

Due to the basic research-focused profile of the centre and the diversity of industrial partners engaged, there are some question marks regarding the future of the centre without continuation of the SFI funding. It is expected that instead of the current format, the centre will operate on the basis of bilateral relationships with individual businesses to conduct use-case driven research.

An important aspect of the centre's work is that the research results can also be used and adapted to other subject fields. There are plans to expand the activities and possible use of data processing technologies and explore solutions for the health sector and for public administrations as well.

Ultimately, the SFI grant provides the opportunity for the centre to build up its own culture, working methods and identity, and if successful, apply for another funding round. There are many centres of excellence in the country and even at the university, however there are fewer SFI-funded centres and SIRIUS has to respond to the challenge of showcasing the value behind the model by creating a strong profile and brand.

5.3.6 *Interviewees*

- Dr David Cameron, SIRIUS Centre Coordinator
- Prof. Arild Waaler, SIRIUS Centre Director, Department of Informatics, University of Oslo

5.4 The Arctic University of Norway

5.4.1 The institution

The Arctic University of Norway (UiT) was established in 1968. It is the fourth largest university in Norway and the northernmost university in the world (located some 370 km north of the Arctic Circle). Since the start, UiT has been through three mergers: in 2009 with the University College of Tromsø, in 2013 with the University College of Finnmark and in 2016 with both the University College of Harstad and the University College of Narvik. The main campuses are in Tromsø, Alta, Narvik and Harstad, with smaller units in the towns of Bardufoss, Bodø, Hammerfest, Kirkenes, Longyearbyen (Svalbard) and Mo i Rana.¹²⁵

The university is organised in seven faculties and a university museum, covering all classical subject areas from Health Sciences, Social Sciences, Education and Humanities, Science and Technology to Economics, Law, Social Work, Tourism, Sports and Fine Arts. The university's key research focuses on the polar environment, climate research, indigenous peoples, peace and conflict transformation, telemedicine, medical biology, space physics, fishery science, marine bioprospecting, linguistics and computational chemistry. The university has more than 3,400 employees, 700 PhD students and 16,000 students (as of 31st December 2016). More than 20% of the academic staff and 10% of the student body are from abroad. The turnover is NOK 3,441m. Two researchers from UiT have received a European Research Council Starting Grant, one has received a European Research Council Advanced Grant and two have received an ERC Proof of Concept Grant.¹²⁶

UiT is a founding member of the University of the Arctic, an international network of 160 study and research institutions of the circumpolar region. Furthermore, UiT has over 200 international agreements to secure an active exchange of students and staff with partner institutions worldwide. Four of UiT's centres have been designated Norwegian Centres of Excellence: CASTL (Centre for Advanced Studies in Theoretical Linguistics), CTCC (Centre for Theoretical and Computational Chemistry), CAGE (Centre for Arctic Gas Hydrate, Environment and Climate) and the Hylleraas Centre for Quantum Molecular Sciences. The university is also a part of the FRAM, the High North Research Centre for Climate and the Environment in Tromsø.¹²⁶

5.4.2 Model for organising IDR

The model for organising IDR at UiT could be viewed as a combination of top-down and bottom-up approaches and a main driver for the institutional support for IDR is to address global and societal challenges.¹²⁷

In 2013, UiT presented a strategy for the period 2014–2020, identifying five key research areas, many of which are interdisciplinary.¹²⁸

- Technology
- Energy, climate, society and environment
- Sustainable use of resources
- Community development and democratisation
- Health, welfare and quality of life

IDR structures also emerge from a bottom-up process driven by the faculties. One example is the Arctic Centre for Sustainable Energy (ARC) which was established in 2017, following an initiative from the faculty level.¹²⁹ This is an interdisciplinary centre focusing on Arctic challenges and conditions within

¹²⁵ https://en.uit.no/om/art?p_document_id=343547&dim=179040

¹²⁶ https://en.uit.no/om/art?p_document_id=343547&dim=179040 and information provided by the university

¹²⁷ Interview

¹²⁸ https://en.uit.no/om/art?p_document_id=377752&dim=179033

¹²⁹ https://en.uit.no/forskning/forskningsgrupper/gruppe?p_document_id=453700

renewable energy and greenhouse gas management. Four faculties are involved in the work at this centre. The centre combines expertise in physics, humanities, chemistry, social sciences, applied mathematics, marine biology, computer science, and electrical engineering. The initiative is expected to strengthen existing research activities at UiT within the scope of the centre. The centre is financed with NOK110m from UiT.¹²⁹ A similar large-scale bottom-up IDR-initiative on population studies in the north has also been initiated recently, and UiT will use NOK100m on this over a four-year period.

There are also a couple of research infrastructures in place that are of relevance to IDR.

- The Norwegian Historical Data Centre (NHDC) is a national institution under the Faculty of Social Science. The aim is to computerise the Norwegian censuses from 1865 onwards together with the parish registers and other sources from the 18th and 19th centuries¹³⁰
- The Tromsø Study¹³¹ was initiated in 1974 to help combat high mortality due to cardiovascular diseases in Norway. The primary aim of the Tromsø Study was to determine the reasons for the high mortality and to develop ways of preventing heart attacks and strokes. The study was gradually expanded to include many other diseases such as rheumatism, neurological and mental diseases, skin diseases, stomach and bowel-related diseases, cancer and osteoporosis. The health study has been repeated at regular intervals and involves a large proportion of the municipality's population. In all, a total of 40,051 different people have participated in at least one of the six studies. The studies have been carried out by the Department of Community Medicine (ISM) in collaboration with the Norwegian Institute of Public Health, the University Hospital of Northern Norway (UNN) and Tromsø City Council. Data from the Tromsø Study is included in several international collaborative projects and also forms part of a larger Norwegian collaborative study

These infrastructures form a basis for IDR, at least in part, besides the five thematic areas. The infrastructures as such should be regarded as top-down in character, but research that uses them can naturally originate bottom-up.

5.4.3 Interventions to stimulate and grow IDR, their implementation and results

In parallel with the identification and selection of the five thematic areas, an internal process for stimulating and funding IDR projects was established. Since 2015, annual calls for IDR projects with a yearly budget of NOK45m have been announced. The project ideas are identified by the faculties in a bottom-up process. To be considered for funding, applicants need to include at least three faculties in the project, and the applications are assessed by a panel of five international experts. Currently, the five experts come from Finland, Canada, Germany, and Sweden (two experts).

Apart from initiatives like the ARC, the process of stimulating and developing IDR is primarily project-oriented. Over time, the process for internal funding has been established and is perceived to be well known among the faculties and researchers. So far, the results from the funded initiatives have been presented on a few occasions; however, the model for internal funding of IDR projects will be evaluated during 2018.¹³²

Most of the applications are from the health sciences and technology fields, while the humanities and social sciences are slightly underrepresented. The funding has primarily been allocated to well-established research environments at UiT. The number of applications has been stable so far, with 12, 14 and 14 applications in 2015, 2016, 2017 respectively.¹³³ The 10 projects that have been funded so far as shown in the table below.

¹³⁰ www.rhd.uit.no/indexeng.html

¹³¹ https://en.uit.no/om/enhet/artikkel?p_document_id=80172&p_dimension_id=88111

¹³² Interview

¹³³ Information provided by the university

Table 2 Interdisciplinary projects funded by the Arctic University of Norway (UiT) since 2015

Year	Project title	Faculties involved
2015	From unexploited marine biomass to high value products	<ul style="list-style-type: none"> - Faculty of Biosciences, Fisheries and Economics - Faculty of Science and Technology - Faculty of Health Sciences - Faculty of Humanities, Social Sciences and Education
2015	Centre for Advanced Nanoscopy to Decode Sub-cellular Biological Systems	<ul style="list-style-type: none"> - Faculty of Health Sciences - Faculty of Science and Technology - Faculty of Biosciences, Fisheries and Economics
2015	Arctic Ocean Technology and Law of the Sea Research	<ul style="list-style-type: none"> - Faculty of Science and Technology - Faculty of Biosciences, Fisheries and Economics - Faculty of Law
2015	Personalized medicine for public health	<ul style="list-style-type: none"> - Faculty of Health Sciences - Faculty of Science and Technology - Faculty of Engineering Science and Technology
2016	Biofilm-inhibitors and eradicators from unexploited marine	<ul style="list-style-type: none"> - Faculty of Biosciences, Fisheries and Economics - Faculty of Science and Technology - Faculty of Health Sciences
2016	COAT Tools Methodological advancement of Climate-ecological Observatory for Arctic Tundra	<ul style="list-style-type: none"> - Faculty of Health Sciences - Faculty of Science and Technology - Faculty of Biosciences, Fisheries and Economics
2016	AntiBioSpec – Discovery and design of new antibiotics	<ul style="list-style-type: none"> - Faculty of Biosciences, Fisheries and Economics - Faculty of Science and Technology - Faculty of Health Sciences
2017	Transforming CO ₂ to capital by interdisciplinary CCU optimization strategies	<ul style="list-style-type: none"> - Faculty of Biosciences, Fisheries and Economics - Faculty of Humanities, Social Sciences and Education - Faculty of Science and Technology
2017	Data-Driven Health Technology	<ul style="list-style-type: none"> - Faculty of Science and Technology - Faculty of Law - Faculty of Health Sciences
2017	Lead-to-drug development of amphipathic scaffolds targeting multi-resistant bacteria	<ul style="list-style-type: none"> - Faculty of Health Sciences - Faculty of Science and Technology - Faculty of Biosciences, Fisheries and Economics

Source: UiT

As shown above, the Faculty of Science and Technology, Faculty of Biosciences, Fisheries and Economics and Faculty of Health Sciences dominate participation in the projects funded. In contrast, there is occasional participation from the Faculty of Law, Faculty of Engineering Science and Technology and Faculty of Humanities, Social Sciences and Education. The Faculty of Fine Arts has not participated in any of the projects so far.

UiT provides support both at the institutional and faculty level to help researchers write applications for external funding. Researchers can also apply for financial support from a support programme called PES (Project Establishment Support),¹³⁴ which is one of several funding instruments run by RCN to strengthen Norwegian participation in Horizon 2020 and improve the project funding return rate.

5.4.4 *Lessons learned and ‘what works’*

The thematic initiatives (five priority areas) have created an awareness of the possibilities of building collaborations. This might also have stimulated the larger IDR initiatives (i.e. centres) that have emerged bottom-up. The process is perceived to be well anchored within the management and the entire organisation. The bottom-up perspective creates motivation, and is an important prerequisite. However, the university’s priority thematic areas can be regarded as a top-down mechanism. While researchers formulate the research ideas and suggest collaboration partners, they also adapt to the requirements and orientation of funding sources and calls. Thus, a balance between bottom-up and top-down approaches is crucial, and probably unavoidable. At UiT, this balance has worked well.

There have still been some challenges. One observation was that very few applications had come from the humanities and social sciences. Apparently, researchers from these fields were either less interested in applying for the interdisciplinary calls or they had more problems in formulating projects that involved three faculties.

Another challenge relates to the location of the funded IDR projects. Often the researchers involved continue to sit in their home departments. The project has thus no physical space of its own. This circumstance was perceived as a barrier towards more intense interaction within the project team.

The largest challenge is possibly that faculty administration is not well designed for facilitating research collaborations and sharing funding across faculties. The researchers who were funded experienced problems and frustration because of lack of routines to handle IDR within the faculty administration.

A final lesson learned was that early career researchers are more likely to engage in IDR than senior researchers. Although developing and nurturing IDR is demanding, for example a PhD candidate may need two supervisors from different faculties, funding for early career researchers to conduct IDR projects carries a great potential for ground-breaking research results.

The internal calls for IDR projects with at least three faculties involved has clearly worked as an instrument for supporting IDR. The level of funding has been sufficient and the funded projects have been innovative and are characterised by concrete and intensive collaboration between researchers from the participating faculties. The fact that the applications are evaluated by an international and thus external evaluation panel has been another success factor. With an internal evaluation panel, there is always a risk that panel members wish to promote their favourite fields or favourite candidates, and pay less attention to the novelty of the proposed research.

5.4.5 *Future strategy for IDR*

UiT intends to continue to support and develop research in the five identified thematic areas, which are largely interdisciplinary in nature. The Strategic Plan for 2014–2020 reveals some of motives for selecting the five priority areas.¹³⁵ Understanding what happens in the Arctic is key to understanding global climate change, and in a region characterised by long distances and a challenging climate, new technological solutions are needed to deliver welfare to the people living there. Attractive communities in the north depend on good schools, health services and other services that promote people’s quality of life. Moreover, societal development and democratisation rely on inclusion of the entire population through education, work, involvement and a feeling of belonging. And finally, economic growth in the north is based on the continued use of natural resources. All these issues are interdisciplinary in nature and researchers will need to draw on a variety of knowledge bases and stakeholders to address them.

¹³⁴ <https://www.forskningssradet.no/en/Funding/PES2020/1253991614799>

¹³⁵ https://en.uit.no/om/art?p_document_id=377752&dim=179033

5.4.6 Interview respondents

Balpreet Singh Ahluwalia, Associate Professor

Hans C. Eilertsen, Professor

Kathrin Hopmann, Research Fellow

Peter McCourt, Associate Professor

Kenneth Ruud, Professor, Pro-rector of Research

Øyvind Stokke, Associate Professor

Pål Vegar Storeheier, Research Director

Cristina Øie, Research Fellow

5.5 Department of Interdisciplinary Studies of Culture, Norwegian University of Science and Technology

5.5.1 *The institution*

The Department of Interdisciplinary Studies of Culture (KULT) is a part of the Norwegian University of Science and Technology (NTNU). It is hosted by the Faculty of Humanities. The department was formed in 1999 as a merger between the Centre for Gender Studies and the Centre for Technology and Society. Both centres were established in the late 1980s to undertake interdisciplinary studies.

The research activities of the department are focused on gender, and social and cultural aspects of science and technology. The research topics are diverse, covering a wide range of techno-scientific phenomena and gender and equality issues from a historical as well as contemporary perspective. The main emphasis is on cultural changes as a starting point for asking new questions about fields of study that the research focuses on.¹³⁶ Currently, there are 45 scientific members of staff, of which the majority are doctoral or postdoctoral research fellows.

5.5.2 *Model for organising IDR*

The overall purpose of the department's work is to conduct and teach interdisciplinary studies. The staff of the department as well as the students all have diverse disciplinary starting points, but the department strives towards a collectively oriented research culture, where people actively collaborate in their research. There are internal interdisciplinary research groups as well as project-level collaborations. Several of the projects have broad interdisciplinary collaboration with experts in medicine, science and technology. This extensive collaboration between disciplines means that all staff – students as well as researchers – are engaged in interdisciplinary research. An interdisciplinary approach is part of the department's DNA.

The research is primarily organised around two centres: Centre for Technology and Society and Centre for Gender Studies. The main research areas are energy and sustainability (policy, urban planning, innovation, public engagement and consumption); nature and culture; responsibility in production of knowledge and innovation, biopolitics; ethnicity, gender and equality; sexuality and culture; and welfare technology.¹³⁷ In order to address complex challenges of great importance for society, NTNU has established four strategic research areas for 2014–2023: energy, health, oceans and sustainability.¹³⁸ It is evident that these priority areas correlate with the primary objectives and priorities of the Norwegian Government's policy for strengthening research and education between 2015 and 2024, as presented in the government's long-term plan for research and education. KULT's research areas are seen to be in line with NTNU's overall strategic profile, especially, the area of sustainable energy.¹³⁹ KULT also engages with other interdisciplinary centres, for example CenSES (the Centre for Sustainable Energy Studies) which is a national research centre for environmentally friendly energy located at NTNU, and the Nordic Centre of Excellence for Gender balance in academia.¹⁴⁰

5.5.3 *Interventions to stimulate and grow IDR, their implementation and results*

The department has become more standardised over time and has adapted to the overall organisational and financial systems at NTNU. From the beginning, the department distinguished itself from other parts of the faculty through acquiring a large volume of external funding. KULT has not only been able to benefit from its long experience of applying for external funding but also from its interdisciplinary competences which help to frame grant proposals that are considered relevant by funding agencies.

¹³⁶ <https://www.ntnu.edu/kult/research>

¹³⁷ <https://www.ntnu.no/kult>

¹³⁸ <https://www.ntnu.no/om>

¹³⁹ Interviews

¹⁴⁰ <https://www.ntnu.no/kult/sts>, <http://www.samfunnsforskning.no/core/nordicore/english/>

The department's employees are engaged in several national and international research projects. A large part of this research is funded by RCN or other external funding.¹⁴¹ In January 2018, the department had 24 research projects in progress and 12 of these were funded by RCN. The total external funding was NOK129m of which the Research Council had granted NOK74m from various research programmes.¹⁴² The department had also received research funding of around NOK7m from Horizon 2020 and presently participates in five Horizon 2020 projects.

The research groups are to a large extent initiated and shaped by the on-going projects and are often quite small (only 4–6 researchers). The largest research area in the field of technology and society is sustainable energy. The field of gender research consists of many different sub-areas. Within KULT there is extensive cooperation between the two main research areas and some employees work in both fields. At the same time, several projects are limited to the respective fields. Although there have been some discussions over time regarding which thematic areas and research groups the department should have, there has not been any explicit strategy for how the cooperation between the fields should be further developed. This means that the creation of projects is mainly driven by the researchers from a bottom-up perspective.¹⁴³ In 2017, the Head of Department and Research Leader appointed a group of researchers whose mandate is to discuss and suggest some overarching research strategies.

In the national evaluation of humanities research undertaken in 2016–2017, the Centre for Technology and Society was included as a research area. It got strong reviews, and the overall assessment stated: “Excellent and competitive research at the national and international levels; the CTS group is definitely a leader in user studies and domestication of technology studies”.¹⁴⁴

The department has been running a PhD programme in Interdisciplinary Studies of Culture since 2007, which covers both Science and Technology Studies (STS) and Gender Studies.¹⁴⁵ The programme is aimed at candidates with a background in both social sciences and the humanities as well as in technology and natural sciences. The PhD students at KULT normally have two supervisors, often from different disciplines. At present, there are 17 PhD students in the department. Although many of the PhDs remain in the research community, some work in the public sector. There are also a few examples of PhDs who have gone to work in the business sector.

Besides the PhD programme, the department also offers two master's programmes: Equality and Diversity and Science and Technology Studies. The first master's programme was established in 2004. This was a joint programme between the two centres in the department. In 2011, the programme was divided into two programmes. The applicants are not required to have any specific bachelor's degree and the diverse student population contributes to the interdisciplinary profile of the department. However, the majority of the student population has a background in social sciences or humanities such as sociology, political science, social anthropology and history. To secure a common ground in interdisciplinary methods and theories, the master's students attend joint courses in the beginning of the programme. The students can participate in the work of KULT's research groups and write their master's thesis on on-going research projects. At the bachelor's level, the department offers two one-year study programmes – Equality and Diversity, and Science and Technology Studies – which can constitute part of a bachelor's degree in the Humanities or Social Sciences.¹⁴⁶

All study programmes at the second degree (master's) level at NTNU include a mandatory course called Experts in Teamwork (EiT). In this course, students develop teamwork skills by reflecting on and learning from specific situations involving cooperation in carrying out a project. Students work in

¹⁴¹ <https://www.ntnu.no/kult>

¹⁴² Programmes such as EnergiX, Klimaforsk, Frihumsam, Miljø2015, SAMKUL, Biotek21, ELSA, BYFORSK, FINNUT, and *Kjønnsbalanse i faglige toppstillinger og forskningsledelse* – BALANSE.

¹⁴³ Interviews

¹⁴⁴ Evaluation of the Humanities in Norway. Report from Panel 6 – Philosophy and Studies in Science and Technology, page 31. The Research Council of Norway, 2017

¹⁴⁵ <https://www.ntnu.no/studier/phkult>

¹⁴⁶ <https://www.ntnu.no/kult/studier>

interdisciplinary teams with participants from diverse programmes of study. Interdisciplinary teamwork is used as an opportunity to develop collaborative skills that make teamwork more productive.¹⁴⁷ On behalf of Faculty of Humanities, KULT offers a particular version of this course called “Humanists in Practice”.¹⁴⁸

5.5.4 *Lessons learned and ‘what works’*

One possible success factor for KULT is a tolerant view regarding staff members’ disciplinary identity. For some, keeping and relying on one’s disciplinary identity is important and a way to approach and participate in IDR. One remains a ‘political scientist’ or ‘historian’, and contributes with such a perspective and expertise. For others, a new identity is grown, one that is more interdisciplinary. At KULT, this may mean becoming an STS researcher or a gender studies researcher. Most people actually combine a disciplinary and an interdisciplinary identity (or several). To reach a new identity may take time, and hence, time and patience are also seen as prerequisites to develop an environment with functional IDR. Tolerance and openness, and nurturing of personal relations, were repeatedly emphasised as key success factors.

Combining disciplinary identity with one or more interdisciplinary identities facilitates IDR and strengthens its quality since it helps scholars keep up with a wider set of theoretical and methodological advances. At one level, the staff members interviewed at KULT think that it is easier to cooperate with colleagues who come from disciplines that are farther away from one’s own than those who come from fields that are considered to be closer. According to them, it may be easier to accept and respect opinions from more distant disciplines especially when the ambition is to add research results together than to provide synthesis. There is often an underlying assumption that people from nearer fields will understand each other better and thus be able to synthesise across such fields. However, when differences still appear and synthesis proves to be challenging, there may be tensions. A related lesson learned is that while representatives from neighbouring research fields may think that they have a similar view on research methodology and terminology, in reality they may not. One researcher explained that the team members in one project thought they shared an understanding of the methods and concepts and it was not until the results were to be published that they realised that they had different understandings of them. On the other hand, KULT scholars have increasingly improved their ability to foresee and overcome such problems. Thus, many publications combine disciplinary perspectives, in particular from political science, social anthropology and sociology. This is helped considerably by the fact that KULT scholars are fluent in the interdisciplinary practices and approaches of the relevant areas.

Dissemination of IDR results can be more problematic than research results that have a clearer disciplinary origin. Publishing IDR that combines humanities/social science research with architecture, engineering science, etc. and writing papers that address a sufficiently wide scholarly audience to get them accepted in well-established scientific journals, has proven to be a challenge. However, there are exceptions. Publishing books or book chapters is easier, particularly if they have a wider audience than just academics. Consequently, researchers at KULT usually publish in disciplinary journals or in social science/humanities journals with a thematic orientation, e.g., energy, environment, gender, innovation and science and technology studies, even if the published results are produced in an interdisciplinary project with team members from architecture, engineering science, etc. This is not considered a problem, since interdisciplinary deliverables tend to be aimed at user audiences and scholarly publications aim at more specialised scholarly exchanges. However, it is a problem that the present organisation of the National Science Index (NVI) in Norway systematically favours publications in disciplinary journals and provides strong economic disincentives to interdisciplinary publishing even within social science/humanities areas.

The internal administrative and finance system is a source of friction and hinders IDR. Each faculty and department has its own budget, and involving supervisors or teachers from other units at the university

¹⁴⁷ <https://innsida.ntnu.no/wiki/-/wiki/English/Experts+in+Teamwork>

¹⁴⁸ <https://www.ntnu.no/hip>

means costs. The internal organisation is not built to underpin and support IDR. The creation of KULT as an interdisciplinary department is one solution, but cooperation between KULT and other departments still causes some administrative and financial burden.

The department fosters interdisciplinarity right from the student level. Admission to the master's programmes is independent of the subject of a student's bachelor degree, and a couple of joint mandatory courses at the beginning of the master's programme ensure that the students develop a common understanding. Through this approach, interdisciplinarity is fostered among students from the beginning and interdisciplinary research capacity is built. Some of the students continue to PhD training and some of the PhDs continue to employment positions at the department.

No doubt, the creation of KULT as an IDR department has worked very well. All the research conducted at KULT is IDR. Merging two centres to create the department has not been a problem, and any barriers resulting from this merger have largely been overcome. It is difficult to explicitly state what has been the reason behind the success of the merger. One possible explanation is that researchers from the two centres were allowed to keep doing their research as before, and then, with time, the boundaries loosened up and cooperation emerged naturally. In this way resistance and an 'us and them' culture never started to grow. The fact that research at the department has for a long time been largely externally funded may be another reason, as this has shaped a certain adaptation towards goals and problems set out in the calls for external funding; if an interdisciplinary team needed to be formed in order to get funding, then this was done – and in the end rewarded. Last, it is possible that good management has played an important role as well.

5.5.5 Future strategy for IDR

For KULT, the future strategy for growing IDR is synonymous with the strategy to develop the department. Hence, there is no specific strategy regarding IDR as such, but new research fields are emerging slowly and naturally. One example is research oriented towards integration in society, a natural focus area due to immigration in recent years.

In response to the recommendations of the national evaluation of humanities research (mentioned above), a 'cutting edge strategy group' has been formed with the purpose of strengthening research in the theory development area, which the evaluation identified as important for future strategic development. At the same time, the department wishes to strengthen career development, especially for early career researchers. The department wants career development to be tailored to the individual, avoiding a one-size-fits-all structure.

Another thing that needs to be dealt with is maintenance of Norwegian as a working language at the department. There are many foreign students, PhD candidates and staff members, and keeping Norwegian as a working language is an increasing challenge. As many research topics at the department relate to societal structures and circumstances in Norway, an understanding of at least one Scandinavian language is important to fully understand the topic at hand and the empirical material available. In the STS are at KULT, understanding a Scandinavian language is now required to get a research position.

Strengthened administrative support at the department is another ambition, one that should be possible to realise, as the finances of the department are currently in good shape.

5.5.6 Interviewees

Margrethe Aune, Professor

Håkon Fyhn, Post-doctoral researcher

Guro Korsnes Kristensen, Associate Professor

Knut Holtan Sørensen, Professor

Appendix A Interview questions

About the institution

1. Please describe the institution's main structure and any recent changes in it
2. Can you describe the institution's research resources (incl. staff, disciplinary areas, infrastructure)?
3. What are the institution's main research priorities and the available funding sources to pursue them?
4. How do you ensure the alignment of the institution's research priorities with relevant national and international strategies?
5. What do you regard as key research strengths of the institution?
6. Are there any research areas that need further addressing and improvement?

Models for organising IDR

7. What is the institution's approach to IDR and is it reflected in institutional policies/strategies? If so, how?
 - a. Are IDR activities fostered as top down priorities or do they emerge as bottom-up initiatives?
 - b. How is IDR managed and supported? What is the reason for using this particular model?
 - c. What are the key motivations/incentives for researchers to get engaged in IDR?
8. Which disciplines does your institution's IDR span?
9. What is the role of national and international funding in pursuing IDR?

Interventions, their implementation and results

10. What particular approaches have you used to
 - a. stimulate and grow IDR
 - b. support and sustain IDR, and
 - c. embed IDR in your institution?
11. Did you draw on other examples (national or international) when devising the approaches?
12. Did you encounter any challenges in implementing these approaches and how did you manage them?
13. Did you have to revise your approach during implementation? Why?
14. How successful were your approaches? Was the approach evaluated? When and how was this done?
 - a. What were/are your criteria for success?
 - b. Do you use any indicators/targets?
 - c. Why and how did you decide to use these criteria?
 - d. Were the criteria agreed at the outset and were they considered contentious?

15. Which initiatives do you currently use? Have you made any changes since they were first implemented? Why?
16. Has your institution taken steps with regard to the following in relation to IDR? For what purpose?
 - a. Infrastructure and support structures (and their level of embeddedness in the institution)
 - b. Culture change
 - c. Rewards and career structures
 - d. Training
 - e. Networking/collaborating – Which stakeholders (national and international)?

Lessons learned and ‘what works’

17. What did you learn? Has there been a shift in the institution’s perception and research activities with regards IDR as a result of the approaches?
18. What is the current legacy of these approaches?
19. In your opinion, what consistently works in supporting IDR?
20. Are there approaches that should be avoided in your opinion?
21. What are the key enabling and success factors for the approaches used?
22. What are the common barriers and how can they be overcome?

Future strategy for IDR

23. What are the institution’s future plans in relation to IDR?
24. Do you have any other comments/issues?

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